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Vipac Engineers & Scientists

Australian Agricultural Company Limited

Northern Australian Beef Limited

Livingstone Beef - Odour Audit

70Q-15-0248-TRP-518845-1

16 Dec 2015

Livingstone Beef - Odour Audit **Northern Australian Beef Limited**	
DOCUMENT NO: 70Q-15-0248-TRP-518845-1 **PREPARED FOR:** Australian Agricultural Company Limited Level 1, Tower A Glassworks Plaza 76 Skyring Terrace Newstead, Queensland, 4006, Australia **CONTACT:** Gerard Davis **Tel:** +61 7 3368 4400 **Fax:**	**REPORT CODE:** TRP **PREPARED BY:** Vipac Engineers & Scientists Ltd. Level 2, 146 Leichhardt Street, Spring Hill, QLD 4000, Australia **Tel:** +61 7 3377 0400 **Fax**: +61 7 3377 0499
PREPARED BY: Author:  Michelle Clifton Consulting Scientist	Date: 16 Dec 2015
REVIEWED BY: Reviewer:  Vic Natoli Independent Auditor	Date: 16 Dec 2015
AUTHORISED BY: Gerard Davis General Manager of Innovation and Technology (AACo)	Date: 16 Dec 2015

REVISION HISTORY

Revision No.	Date Issued	Reason/Comments
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EXECUTIVE SUMMARY

An Environmental Protection Licence (EPL131) was issued to Northern Australian Beef Limited (NABL) on 31st October 2014, to allow for 'storing, re-cycling, treating of a listed waste on a commercial or fee for service basis other than in or for the purpose of a sewage treatment facility'. The permit contained 78 conditions, including the preparation of an Environmental Audit every two years.

The Northern Territory Environment Protection Authority (NT EPA) issued its Notice to Carry Out Environmental Audit Program (the Notice) to NABL on 17th August 2015. The Notice was issued on the basis that EPA considered that the Activity is (or was) generating odour that are likely to cause nuisance. The Notice was issued pursuant to s48 of the Act. The scope of this Audit was defined by the requirements of the Notice.

Table E-1-1: Summary of Audit Information

Auditor	Vic Natoli
Name of Person Requesting the Audit	Gerard Davis (AACo)
Date of Request	17th August 2015
Completion date of the Audit	9th December 2015
Reason for Audit	Notice
Description of Activity	Abattoir
Premises Address	Street Address
Project Team	Auditor: Vic Natoli Sampling and Analysis: Chris Clunies-Ross and Ian Brash (Airlabs Environmental) Community Consultation: John Fraser (former QLD EPA Inspector) Odour Modelling: Andrew Balch (Air Environment) Project Coordinator/Document Author: Michelle Clifton (Vipac Engineers & Scientists)
Outcome of Audit	The monitoring and modelling identified the waste water irrigation as the major odour source by a significant margin. This was followed by the cattle holding areas and the water treatment plant. This Audit has identified that the DAF is the only wastewater treatment process at present, with an expected DAF outlet BOD of 800 mg/L based on maximum design production, which is significantly higher than the long-term 20 mg/L licence condition. The high BOD level indicates the waste water is only partially treated, which contributes to the elevated odours from the water treatment plant and the irrigation areas. In relation to current processes and practices, there is a tiered level of inspections, checklists, testing requirements and procedures in place that would identify any issues which may lead to increased odour generation. The level of cleaning at the end of the day is very high. As part of this Audit, the Complaints Handling Procedure has been revised as part of the company's Quality Assurance program of continuous improvement. The approved upgrade of the wastewater treatment plant was modelled in the most recently proposed location. The results show an 87% reduction in the total odour emissions from the Facility.
Further Work or Requirements	An upgrade to the existing wastewater treatment plant is currently going through the approvals process. This upgrade will reduce odour by 87%. A recommendation for an external specialist to provide training and assistance in relation to wastewater testing and responses has been made.

Auditor's Declaration

This document and the associated Odour Management Plan has been reviewed by the Auditor. At the end of some Sections where technical review was required, the Auditor has added their opinion.

The methodologies used in the two documents are sound and the assumptions made are reasonable and consistent with the information available. Implementation of recommended controls will significantly decrease the odours emitted from the Livingstone Beef Plant site and should allow the Plant to meet its regulatory obligations with respect to odour emissions.

ABBREVIATIONS AND GLOSSARY

Abbreviations	Definition
Air Environment	Air Environment Consulting Pty Limited
Airlabs	Airlabs Environmental Pty Ltd
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AQIA	Air Quality Impact Assessment prepared by Air Environment Consulting Pty Limited
BoM	Bureau of Meteorology
CALMET	Meteorological model used in conjunction with CALPUFF
CALPUFF	An advanced non-steady-state meteorological and air quality modelling system
NT EPA	Northern Territory Environment Protection Authority
TAPM	The Air Pollution Model
Technical Framework	Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW

Glossary

Hedonic tone	A judgement of the relative pleasantness or unpleasantness of an odour.
Odour	The property of a substance which affects the sense of smell.
Odour annoyance	The generation of one or more of a wide variety of responses due to the intensity and hedonic tone of an odour. Odour annoyance is generally considered to occur at levels of 5 - 10 times the detection threshold.
Odour character	The property that identifies an odour and differentiates it from another odour of equal intensity. The character of an odour results from the combination and concentration of compounds in a mixture.
Odour complaints	Odour complaints are formal acknowledgments of odour annoyance to a person and usually requires persistent or repeated odour annoyance over a considerable length of time.
Odour concentration	The concentration of the odorous gas relative to the concentration at the threshold of detection.
Odour emission rate	Total rate of emissions from an odour source expressed in units of odour units per unit time (such as OU/s, OU/min and OU/hr). The odour emission rate is analogous to the emission rate of other pollutants (such as sulphur dioxide) that may be expressed in grams per second.
Odour intensity	An assessment of odour strength based on an initial perception. This perception will rapidly diminish with constant exposure.
Odour threshold	For individuals, the odour detection threshold is that concentration of an odorant above which the individual can smell the odorant and below which they cannot. Human odour sensitivity varies over a significant range; therefore the odour threshold is defined as the level at which 50 % of the population can just detect the odour.

Panel	A group of panel members (assessors who are qualified to judge samples of odorous gas, using dynamic olfactometery in accordance with AS 4323.3).
Peak-to-mean ratio	A conversion factor that adjusts mean dispersion model predictions to the peak concentrations perceived by the human nose.
Percentile	The frequency of occurrence, for example the 99^{th} percentile gives the value exceeded by 1% of the measurements or predictions.
Perception	Awareness of the effects of single or multi-sensory stimuli.
Routine operations	Operations that may occur at a facility that are part of the general day to day operations.
Sensitive receptor	A location where people are likely to work or reside; this may include a residential dwelling, school, hospital, office or public recreational area (DEC 2006).
Nose-response-time	Instantaneous response of the human nose which is typically between 0.1 and 1 second.

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1 INTRODUCTION

An Environmental Protection Licence (EPL131) was issued to Northern Australian Beef Limited (NABL) on 31st October 2014, to allow for 'storing, re-cycling, treating of a listed waste on a commercial or fee for service basis other than in or for the purpose of a sewage treatment facility'. The permit contained 78 conditions, including the preparation of an Environmental Audit every two years.

The Northern Territory Environment Protection Authority (NT EPA) issued its Notice to Carry Out Environmental Audit Program (the Notice) to NABL on 17th August 2015. The Notice was issued on the basis that EPA considered that the Activity is (or was) generating odour that are likely to cause nuisance. The Notice was issued pursuant to s48 of the Waste Management and Pollution Control Act (the Act). The scope of this Audit was defined by the requirements of the Notice.

This Environmental Audit Report has been reviewed and approved by Vic Natoli (the Auditor) at the request of Mr Gerard Davis of Australian Agricultural Company (AACo), which operates NABL's Livingstone Beef Processing Facility (the Facility).

In accordance with s68 of the Waste Management and Pollution Control Act (the Act), the Chief Executive Officer of the NT EPA is required to establish and maintain a register of persons qualified to perform environmental audits for the purpose of an environmental audit program. The register consists of all Auditors appointed under New South Wales and Victorian jurisdictions. The Auditor has been appointed under s53S of the Environment Protection Act 1970 by EPA Victoria for over 15 years.

Although not required under the Act, guidelines or Notice, AACo notified the EPA of the Auditor and Project Team's appointment during a meeting on in September 2015.

As permitted under s50 of the Act, the Notice was amended on 9th September 2015 to alter the timeframe for completion of the Audit. The final completion date was amended to 31st October 2015. NT EPA approved the extension of the Audit submission date, which is the same date as the Odour Management Plan submission date and the anniversary date of the EPL 131.

An Odour Sampling Plan (OSP) derived by Airlabs Environmental, Air Environment and the Auditor was submitted to NT EPA on 8th September 2015, which was a requirement of the Notice. Due to unknown aspects of odour measurements at the facility, the OSP became a two-staged process with the first stage approved by NT EPA on 9th September 2015. The second stage OSP, based on site observations was approved by the Auditor on 23rd September 2015 and submitted to NT EPA on the same day.

A second extension for the delivery of both the Audit and the Management Plan on 30th November 2015 was requested in writing on 11th October 2015 and approved by NT EPA on 15th October 2015. The basis for this extension was to allow for a detailed analysis of the odour samples and remodelling odour assessment to replicate the current facility.

During a meeting with the NT EPA on 13th October 2015, the content of the Audit and Management Plan was discussed; it was agreed by both parties that the Management Plan deliverable would be beneficial to NABL if it was a stand-alone document which could be used in conjunction with the plant operational manuals. As such, some of the information requested by the Notice to be included in the Management Plan has been included into the Audit. The Management Plan will be divided into the separate operational areas and provide individual plans for managing odour.

The extended Notice is reproduced in Appendix A.

The Auditor notes that this Audit has been undertaken in accordance with s47 of the Act and is for the purpose of determining whether the relevant beneficial uses are at risk of possible harm or detriment due to pollution resulting from the Activity.

2 AUDIT SCOPE AND METHODOLOGY

This Section outlines the requirements of the Audit and the methodologies adopted by the Project Team. The objectives, scope and methodology for the Audit are provided in Table 2-1.

Table 2-1: Audit Objectives, Scope and Methodology

Scope Item	Description
Activity to be Audited	Operations at the Livingstone beef processing facility located at Lot 4, Hundred of Cavanagh and Section 541 0 Hundred of Strangways otherwise known as 270 Blyth Road and 2660 Stuart Highway in the Northern Territory
Segment to be Audited	The air environment
Elements to be Considered	Odour
Beneficial Uses	Local amenity and enjoyment
Audit Criteria	No odour complaints
Sampling & Analysis Plan	Air Labs Environmental, Northern Australian Beef Ltd – Livingstone Beef Plant Odour Sampling Plan – September 2015
Audit Timeframe	The audit is required by EPA to be completed by 30th November 2015.

For clarity, the requirements of the Audit and Odour Management Plan (OMP) and the locations in this document where the information can be found are provided in Table 2-2. For ease the Table is sorted in order of the requirements of the Audit rather than location in the report.

OMP refers to the Odour Management Plan (Vipac document 70Q-15-0248-518855-1). As discussed in Section 1, the Management Plan deliverable would be more beneficial to NABL if it was a stand-alone document which could be used in conjunction with the plant operational manuals. As such, some of the information requested by the Notice is to be included in the Management Plan has been included in this Audit Report. The Management Plan will be divided into the separate operational areas and provide individual plans for managing odour.

Table 2-2: Audit Requirements and Location in this Document

Audit Scope	Document Location	Auditor's Sign Off
Contain provision for NABL to consult with NTEPA and the qualified person prior to conducting the audit	Email dated 8th Sept 2015 to Roni Opden at NT EPA	VN
Contain provision for NABL to consult with the affected community	Section 8 Appendix J	VN
Audit the effectiveness of odour controls at the premises	Section 6.3	VN
Audit the effectiveness of all cleaning, maintenance and housekeeping practices from all operations at the premises	Section 6.1 and 6.2	VN
Review the licensee's production data that are relevant to the odour audit and complaint records	Section 9	VN
Review the relevant odour sections of the NABL Air Quality Impact Assessment	Section 11	VN
Measure all key odour sources at the premises and collect all emissions data (emissions inventory) including: i) Consideration of weather conditions providing all raw data used in this analysis; ii) consideration of emissions from all processes; iii) a comparison of the results of these measurements against predictions in the NABL Air Quality Impact Assessment dated 26th March 2015	Section 10	VN

Audit Scope	Document Location	Auditor's Sign Off
Determine whether operations at the premises are complying with the requirements of EPL 131 to protect receivers against offensive odour	Section 12	VN
Outline all reasonable and feasible measures that may be required to improve odour control at the premises	Section 13	VN
Recommend and prioritise recommendations for their implementation including dates of implementation	Section 13	VN
A detailed process description, describing activities and odour	Section 5 Appendix B Appendix C	VN
Identification of odour release points including maps and plans	Section 10.6	VN
Identification of sensitive receptors within 7 km radius of the bio-filter	Appendix H	VN
A detailed description of meteorological conditions prevailing at the Facility	Section 7 Appendix G	VN
Installation of a weather station	Section 5.7	VN
Routine Ambient Odour Monitoring Program	OMP	VN
Description of routine odour mitigation on a day-to-day basis	OMP	VN
Routine maintenance of plant processes	OMP	VN
Management of wastewater treatment plant	OMP	VN
A list of actions and responsibilities for the routine cleaning/ maintenance/mitigation	OMP	VN
Identification of risk factors.	OMP	VN
Contingency plans for upsets, maintenance and in the event of exceedances	OMP	VN
A description of additional measures that will be applied during these periods to deal with the risks	OMP	VN
A list of actions and responsibilities for the abnormal conditions	OMP	VN
A description of what would trigger further actions	OMP	VN
Odour complaints monitoring	OMP	VN
A description of roles and responsibilities of staff	OMP	VN
Details of how the OMP will be implemented, maintained and reviewed	OMP	VN
Details of how odour incidents will be address	OMP	VN
Details of checks, planned maintenance and record keeping	OMP	VN
Details of communicating with local community and local authorities	OMP	VN
Verification of operational and compliance performance	OMP	VN
Standard operating procedures	OMP	VN
Submission of Odour Impact Assessment	Appendix G	VN
An annual odour audit requirement	Section 14.5	VN

2.1 DOCUMENTS REVIEWED

The documents reviewed as part of this study include:

- Various documents, production data, procedures and supporting information from NABL;
- AACo. (2015, May). Effluent and Irrigation Management Procedures. Australian Agricultural Company Limited.
- Air Environment Consulting Pty Limited. (2015a, March 10). Livingstone Beef Plant Air Quality Impact Assessment.
- Air Environment Consulting Pty Limited. (2015b, November 29). Livingstone Beef Plant Air Quality Impact Assessment.

- Air labs Environmental. (2015, October 30). Odour Monitoring Program Conducted at the AACo – Livingstone Beef Facility in Livingstone Valley.
- Air Quality Professionals Pty Ltd. (2015, March 5). AACo Meat Processing Facility - Odour Review - Site Visit Report.
- EcOZ. (2015, June 1). Operational Environmental Management Plan (OEMP). Australian Agricultural Company Limited.
- EcOz. (2015b). Water Quality Monitoring Plan for Northern Australian Beef Limited. Darwin: EcOz.
- Haarsley Industries. (2015, March 31). Livingstone Meat Processing Plant - Rendering Plant Bio-Filter Operations Manual. Haarsley Industries.
- Haarslev Industries. (2013, August 22). Northern Australian Beef Darwin Flo-Dry DAF Wastewater Treatment. Auckland, New Zealand: Haarslev Industries.
- Johns Environmental Pty Ltd. (2015, November). Final Process Design for Stage 1 Wastewater Treatment Upgrade at the AACo Livingstone Meat Processing Plant. Aspley, QLD, Australia: Johns Environmental Pty Ltd.

The following guidance documents were consulted:

- Department of Environment & Conservation. (2005). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.*
- Department of Environment & Conservation. (2006). *Technical Framework: Assessment & Management of Odour from Stationary Sources in NSW.*
- Department of Environment & Conservation. (2006). *Technical Notes: Assessment & Management of Odour from Stationary Sources.*
- Department of Environment and Conservation. (2007). *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.*
- Department of Environment, Heritage & Protection. (2013). *Guidelines for Odour Impact Assessment from Development.*
- NT EPA. (2013, January 29). Guidelines for Consultants Reporting on Environmental Issues.
- Standards Australia. (2001). *AS/NZS 4323.3: 2001 - Stationary Source Emissions - Part 3: Determination of Odour Concentration by Dynamic Olfactometry.*
- Standards Australia. (2009). *AS/NZS 4323.4:2009 - Stationary Source Emissions - Area Source Sampling - Flux Chamber Technique.*

2.2 SITE VISITS

Three site visits were undertaken as part of this Audit, as detailed in Table 2-3.

Table 2-3: Site Visits

Dates	Personnel	Purpose of Visit
15-17 Sept 2015	Ian Brash (Airlabs Environmental) Andrew Balch (Air Environment)	• Observe Facility operations; • Review sensitive receptors; • Discuss current odour management practices; and • First round of odour sampling (see Section 10).
28 Sept to 1 Oct 2015	Ian Brash (Airlabs Environmental) John Fraser (former QLD EPA)	• Second round of odour sampling (see Section 10); • Community review; • Review of local area; • Informal odour training to respond with community complaints; and • Discussions about odour with staff.
12 October 2015	Michelle Clifton (Vipac Engineers and Scientists)	Carried out a site tour to put the Facility into context by discussing the current operations, odour sampling locations and locality.

3 TECHNICAL OVERIVEW – ODOUR, ANNOYANCE AND ABATTOIRS

In the context of environmental annoyance and nuisance, it is vital to address the response of individuals to the odour stimulus and the variance in this response across populations. Apart from the response to the physical characteristics of an odour if an individual believes that a specific odour has potential negative health implications, they are more likely to appraise that odour negatively.

The annoyance of an odour is a function of the FIDOL factors, which are Frequency, Intensity, Duration, Offensiveness and Location. The FIDOL factors can be used as a basic means of assessing the potential odour impact of proposed developments.

- Frequency indicates how often a person is exposed to an odour. Even an odour with pleasant hedonic tone can be perceived as a nuisance if exposure is too frequent. At low concentrations a rapidly fluctuating odour is more noticeable than a steady background odour; therefore a high frequency is an aggravating factor.
- Intensity indicates the strength of the odour; it is proportional to the $\log_{10}$ of the odour concentration (Steven's law).
- Duration indicates the time length of an odour episode, i.e. how long the concentration remains consecutively above the odour threshold.
- Offensiveness is a mixture of odour character and hedonic tone at a given odour concentration. Some odours are universally considered offensive, such as decaying animal matter or rotten eggs. Other odours may be offensive only to those who suffer unwanted exposure in the residential intimacy, for example coffee roasting odour.
- Location indicates the type of land use and nature of human activities in the vicinity of an odour source. Particular attention must be paid to sensitive receptors, which include housing, schools, hospitals, commercial premises (such as restaurants, offices, shops etc.) and outdoor recreational space.

3.1 QUALITATIVE METHODS

Sensory testing involves evaluating odours with the human nose. Odour concentration, intensity, character, and hedonic tone need to be determined for full characterisation of odours (Figure 3-1). Although the nose provides only a subjective response to the presence or absence of an odour, several recently developed techniques quantify the human response.

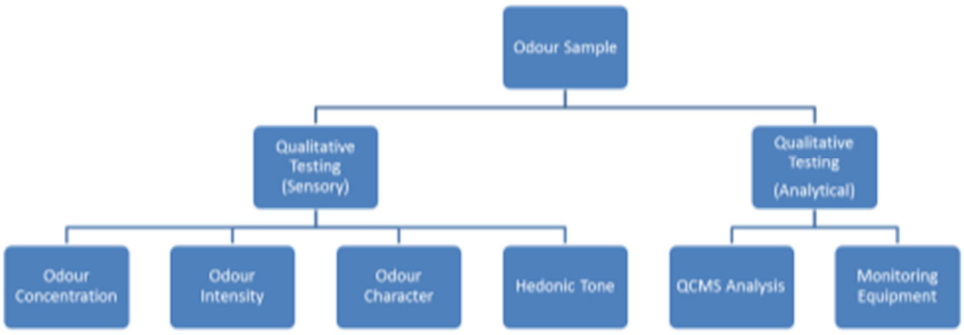


Figure 3-1: Odour Sensory Evaluation Methods

3.2 THE ODOUR PATHWAY

For an odour to be a nuisance, four basic ingredients are required:

- **An odour source** – unstable organics generally exposed to anaerobic conditions that facilitate decomposition of easily biodegradable materials resulting in the generation of malodorous gasses;
- **Odour release to the atmosphere** – malodorous gasses generated as a result natural escape or mechanical introduction into the atmosphere;
- **Off-site odour transport** – odorous emissions are conveyed from the point of generation / release to nearby properties which are not under the control of the facility operator; and
- **Odour perception** – odours are detected by people off-site who judge them to be offensive and register a complaint.

If any of these four factors are absent, no odour problem exists. Hence, it follows that management involves examination of these factors to find the best point(s) at which to interrupt the odour pathway and avoid complaints, as illustrated in Figure 3-2.

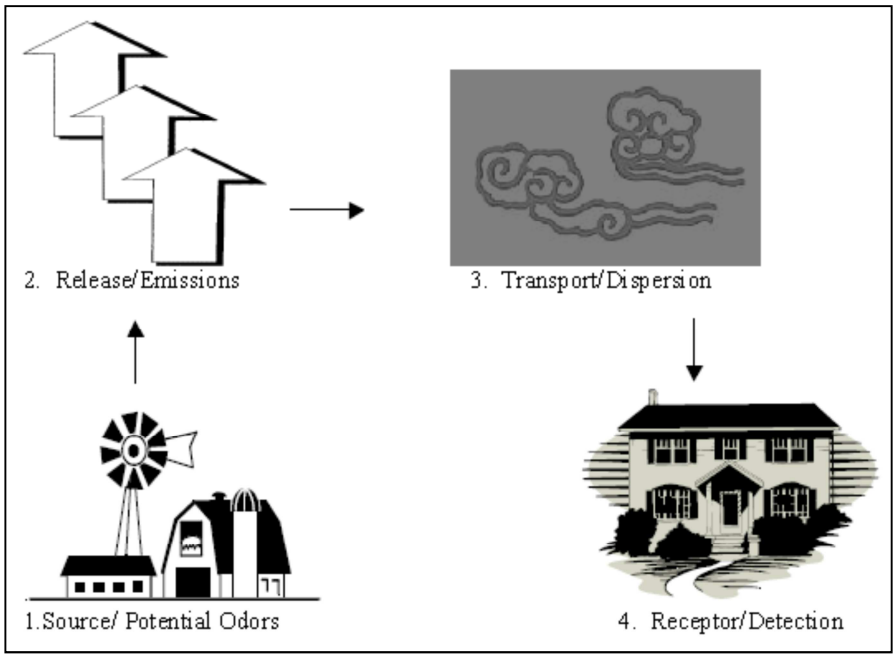


Figure 3-2: The Odour Pathway [Brandt, et al., No Date]

3.2.1 ABATTOIR ODOUR RELEASES

NABL is a typical beef slaughter operation which comprises receiving cattle in holding pens, stunning the animals and draining their blood on the kill floor, removing their hides, and evisceration (removal of internal organs) and trimming. Each animal's carcass is separated into edible parts for human consumption and inedible by-products, which are processed in the rendering plant. Choice fatty parts from the cutting operations are processed into edible fats by a rendering process.

Manure is collected from the holding pens and paunch manure is separated from the viscera (internal organs within the abdominal and thoracic cavities) and inedible materials removed from the rendering processes. The dressed beef are refrigerated within 24-hours for human consumption. More information on the processes is presented in Appendix B and Appendix C.

Odour emissions from abattoirs are relatively complex mixture of organic compounds. Typical odorous compounds associated with abattoirs are presented in Table 3-1.

Nearly all odorous compounds are a result of biological degradation with protein breakdown producing many obnoxious smelling compounds (Zhu & Jacobson, 1999). The Biological Link Organic matter decomposes through two basic biological mechanisms.

- In aerobic decomposition, micro-organisms that require an oxygen rich environment perform the breakdown of proteins and carbohydrates to smaller molecular forms needed for metabolism. The primary gaseous end-product is carbon dioxide.
- In anaerobic decomposition, a different set of micro-organisms uses compounds other than oxygen for metabolism. Under these conditions, the end products of decomposition can include highly odorous compounds such as hydrogen sulfide (rotten egg odour).

Odour can be a problem if wastewater is not completely treated to control the biological oxygen demand (BOD), which may result in anaerobic activities.

Table 3-1: Typical Odorous Compounds Resultant from Abattoir Operations [Buonicore & Davis, 1992]

Substance	Formula	Molecular Weight	Odour Threshold[1] (ppb)	Odour Descriptions
Nitrogen Compounds				
Ammonia	NH_3	17.03	17,000	Sharp, pungent
Methylamine	CH_3NH_2	31.05	4,700	Putrid, fishy
Ethylamine	$C_2H_5NH_2$	45.08	270	Ammonia-like
Dimethylamine	$(CH_3)_2NH$	45.08	340	Putrid, fishy
Skatole	C_9H_9N	131.2	1	Faecal, repulsive
Indole	C_2H_6NH	117.15	0.1	Faecal, repulsive
Sulfur Compounds				
Dimethyl sulfide	CH_3-S-CH_3	62.13	1	Decayed vegetables
Dimethyl disulfide	CH_3-S-S-CH_3	94.2	1	Decayed vegetables
Ethyl mercaptan	CH_3CH_2-SH	62.1	0.3	Decayed cabbage
Hydrogen sulfide	H_2S	34.1	0.47	Rotten eggs
Methyl mercaptan	CH_3SH	48.1	0.5	Decayed cabbage
Acids				
Acetic acid	CH_3COOH	60	0.16	Vinegar
Butyric acid	$CH_3(CH_2)_2COOH$	74	0.1	Rancid
Aldehydes and Ketones				
Acetaldehyde	CH_3CHO	44	1	Fruity, apple

3.2.2 ODOUR TRANSPORT

Odours are often low-density gasses; once released into the environment they are transported by wind, and diluted and dispersed by atmospheric turbulence.

Wind is responsible for the rapid horizontal transport of humidity, warm air, pollutants, and odours while turbulence is responsible for vertical transport. Wind turbulence can be visualised as eddies of different sizes that cause fluctuations in concentration over short time intervals.

[1] The odour detection threshold is the minimum odorant content required to perceive a smell in ambient air. This is distinguished from the recognition threshold, at which point an odour can be identified.

Under typical atmospheric conditions, area source odorants undergo fairly rapid dilution as the distance from the source increases. Under such conditions, odorants are less likely to be objectionable to neighbours. Conversely, pervasive odorants can be detected at considerable distances from the source. Rough terrain, valleys, and other topographical features can increase the complexity of airflow patterns.

Odours emitted from ground-level sources remain most concentrated during periods of high atmospheric stability associated with air temperature inversions and stagnant conditions at night and early morning. This means that odour complaints may be higher during these hours. Odour dispersion is enhanced once the sun has warmed the ground surface.

The use of separation distances is an approach to ensure that there is adequate separation between an industry and receptors to minimise environmental nuisance. They are a means of reducing the effects of residual emissions and, in exceptional circumstances, the emissions of a plant operating under less than optimum conditions. Table 3-2 provides the recommended buffer distances by State and are based on the assumption that Best Available Technology Economically Achievable (BATEA) is implemented.

Table 3-2: Buffer Distances by State for Abattoirs

Jurisdiction	Recommended Distance
NSW/VIC	500 m - 1000 m (with rendering plant)
SA	500 m
WA	500-1000 m (depending on size)
QLD	100 m (ERA 25 – up to 5,000 tonnes per annum)
NT/ACT	None prescribed

The NABL rendering building is located 950 m from the nearest complainant receptor whist the bio-filter is located 980 m from the complainant receptors. The nearest receptor is located approximately 650 m to the east of the Facility, however no odour complaints have been received from this premises.

3.2.3 PERCEPTION

The ability to perceive odours provides us with information about our surrounding environment. The human nose consists of a system of sensors that firstly detect odour molecules. The sensors then send a signal to the olfactory bulb, which relays a pattern of the signals to the brain and the brain perceives this sensation as an odour.

The response to the type and magnitude of the odour stimulus varies dramatically between individuals. Detection thresholds – the ability to detect an odour at a given concentration – vary over several orders of magnitude in different people. In addition to the basic measure of odour concentration there can also be a large variation in a population's description or perception of odour characteristics, including: intensity, pleasantness, irritation and familiarity (Distel, et al., 1999). The NSW EPA states that there are people who are very sensitive to odour. This odour-sensitive sector of the population can react, often strongly, to odours that are barely noticeable to others. The odour-sensitive sector of the population may also have an expectation of very low environmental odours (Department of Environment & Conservation, 2006).

The variation in the perception of an individual to a specific odour can also be affected by circumstances surrounding the individual's previous exposure to that, or similar, odours. If an odour is associated with a negative memory it can elicit a negative cognitive or emotional response in that individual.

4 LICENCE CONDITIONS

This section provides the licence conditions contained within the EPL 131 and the assessable criteria for the Audit.

The Facility received Development Approval in March 2012 and became operational on the 12th September 2014. The Facility had a 12-week testing period (12th September – 5th December 2014) during which 2,739 head were processed to test the equipment was functioning as required. The EPL 131 was issued on 31st October 2014, six weeks after the testing phase commenced; this is discussed further in Section 5.4.

There are 78 conditions contained in the EPL 131, issued on 31st October 2014. Condition 34 contains the only quantifiable limits within the EPL 131 and these limits are concerned with the quality of the wastewater for water quality purposes as presented in Table 4-1 with the characteristics and potential effects identified in Table 4-2.

Table 4-1: Water Quality Limits at Treated Wastewater Storage Tank Outlet [EPL 131]

Contaminant	Units	Commissioning Period (Until 30 Nov 2014)	2014/15 Wet Season (1 Dec 2014 to 30 April 2015)	Long Term Operation (After 1 May 2015)
Biological Oxygen Demand (BOD)	mg/L	100 (max.)	50 (max.)	20 (max.)
Dissolved Oxygen (DO)	mg/L	-	-	2 (min.)
Total Suspended Solids (TSS)	mg/L	-	40 (max.)	30
pH	-	-	6.5 (min.) 8.5 (max.)	6.5 (min.) 8.5 (max.)
Total Nitrogen (as N)	mg/L	-	-	15 (max.)
Total Phosphorus	mg/L	-	5 (max.)	0.5 (max.)
Electrical Conductivity	µs/cm	-	-	600 (max.)
From Chlorine Residual if Chlorination Disinfection	mg/L	-	0.2 (min.) 2.0 (max.)	0.2 (min.) 2.0 (max.)
E coli	MPN/100 ml	-	100 (max.)	90th percentile:10* Maximum: 100

*Nine out of any 10 consecutive samples must comply with the percentile limit

Table 4-2: Characteristics of Wastewater [EcOz, 2015b]

Contaminant	Characteristics and Potential Effects
Biological Oxygen Demand (BOD)	High BOD in wastewater, which may affect downstream aquatic health by removing dissolved oxygen from the water column.
Dissolved Oxygen (DO)	High DO in wastewater, which may affect downstream aquatic health by removing dissolved oxygen from the water column
Total Suspended Solids (TSS)	High suspended solids in wastewater, which may affect downstream aquatic health by smothering benthic habitats and photosynthetic productivity
pH	Variable pH in wastewater, which may affect downstream water quality
Total Nitrogen (as N) and Total Phosphorus	High nutrients in wastewater, which may be toxic to aquatic life (i.e. ammonia) and/or result in algal blooms downstream
Electrical Conductivity	High EC in wastewater, which may affect downstream water quality
From Chlorine Residual if Chlorination Disinfection	High concentrations in wastewater may impact on downstream aquatic health
E coli	High counts in wastewater, which could impact on downstream beneficial uses (e.g. human health associated with contact with waters)

Conditions 36-41 are concerned with air quality, as shown in Table 4-3 below.

Table 4-3: Licence Conditions Relating to Air [EPL 131]

Emissions to air	
36	The licensee must conduct an Air Quality Assessment for all point and diffuse air emission sources at the premises.
37	The Air Quality Impact Assessment must be conducted in accordance with the *"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" and include:
	37.1 identification of all sources of air emissions from the development including all point source and fugitive emissions;
	37.2 details of the project that are essential for predicting and assessing air impacts;
	a) the quantities and physico-chemical parameters (e. g. concentration, moisture content, bulk density, particle sizes) of materials to be used, transported, produced or stored;
	b) an outline of procedures for handling, transport, production and storage;
	c) the management of solid, liquid and gaseous waste streams with potential for significant impacts
	37.3 meteorological and climatic conditions in the area;
	37.4 topography of the surrounding area;
	37.5 a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data;
	37.6 identification of all pollutants of concern and an estimation of emissions by quantity (and size of particles), source and discharge points;
	37.7 an estimation of the resulting ground level concentrations of all pollutants of concern;
	37.8 a description of the effects and significance of pollutant concentration on the environment, human health and amenity of nearby receptors and regional ambient air quality standards or goals;
	37.9 for potentially odourous emissions provide the emission rates in terms of odour units;
	37.10 a detailed description of all air mitigation measures that will be implemented as a result of the Air Quality Impact Assessment; and
	37.11 monitoring that will be undertaken.
38	The licensee must ensure the Air Quality Impact Assessment is reviewed by a qualified person who must produce a written report about their review.
39	The Air Quality Impact Assessment must be submitted to the NT EPA, with a copy of the written review by the qualified person, by 28th February 2015.
40	The licensee must implement and follow all mitigation measures, controls and recommendations specified in the Air Quality Impact Assessment and written review by a qualified person by 30th June 2015.
41	The activity must not cause or release, beyond the boundary of the premises; visible steam, smoke, offensive odour, dust or particulate or noise which unreasonably interferes with or is likely to unreasonably interfere with the enjoyment of the area by persons who occupy a place within the area.

An Air Quality Impact Assessment was prepared by Air Environment Consulting Pty Limited (2015a) and submitted to the EPA. A review of this assessment concludes that the assessment complies with Condition 37 of the EPL 131 as detailed above. The assessment is discussed in further detail in Section 11.1.

5 LIVINGSTON BEEF PROCESSING FACILITY

This Section looks at the Facility operations, potential odour sources and odour controls employed at present.

5.1 LOCATION

The Facility is located at Lot 4, Hundred of Cavanagh and Section 5410, Hundred of Strangways (270 Blyth Road and 2660 Stuart Highway, Livingstone). The Facility is approximately 30 km southeast of Darwin, situated on the western side of the Stuart Highway, south of Livingstone, at the point in which the rail line and highway converge and run parallel to one another as shown by the red line in Figure 5-1. As per the Notice all land parcels within a 7 km radius of the bio-filter are identified in Appendix H.

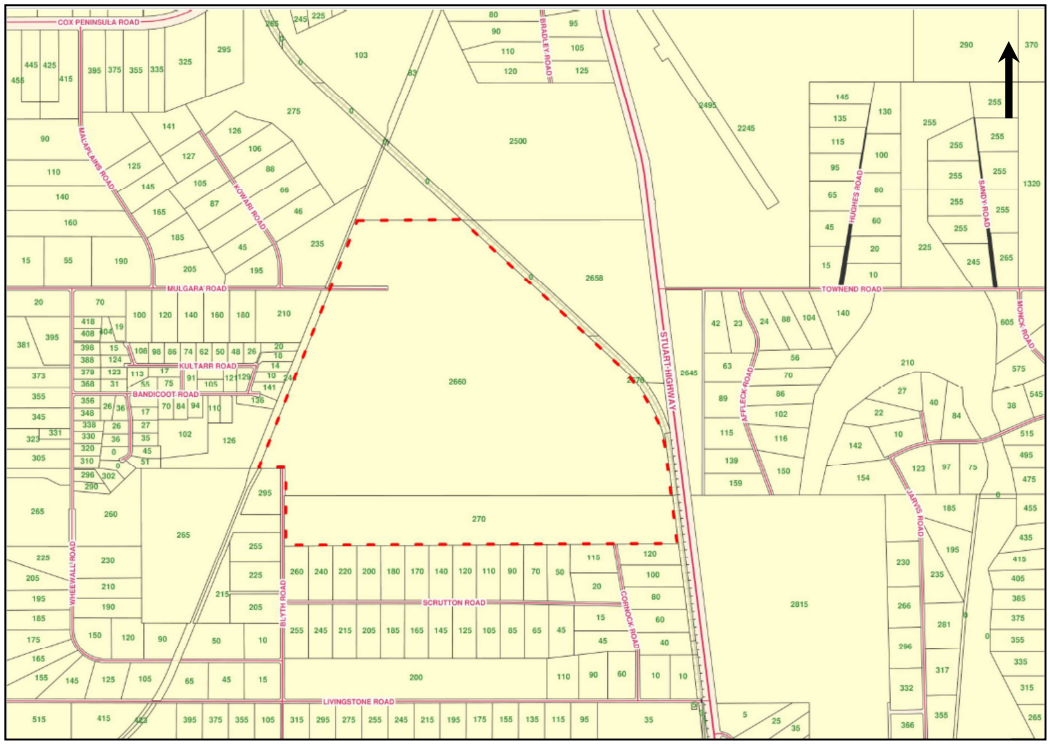


Figure 5-1: Property Location [MapsNT, 2015]

5.2 PROCESS DESCRIPTION

The Facility is designed as a hot-boning meat processing operation where carcasses are boned and processed immediately after slaughter. The slaughtering capacity of the Facility is designed to be a maximum 1,040 head per day processed over two 8-hour work shifts, with processing occurring between 05:00 - 17:00 hours.

Approximately eight or nine road trains will deliver the cattle between 07:00 - 19:00 hours each day for processing, with all cattle on site the night before being processed the following day.

The general layout of the Facility is shown in Figure 5-2. The Facility comprises:

- Administration buildings, offices, training room, employee car parking and amenities;
- Processing building containing the slaughter floor, boning and packaging area;

- Carcass chilling, sorting area and feed to boning operations;
- Cold storage areas including freezers, carton sorting, palletising and dispatch zone;
- Hides processing area;
- Saltwater evaporator;
- Rendering Plant and bio-filter;
- Livestock unloading facility and grazing areas;
- Covered Australian Quarantine and Inspection Service (AQIS) livestock holding yards;
- Sewage treatment system;
- Dissolved Air Floatation (DAF) water treatment plant;
- Irrigation areas for wastewater disposal and haymaking.

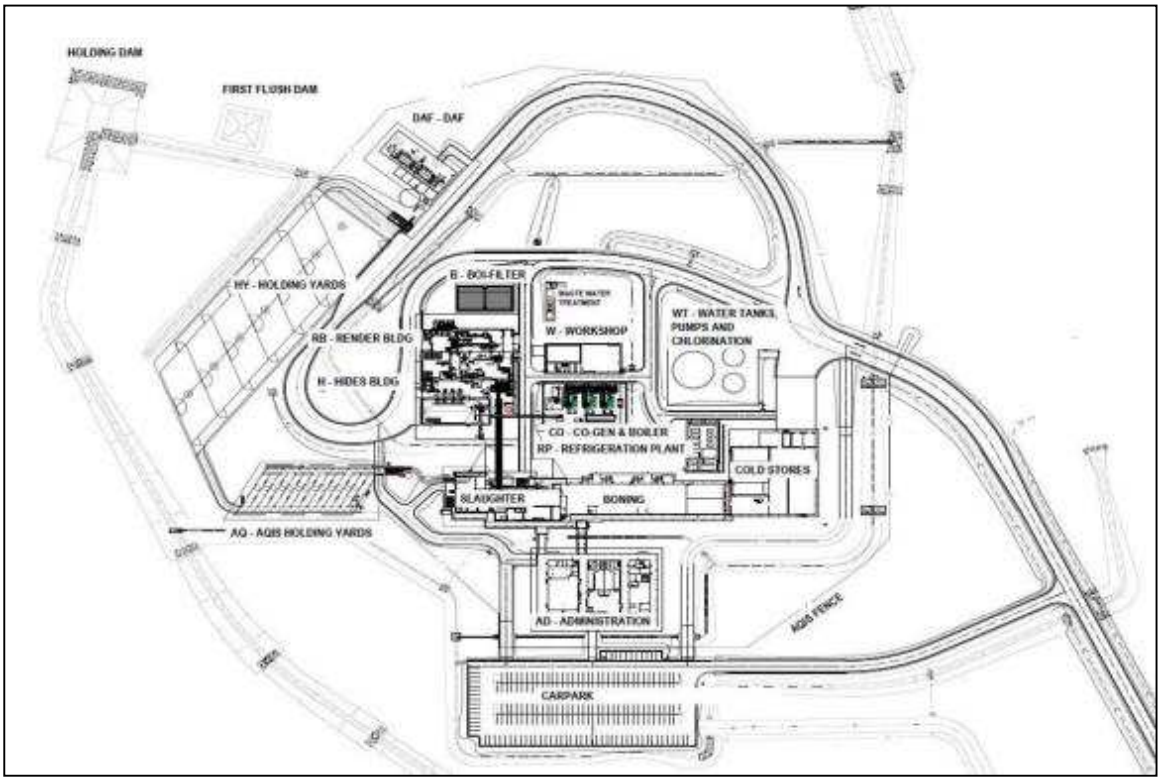


Figure 5-2: Facility Layout (excluding Irrigation Areas)

5.3 ODOUR GENERATING ACTIVITIES

Potential sources of odours from the Facility include:

- Lairage – animal receival, AQIS yards and animal holding pens;
- Animal processing – slaughter, boning, packaging and cold storage;
- Waste product handling – by-product processing (rendering), hides salting/preservations, paunch and tallow storage/transfer;

- Wastewater handling, treatment and storage – Dissolved Air Floatation (DAF) tank, lamella, treated effluent storage tank, green waste holding tank, first flush dam and holding dam;
- Disposal of treated wastewater – spray irrigation; and
- Bio-filter.

Sources of odours in the rendering plant include stale materials and fugitive emissions from cookers. Odours in animal holding pens are produced by manure and urine. Slaughterhouse odours come from solid wastes such as paunch contents and blood residues.

The primary pollutant of concern released from the project is expected to be odour from routine animal processing operations. The main processes and emission pathways associated with the Facility are outlined in Figure 5-4 (Air Environment Consulting Pty Limited, 2015a).

5.4 IRRIGATION AREAS

Treated wastewater is currently disposed of via land irrigation within three designated irrigation zones, with a total area of about 80 ha (Figure 5-3). The majority of surface irrigation is undertaken via a 'K-Line' system (~60 ha), which has been specifically designed to meet the needs of effluent dispersal, with low application rates and pressures that facilitate nutrient absorption into the soil and avoids pooling and runoff into waterways.

Wastewater can also be irrigated using a small travelling boom irrigator designed and manufactured by Vaughan Irrigators, which currently covers an area of about 20 ha. In June 2015, the southern section (K-Line irrigation) ceased due to complaints. There is a 250 m buffer from the southern irrigation area to the nearest receptors.

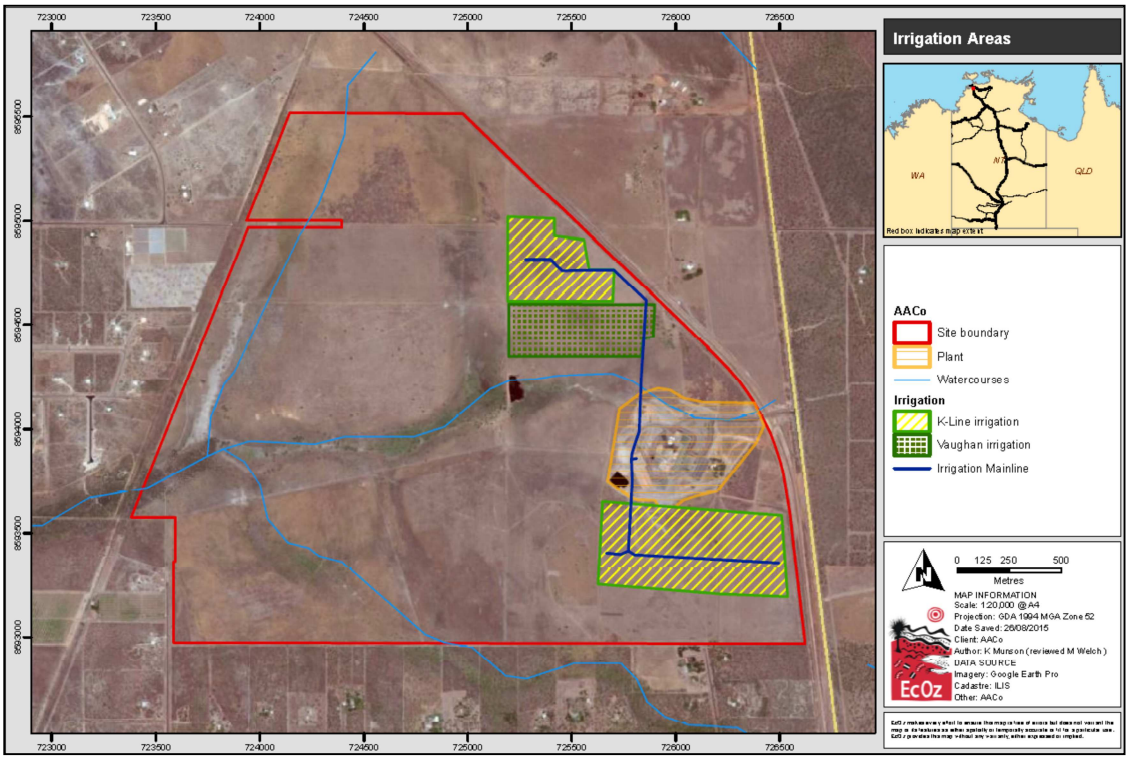


Figure 5-3: Approved Treated Effluent Irrigation Areas [EcOz, 2015b]

Emission source	Process unit	Process description and emission release	Considered to be a source of odour
Lairage	– Live animal receival area – Holding pens	– Open to atmosphere.	Yes
	– AQIS yard	– Open to atmosphere.	Yes
Animal processing	– Animal slaughter, boning, packaging and cold storage.	– Building is sealed and ventilation air is considered to be very low in odour.	No
Waste product handling and processing	– Rendering area. By-product processing. Separated in to two sections.	– Wet rendering building – pre-cooker handling and treatment, building is naturally ventilated and open to atmosphere. – Red Fan Press - Screw Conveyor – Red Fan Press - Tank/Sump – Raw materials bin	Yes
		– - Cooker building - Cooker in cooker building has point source exhaust air collection and extraction to the biofilter for abatement.	No
	– Hides building. Hides salting and preservation.	– There is no emissions collection and treatment. – Building is naturally ventilated and open to atmosphere. – Not considered to be an odorous activity.	No
	– Paunch storage and transfer	– Paunch stored in open bin.	Yes
	– Tallow storage and transfer	– Tallow stored in two fixed roof tanks. – Tank headspace is vented to atmosphere as tank fills.	Yes
	– Meat meal hammer meal vent, storage and transfer	– Air exhausted from hammer mill cyclone vent. Meat meal transferred to trucks for transfer.	Yes
Biofilter	– Odour control unit treating odour emissions extracted from the rendering cooker	– Open to atmosphere. – Earthy odour	Yes
Wastewater handling, treatment and storage	– DAF (Dissolved Air Flotation tank) for removal of suspended solids and effluent clarification	– DAF tank is open on top. – DAF is located within wastewater treatment building. Building structure has roof with no walls. – Building is naturally ventilated and open to atmosphere.	Yes
	– DAF Sludge Decanter	– Small bin holding DAF sludge.	Yes
	– DAF Sludge Storage Storage Bins	– DAF sludge stored on hook bins.	Yes

Figure 5-4: Facility Processes and Air Emission Release Pathway [Air Environment Consulting Pty Limited, 2015b]

Emission source	Process unit	Process description and emission release	Considered to be a source of odour
		– Contra shear scrapings also placed in bin	
	– Lamella for further solids removal and clarification	– Lamella is no longer in use	No
	– Irrigation water storage tank	– Treated effluent is stored in a single fixed roof tank. – Tank headspace is vented to atmosphere as tank fills.	Yes
	– Green sump	– Green side wastewater treatment plant entry point – Open concrete ground level tank.	Yes
	– Common sump	– Red side wastewater treatment plant entry point – Open concrete ground level tank.	Yes
	– First Flush Dam	– Open dam. – No water in dam during dry season when sampling occurred.	No
	– In-ground tank	– No longer in use.	No
	– Equalising Tanks (2)	– Sealed. No vent. Overflow goes to Common Sump.	No
Disposal of treated wastewater	– Spray irrigation	– Effluent water is applied to the paddocks to the north of the facility within the site boundary. – Water is sprayed into the air for disposal via evaporation and ground infiltration.	Yes

Figure 5-4: Facility Processes and Air Emission Release Pathway [Air Environment Consulting Pty Limited, 2015a]

5.5 CURRENT ODOUR CONTROLS

5.5.1 WASTEWATER TREATMENT AND IRRIGATION

The Facility currently employs primary and tertiary treatment of the wastewater. This treatment includes Dissolved Air Floatation (DAF), a lamella clarifier and ultra-violet treatment: The equipment was approved and installed prior to the licence conditions were issued (as discussed in Section 4).

The open-air Flo-Dry FPSS Dissolved Air Floatation (DAF) installed is designed to process 1,500 m^3/day, based on an average rate of 75 m^3/hour with the DAF operating 20 hours per day. The wastewater loading of the DAF and Lamella are presented in Table 5-1 and Table 5-2.

Table 5-1: DAF Wastewater Loadings [Haarslev Industries, 2013]

Parameters	Waste Stream			EPL 131 Licence Condition
	DAF Inlet (mg/L)	DAF Outlet Expected (mg/L)	Reduction (%)	
Total Suspended Solids (TSS)	2,000	300	85	30
Total Solids (TS)	3,200	640	80	-
BOD_5	4,000	800	80	20
Oils and Greases (O&G)	1,000	50	95	-
Total Kjeldahl Nitrogen (TKN)	150 - 200	75 - 100	50	15
pH	7.2 – 7.8	6.0 – 6.5	-	6.5 - 8.5

Table 5-2: Lamella Wastewater Loadings [Haarslev Industries, 2013]

Parameters	Waste Stream			EPL 131 Licence Condition
	Lamella Inlet (mg/L)	Lamella Outlet Expected (mg/L)	Reduction (%)	
Total Suspended Solids (TSS)	300	100 – 150	50	30
Total Phosphorus (TP)	30	3	90	0.5
Total Kjeldahl Nitrogen (TKN)	75 - 100	70 - 90	5	15

It should be noted that the lamella and treatment is not used as the designed wastewater inlet parameters have not been consistently achieved.

A review of the approved equipment wastewater loadings and the achievable reductions compared to the retrospective EPL 131 conditions, it can be determined that:

- The lowest achievable TSS concentration will still exceed the licence condition by 70-120 mg/L;
- The lowest achievable TP concentration will be six times higher than the licence condition of 0.5 mg/L;
- The lowest achievable TKN concentration will be six times higher than the licence condition of 15 mg/L.
- The pH range is not compatible with the licence conditions; and
- The lowest achievable BOD is 800 mg/L, based on maximum design production, which is significantly higher than the long-term 20 mg/L licence condition.

The issued licence conditions are almost as stringent as the wastewater pollutant limits when released to surface waters as presented in Appendix B. The reasoning behind the wastewater limits is understood, however it is clear that the performance of the installed equipment was not taken into consideration when the licence conditions were determined and issued post installation. As mentioned in Section 5.4, the wastewater is irrigated in selected areas and if complaints are received the locations are changed or irrigation is ceased.

5.5.2 RENDERING PLANT

All material is processed fresh on the same day as slaughter (subject to plant breakdowns), and no other material for rendering is imported to the site. This coupled with the large separation distance (up to 950 m) to the nearest complainant sensitive receptor means that the rendering plant does not need to be fully sealed.

The building is open to atmosphere at the junction of the walls and roof, and via doors on two sides that allow passive ventilation by wind. The two main sources of odour within the rendering system are considered to be fugitive emissions from passive ventilation of the rendering building space, and the bio-filter. A photograph of the rendering building is presented in Figure 5-5.

The odour controls used at the Facility's rendering plant is as follows:

- Raw material (except blood) is received into a large bin (the "red bin") which is outside the rendering plant building. This bin is open to atmosphere and any odours are allowed to disperse passively;
- Blood for rendering is kept in a tank until processed;
- Raw material ready for rendering is conveyed into the rendering building in covered chutes and conveyors;
- Odours emitted during cooking, decanting, and liquid phase separation processes are vented in a closed system to the meal dryer;
- Blood is processed by steam coagulation then decanted;
- The meal dryer is housed in a separate building which is open to atmosphere at the junction of the walls and roof, and the walls and floor slab;
- The dryer is a direct-fired, co-current process. Odorous air extracted from the rendering cooking and separation processes is added to the dryer exhaust gases prior to the condenser and dropout box. A portion of the total exhaust stream is ultimately diverted to the bio-filter for odour treatment, and the rest is recycled into the inlet end of the dryer; and
- Odour from the stick-water evaporation system is extracted separately with a dedicated fan, and is added to the exhaust stream destined for the bio-filter.

Figure 5-5: Photograph of the Rendering Building

5.5.3 BIO-FILTER

During the commissioning phase, there were three issues identified with the bio-filter:

- The incoming air supply was not at the correct temperature due to faulty evaporative cooling towers;
- There was not enough medium in the bio-filter at one stage; the amount of medium was increased as required; and
- Low moisture levels due to faulty sprinkler installation,

These issues resulted in a poor micro-biology of the bio-filter medium as the optimal operating conditions were not being met until adequate populations where established. The odour is addressed by fragrant vapour deodorisers that line the perimeter of the bio-filter, as shown in Figure 5-6. Optimum operational conditions for the bio-filter are:

- Media moisture levels should be 40 – 50%;
- Temperature of inlet gases should be <50°C;
- Humidity of input gases should be >60%;
- pH of the media should be in the range of 5 – 6; and
- Backpressure should be in the range 10 - 80 mm

These parameters are monitored continuously by the rendering plant. The bio-filter Operations Manual presents a troubleshooting guide on actions to be taken to rectify these parameters (as discussed in the Odour Management Plan).

Whilst the issues identified above have all been reasonably rectified, vapour is still being released from the bio-filter. Consideration is being given to other medium materials which may be more suitable for the bio-filter application.

Figure 5-6: Photograph of the Bio-filter

5.6 TESTING PERFORMANCE

Condition 34 of the EPL 131 is that the discharge from the wastewater storage tank outlet does not exceed the licence limits. The compliance monitoring measures the concentrations of the contaminants listed in Table 3 of EPL 131 in the treated effluent to determine if compliance with the limits is achieved.

The Irrigation Management Plan (IMP) provides information on the sampling location, parameters measured and frequency of the wastewater sampling.

- Sampling location: Sampling will be undertaken of the treated effluent discharged to the irrigation area (from irrigation pump discharge or storage tank - Sampling Point site 4);
- Sampling frequency: Physical parameters measured in-situ will occur fortnightly, whilst laboratory parameters will be sampled and analysed monthly;
- In-Situ parameters measured:
  - Daily measurements: pH and temperature; and
  - Every two hours (06:00 – 22:00 hours): Electrical Conductivity (EC) and Dissolved Oxygen (DO), Total Dissolved Solids (TDS), salinity and turbidity.
- Sampling Methodologies:
  - Australian/New Zealand Standard on *Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998); and
  - Australian/New Zealand Standard on *Water Quality Sampling – Part 10: Guidance on sampling of waste waters* (AN/NZS 5667.10:1998).

Wastewater samples are sent to Eurofins Scientific (NATA accreditation number 1261) where they are analysed for a variety of parameters as detailed in Table 5-3.

Table 5-3: Laboratory Test Methodologies and Limit of Reporting [Eurofins]

Test	Methodology	Limit of Reporting
Ammonia (as N)	APHA 4500-NH3 Ammonia Nitrogen by FIA	0.05 mg/L
BOD (BOD-$_5$ Day)	LTM-INO-4010	5 mg/L
Chlorine (free)	APHA 5520	0.1 mg/L
Oil & Grease	APHA 5520	10 mg/L
Suspended Solids	APHA 2540D Total Suspended Solids	1 mg/L
Phosphorus	USEPA 6010	0.5 mg/L
Alkali Metals	USEPA 6010 Alkali Metals	0.5 mg/L
E.coli	LTM-MIC-6621	1 MPN/100 ml
Thermotolerant Coliforms	In-house LTM-MIC-6623: Thermotolerant Coliforms by MPN	1 MPN/100 ml
Total Nitrogen Set (as N)	APHA 4500-NO3/NO2 Nitrate-Nitrite Nitrogen by FIA	0.2 mg/L
Total Kjeldahl Nitrogen (as N)	APHA 4500 TKN	0.2 mg/L

5.7 WASTEWATER PERFORMANCE DATA

The only wastewater licence condition parameter which provides an indication of odour is BOD (refer to Section 3.2.1). As detailed in Section 5.5.1, the lowest achievable BOD level based on the wastewater equipment approved and installed prior to the licence conditions were issued is 800 mg/L.

Wastewater compliance is managed through the Operations Environmental Management Plan (OEMP), Irrigation Management Plan (IMP) & regular reporting to NT EPA. It should be noted that until June 2015, NABL submitted every wastewater measurement (carried out every two hours during plant operations) in addition to the full wastewater testing dataset. The wastewater testing dataset which was submitted to NT EPA has been reviewed.

Wastewater testing data was provided for the dates 05/01/2015 – 09/07/2015, excluding days where the plant is not operational (i.e. weekends, public holidays etc.). These dates correspond to the 12-week period when daily measurements had to be taken. Since the 12-week period ceased, the testing frequency has been reduced in accordance with the revised Irrigation Management Plan.

Figure B-16-2 outlines the current wastewater treatment System and identifies the Sampling Points. From this Figure, it can be determined that:

- Sampling Point 1 is pre-DAF treatment. The BOD levels should be the highest at this Point. The DAF inlet BOD limit is 4,000 mg/L;
- Sampling Point 2 is post-DAF. The BOD levels should be dramatically reduced at this Point. The DAF outlet design performance is 800 mg/L (Table 5-1);
- Sampling Point 3 is post lamella and UV treatment and before entering the irrigation tank, however as discussed previously, these two treatment phases are not used. Therefore the BOD levels are expected to be similar to Sampling Point 2; and
- Sampling Point 4 is the outlet of the irrigation tank. Again, there is no treatment between Point 3 and 4; therefore the BOD levels are expected to be similar. This point is the licence limit Sampling Point and had only been active since February 2015.

Figure 5-7 presents the BOD levels as 10^{th} and 90^{th} percentiles as well as the median values for each Sampling Point. It can be seen from the Figure that the 90^{th} percentile of Point 1 is below the 3,930 mg/L inlet limit, with the median at 1,100 mg/L. The Sampling Point 2 data shows that the median is 310 mg/L and the 90^{th} percentile is 980 mg/L.

It can be seen from Figure 5-7 that the wastewater progressively improves, with the greatest improvement between Sampling Point 1 and 2, when the water is treated by the DAF.

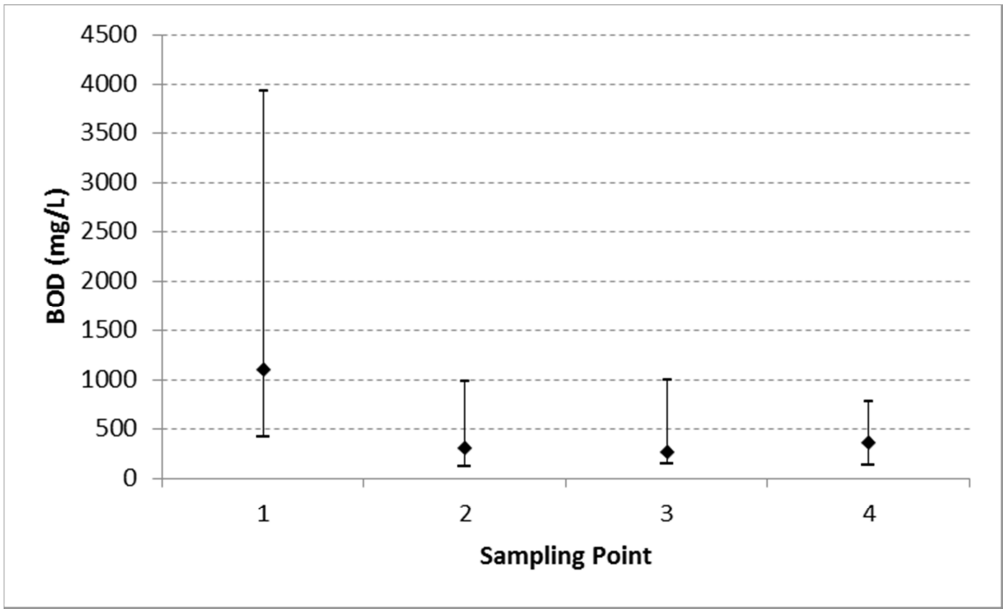


Figure 5-7: BOD Percentile at All Four Monitoring Sites [NABL Wastewater Data, 2015]

Figure 5-8 presents a comparison of the BOD levels at Sampling Point 1 (DAF inlet) and Sampling Point 2 (DAF outlet). The graph also identifies the DAF inlet limit of 4,000 mg/L (identified by the grey line) and the expected performance based on the inlet limit (identified by the red line).

Analysis of the data has identified that the average weekly reduction in BOD levels from the DAF treatment can range 37 - 92%, with a median of 72%. This average value is just below the expected 80% reduction performance from the DAF as detailed in Table 5-1.

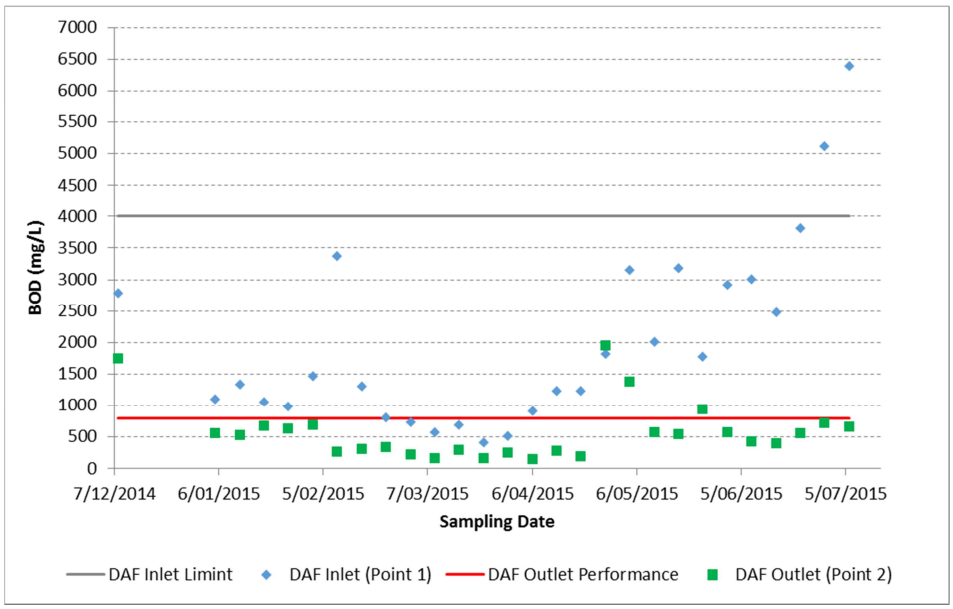


Figure 5-8: Comparison of BOD Levels at Sampling Points 1 and 2

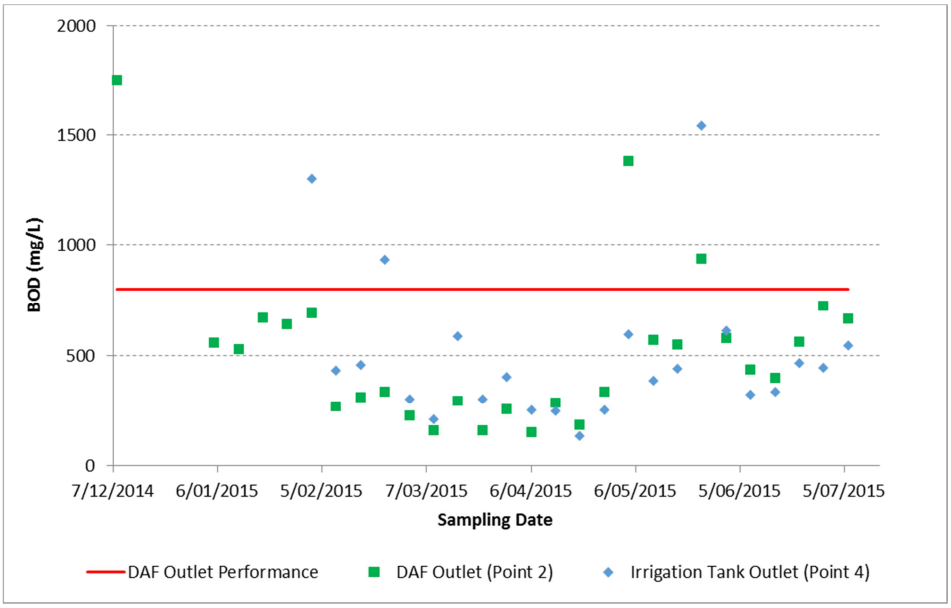


Figure 5-9: Comparison of BOD Levels at Sampling Points 2 and 4

It can be seen from Figure 5-9 that the BOD levels at Sampling Point 2 (DAF outlet) and Sampling Point 4 (irrigation tank) are quite similar. It is noticeable that from February (when the testing at Point 4 began) to April, the BOD values at Point 4 were slightly higher than the Point 2 samples. However, after April the values are typically lower at Point 4.

Figure 5-10 presents the BOD values for Sampling Points 2, 3 and 4. There is no treatment of the wastewater between these points, and it could be expected that the values between each site should be very similar.

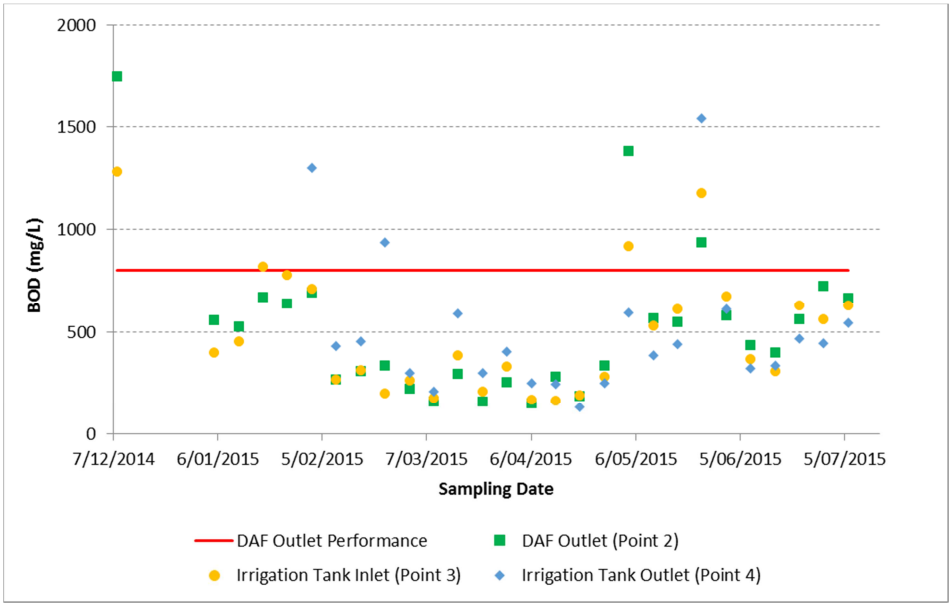


Figure 5-10: Comparison of BOD Levels at Sampling Points 2, 3 and 4

Similar to Figure 5-9, the data for the three Sampling Points presented in Figure 5-10 do not follow the same pattern i.e. that Sampling Point 2 would be highest, Sampling Point 3 would be lower and Sampling Point 4 would identify the lowest BOD levels. This may be explained by the any additional residual time between the Sampling Points, appears to increase odour especially between Sampling Points 3 and 4, as identified in the Figure.

To summarise, the data presented in this section should not be used to determine compliance with the EPL 131 on the basis that the equipment performance was not taken into consideration when defining the licence conditions.

The DAF is the only wastewater treatment process at present; when reviewing the performance of the DAF unit against the designed wastewater loadings it is clear that in most instances the BOD inlet limits (4,000 mg/L) have been achieved. The median BOD reduction of the DAF is 72%, which is just below the 80% reduction stated in design documentation (Haarslev Industries, 2013); however the level of removal can vary and has been observed at site (See Section 10.1). This variation in BOD reduction may be attributed to high wastewater generation; until recently the incoming water for the DAF was higher than the design capacity. Whilst there are two 35,000 litre balance tanks to store the wastewater prior to DAF treatment, there have been some occasions when incoming flows have exceeded the capacity of the tanks, thus exceeding the DAF capacity. It should be noted that wastewater generation has been reduced in recent weeks to ensure DAF capacity is not exceeded. This has been achieved by reducing the water throughput, however the DAF is ultimately dictated to by incoming flows, and therefore the wastewater treatment flows are adjusted to match the water production rates.

It should be noted that based on the water monitoring data from December 2014 to June 2015, the E-coli levels averaged over 100 million CFU/100 ml with a maximum of 2.6 billion CFU/100ml. This compares to a licence limit of 100 CFU/100ml and typical guideline limits for watering non-edible crops of 10,000 CFU/100ml. If there is any proposal to reuse the water within the plant, then the 100 CFU/100ml will need to be met for safety reasons.

The same monitoring data also found average and maximum EC values of 1,500 and 10,000 uS/cm respectively, which compares to a licence limit of 600 uS/cm. Long term irrigation with water having an EC greater than 800 uS/cm can result in sodic soils, depending on the irrigation water salinity and the ratio of Sodium to Calcium and Magnesium ions in the water.

5.8 WEATHER STATION

A 10 m high solar powered Environdata Weather Maestro weather station was commissioned on 15th August 2015 at the Facility. The station was installed by Novolta and has a 10 channel data logger with NextG modem and omni-directional antenna plus the following sensors:

- Wind Speed (at 10m);
- Wind Direction (at 10m);
- Solar Radiation (at 10m);
- Ambient Temperature;
- Relative Humidity; and
- Rainfall.

The weather station is located in an area free of obstructions (i.e. buildings or trees). The location of the weather station is presented in Figure 5-11. A summary of the weather station is detailed in Appendix I along with the maintenance requirements. The calibration certificates for all the sensors listed above are also presented. The installation of the weather station was requested as part of the Notice.

Location of Weather Station at Site

Installed Weather Station

Figure 5-11: Weather Station Location and Photo [NABL, 2015]

6 HOUSEKEEPING PRACTICES AT NABL

This Section outlines the housekeeping practices for odour control and their effectiveness based on site observations, operational procedures and guidelines.

6.1 HOUSEKEEPING PRACTICES

NABL carry out daily, weekly and monthly inspections and complete inspection checklists. Each checklist is slightly different but all lists correspond to the requirements of the OEMP and the EPL 131. Each checklist has a list of items to assess and a column for corrective actions if required. Odour is reviewed as part of the:

- Daily checklist for general odours, odours from the holding yards and irrigation quantity;
- Weekly checklist for waste (covering of raw materials and transportation); and
- Monthly checklist for wastewater treatment system (checking for leaks).

The inspection checklists are completed and records are kept. If issues are identified then a *Non-compliance and Trigger Value Exceedences Notification* form is completed in accordance with EPL 131 conditions 58 and 62 and corrective actions taken.

6.2 CLEANING, MAINTENANCE AND HOUSEKEEPING

The maintenance and cleaning requirements are detailed in the following documents:

- OEMP provides general requirements for the cleaning of the holding yards;
- Stormwater Management Plan for the stormwater dams;
- Wastewater Treatment Plant Operations Manual for equipment on a daily, weekly, fortnightly etc.; and
- Bio-Filter Operations Manual.

A review of all the documentation, site visits and communication with NABL has identified:

- During the site visit the roller shutter doors remained open all day. Recently, the closing of the roller shutter doors has been enforced for the dryer and hammer mill room (rendering) to prevent fugitive emissions;
- The doors to the wet rendering area which emits most of the odour cannot be shut as there is no ventilation. This creates a potential work health safety issue for the operators; and
- Currently the bins and skips do not have covers, as no waste provider in the Northern Territory has this option. NABL are custom designing bin covers at present.

6.3 EFFECTIVENESS OF ODOUR CONTROLS

The OEMP prepared for the NABL operations provides a list a risk matrix of each activity and the proposed controls and monitoring requirements. The risk matrix was reviewed including the effectiveness of the odour controls as presented in Table 6-1. This table should be cross-check with Table 10-1 which discusses observations during site visits.

Table 6-1: Odour Controls and their Effectiveness

Activity	Summary of Controls (OEMP)	Evidence of Controls	Effectiveness	Comments
Cattle Holding	Daily removal of manure from stock holding yards (by dry clean) to the green waste press for mixing with paunch and dewatering.	• Waste removal database • Inspections of dry clean each night by staff • Cattle holding yards are cleaned approximately 2-3 times a month by All Metro Group Pty Ltd.	During site visits, the holding yards were not considered to be a significant source. More frequent cleaning by All Metro Group will be required when production rates increase.	These actions fulfil the controls outlined in the OEMP.
	Manure / paunch (dewatered) waste is stored in leak-prove skip bins (lids are to be applied only in wet season. Waste will be stored in open bins during the dry season to minimise anaerobic activities) off-site removal by a licensed contractor to Shoal Bay dump.	• Waste removal database • The skips being taken away from the site three times per day by a licensed operator (NTRS). • All Skip bins are inspected and cleaned by operators once they are return back to the site.	The odour from the skips is not controlled effectively; empty skips are also odorous despite cleaning.	NTRS do not provide leak proof listed waste holding bins, due to this NABL is in the process of designing own leak prove bins with impermeable covers suitable for weather conditions in NT.
Meat Processing	Maintain air extraction systems and the bio-filter in accordance with manufacturer specifications to ensure design conditions of 97.5% odour emission destruction efficiency are achieved.	• Inspection checklists.	The checklists identified that a number of vent pipes in the wet area were disconnected from the odour source to the bio-filter.	The vents are currently were reconnected immediately to the bio-filter to reduce odour emissions.
	Capture wastewater and convey through enclosed pit and pipe system to DAF plant for screening and treatment prior to irrigation on irrigation areas.	• The wastewater used to clean the equipment and floors at the end of the day is drained into the DAF system. • Inspections of each night by staff.	During the site visit, one underground pipe that flows from the plant process area to an open earth drain adjacent the skip storage area was highly contaminated with process liquids to the extent that anaerobic activity was noted.	The issue has been acknowledged and resolved by covering the drain to ensure it was completely contained.

Activity	Summary of Controls (OEMP)	Evidence of Controls	Effectiveness	Comments
	Raw materials bins stored undercover and processed within five hours.	• The operations of the raw material holding bin are continual, therefore five hours is the maximum. The system is design to have a continual out flow of raw material when there is an inflow. • Inspections of each night by staff	The odour from this source was relatively low but should be kept covered.	This is only effective when there is an inflow of materials. More frequent checks should be carried out.
	Green waste (manure / paunch) and DAF sludge dewatered and stored in skip bins with lids, located under cover prior to off-site removal by a licensed contractor.	• Waste removal database • The skips being taken away from the site three times per day by a licensed operator (NTRS). • All Skip bins are inspected and cleaned by operators once they are return back to the site.	The odour from the skips is not controlled effectively; empty skips are also odorous despite cleaning.	NRTS do not provide leak proof listed waste holding bins, due to this NABL is in the process of designing own leak prove bins with impermeable covers suitable for weather conditions in NT.
	Daily inspection of raw material holding bins, waste manure / paunch bins and sludge bins to ensure storage requirements met, no leaks / spills and no pest / vermin intrusions.	• Daily inspection sheet records	There were no recorded or reported incidents of vermin intrusions recorded in the waste holding area.	If incidents occur the problem will be solved by Rentokill vermin and pest control external contractors.
Bio-Filter	Bio-filter is regularly maintained in accordance with the Operating Manual. The maintenance routine includes a schedule of routine odour, moisture and airflow testing. The bio-filter media is remediated routinely to prevent it from drying out and forming channels or chimneys that allow untreated emissions to be released.	• Odour testing of the bio-filter was conducted in Feb 2015. • Sprays are manual. • Sprays are to be turned on when the media is under the optimum moisture levels (40-50%). • There are daily inspections of the bio-filter.	A masking agent is in use at present. The agent is effective in masking the odour with a fragrant smell but this is really a short term solution.	This agent is air solution 9304, industrial odour neutraliser manufactured by CS Australia PTY LTD.
Rendering	Tallow is stored in enclosed tanks prior to being pumped out and transported off-site.	• Daily inspection sheet records. • Inspections by staff each night.	Tallow tanks are located in a bunded area, if there was a spill the spillage is designed to be diverted to the DAF.	No spill has been recorded to date.

Activity	Summary of Controls (OEMP)	Evidence of Controls	Effectiveness	Comments
	Meat and bone meal stored in enclosed bins prior to transport off-site.	• Daily inspection sheet records. • Inspections by staff each night.	When there is sufficient amount of meat meal, the product is directly pumped into transport containers and immediately taken off site.	Ensure that the bins are fully enclosed at all times.
Wastewater treatment	Wastewater quality monitoring of inputs to DAF system is undertaken to inform continual improvement in pre-treatment contaminant removal.	An automatic system adds sulphuric acid and bentonite added to the raw influent and polymer is added to the effluent prior to pumping the effluent through the decanter for sludge extraction.	The chemical dosage is automated; however sulphuric acid dosage can be change in order to manipulate the pH levels.	The dosing chemicals are being reviewed in order to remove sulphuric acid being added to the process.
	Integrity of DAF plant pipework, sumps, tanks and bunding.	• Inspection checklist for the wastewater facility. • The DAF is emptied every three months for a full clean. • The plant is spray cleaned each night by the afternoon shift operators. • Pipe work and other infrastructure are inspected daily.	DAF shut down check list to be filled out daily to be checked by management.	Refer to Section 5.5.1 for discussion on the capabilities of the DAF.
Wastewater irrigation	Treated wastewater quality must meet the assessment criteria conditioned in EPL 131 prior to discharge.	Compliance monitoring at the irrigation tank: • Daily monitoring of pH and temperature Every 2 hours for DO,TDS,NTU,EC, Salinity • Monthly testing by Eurofins	Daily inspection check sheets and 2 hourly wastewater testing data sheets are completed by management and environmental officer. The results from the wastewater are added to a spreadsheet each day.	Refer to Section 5.5.1 for discussion on the capabilities of the DAF.
	Treated wastewater discharged to the approved irrigation areas only in accordance with site IMP.	Database detailing the wastewater discharge location, amount and time.	The database ensures that no area is over-irrigated and that pooling of the water does not occur.	Southern irrigation site is no longer in use. See Section 5.4.
All Areas	Cleaning of all plant by general wash-down each night prior to leaving the Facility. This wastewater is also processed in the DAF.	The processing manager is responsible for the management of the cleaning contractors.	Inspection of the Facility identified that there are no old stains/marks or product on the plant which indicates that the facility is cleaned regularly.	Staff do not leave until cleaning has been checked.

7 METEOROLOGICAL CONDITIONS

7.1 OVERVIEW

Darwin's climate is characterised by two major seasons: the dry season and the wet season, influenced by tropical depressions;

- During the dry season (typically May to September), dry southerly and easterly trade winds predominate. Humidity is relatively low and rain is very unusual.
- The wet season (typically October to April) is characterised by warm temperatures and rain. Most of the rain is associated with monsoonal troughs formed over Southeast Asia, although occasionally tropical cyclones produce intense heavy rain over localised areas.

Average annual rainfalls recorded at stations near the Facility site are 1,660 mm at Elizabeth Valley, and 1,900 mm at Noonamah (the period of records at Noonamah is much shorter than for Elizabeth Valley), with two-thirds falling between January and March. The dry season, extending between May and September, is characterised by low humidity, and very little rain.

The seasonality of rainfall in the region means that surface water flows and aquifer recharge occur during the wet season only. At the Facility, surface water flows typically occur between December and April but within this period, flows may be sporadic according to rainfall.

Temperatures inland from the coast are typically one to two degrees hotter in the wet season, and one to two degrees cooler in the dry season. Records held by the Bureau of Meteorology for the nearby weather station at Noonamah show that the mean maximum temperature is 34°C, and the mean minimum temperature is 21°C. Wind speeds recorded at this station are on average between 10 to 30 km/h throughout the year, predominantly from the northwest in the wet season and southeast in the dry season (EcOz, 2015b).

7.2 WIND CONDITIONS

At the time of writing the frequency at which the weather station was recording had not been stabilised; therefore analysis of the limited weather station data was not feasible.

Analysis of meteorological conditions in the vicinity of the premises has been undertaken as part of the Air Quality Impact Assessment (Air Environment Consulting Pty Limited, 2015a) and during a site visit for the Odour Review (Air Quality Professionals Pty Ltd, 2015). The information in this section has utilised information from both documents.

There is one Bureau of Meteorology (BoM) weather station near the site. The station, Noonamah AWS was commissioned in 2008 and in June 2013 it was relocated to Noonamah Airstrip. These two locations are approximately 8 km and 11 km north respectively from the premises.

A windrose of all wind data collected at the two Noonamah sites since 1 August 2010 is presented in Figure 7-1. It should be noted that prior to August 2010 the data is at hourly intervals.

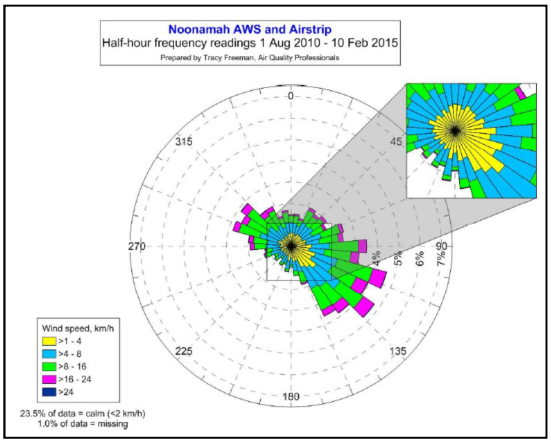
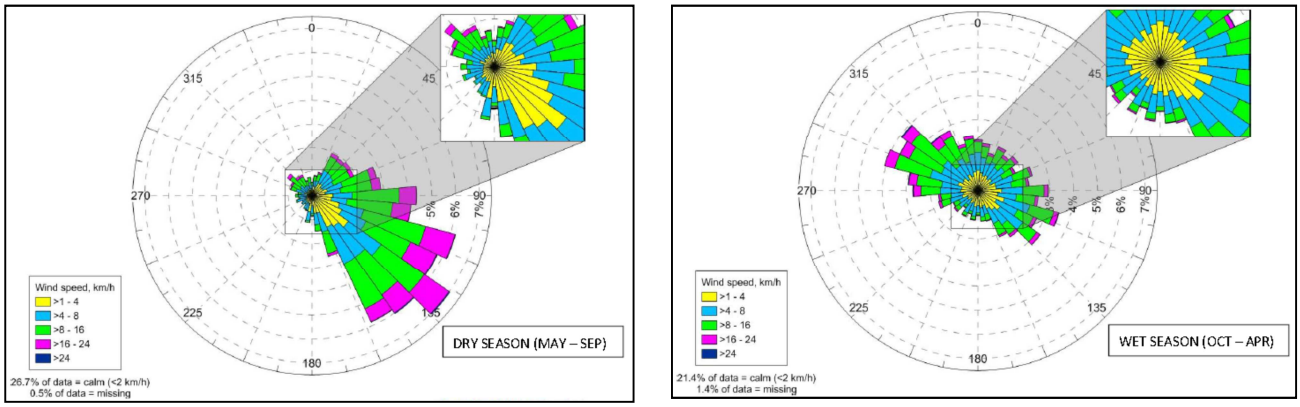


Figure 7-1: Windrose from Noonamah AWS and Noonamah Airstrip [Air Quality Professionals, 2015]

The prevailing wind patterns are different during the wet season (October to April) and dry season (May to September). The wind data for the two Noonamah sites since 1 August 2010, for the wet season and dry season are presented in Figure 7-2. It can be seen that during the dry season there is slightly higher frequency of calm winds and a much stronger prevalence of winds blowing from the southeast sector.



Dry Season (May – Sept) Wet Season (Oct – Apr)

Figure 7-2: Comparison of Dry and Wet Windroses from Noonamah AWS and Noonamah Airstrip [Air Quality Professionals, 2015]

For more detailed analysis of local weather conditions at the premises, please refer to the Air Quality Impact Assessment (Air Environment Consulting Pty Limited, 2015a). This assessment provides annual statistical analysis of weather conditions in Darwin 2008-2013 and a comparison between the measured conditions in Darwin and the TAPM generated data utilised in the dispersion model.

7.3 ATMOSPHERIC STABILITY AND MIXING HEIGHT

Stability is a term applied to the properties of the atmosphere that govern the acceleration of the vertical motion of an air parcel. The acceleration is positive in an unstable atmosphere (turbulence increases), zero when the atmosphere is neutral and negative (deceleration) when the atmosphere is stable (turbulence is suppressed) (Air Environment Consulting Pty Limited, 2015a).

The Pasquill-Gifford Stability Classes define the amount of turbulence in the air, of which the most widely used categories are Classes A-F. Temperature inversions occur during stable conditions (Class E and F); these conditions only occur with clear and calm conditions during the evening and night time periods.

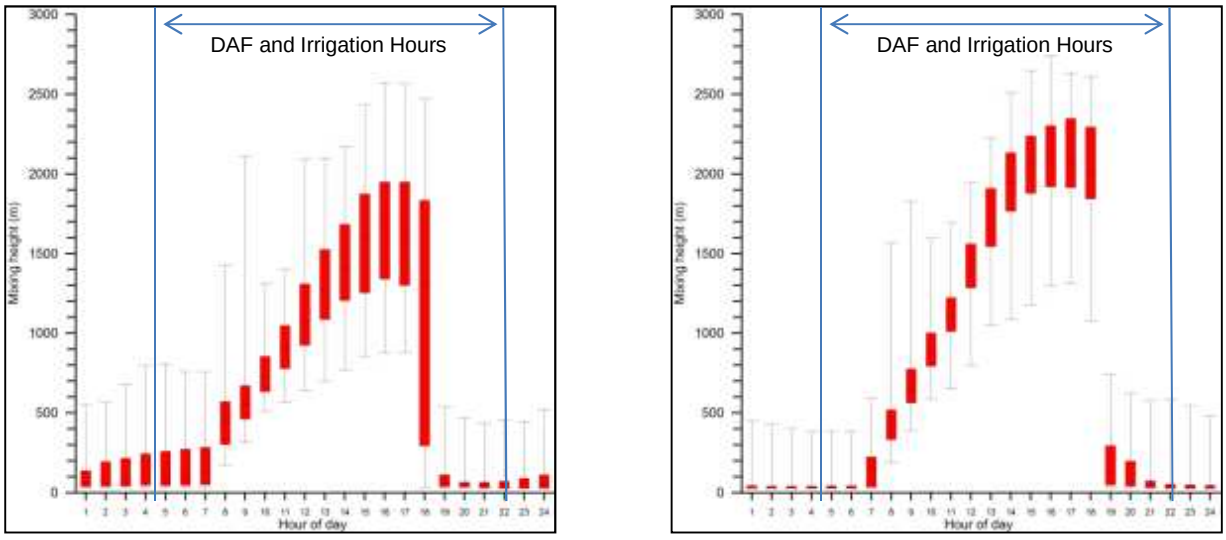
The TAPM generated meteorology dataset used in the dispersion model determined the stability class for each hour of the year. The frequency of each stability class occurrence is shown in Table 7-1.

Table 7-1: Annual Stability Class Distribution [provided by Air Environment Consulting Pty Limited]

Stability Class	Description	Frequency of Occurrence (%)	
		Dry Season	Wet Season
A	Very unstable low wind, clear skies, hot daytime conditions	2	5
B	Unstable clear skies, daytime conditions	8	18
C	Moderately unstable moderate wind, slightly overcast conditions	19	19
D	Neutral high winds or cloudy days and nights	18	10
E	Stable moderate wind, slightly overcast night-time conditions	11	6
F	Very stable low winds, clear skies, cold night-time conditions	42	42

The mixing height refers to the height above ground within which the plume can mix with ambient air. During stable atmospheric conditions at night, the mixing height is often quite low. During the day, solar radiation heats the air at ground level and causes the mixing height to rise through the growth of convection cells. The air above the mixing height during the day is generally colder. The growth of the mixing height is dependent on how well the air can mix with the cooler upper levels of air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions the air will be well mixed, resulting in a high mixing height (Air Environment Consulting Pty Limited, 2015a).

The hourly distributions of mixing height at the Facility are presented in Figure 7-3 for the dry and wet seasons. It can be clearly seen that between 18:00 – 19:00 hours the mean mixing height decreases from approximately 1,350 m to <100 m. during the dry season and from approximately 2,000 m to <150 m. during the wet season. This indicates that the amount of air the odour can mix with (i.e. dilute) is lower during the dry season.



Dry Season Wet Season

Figure 7-3: Distribution of Hourly Mixing Heights at the Facility [provided by Air Environment Consulting Pty Limited]

Figure 7-4 is a graphical representation of the relationship between temperature inversions and the mixing height. If a temperature inversion occurs (i.e. Stability Class F) the inversion layer is closer to the ground, which results in the mixing height decreasing.

Applying this to NABL operations, if we assume that the odour emission rates are constant throughout the day, it can be seen from Figure 7-3 that as the solar radiation (i.e. temperature) increases the amount of air available for the odour to mix vertically within is large; however when the solar radiation decreases (approximately 18:00 hours) the air available for vertical mixture is limited. In some cases, this amount of air can be as low as 10% of the average during the daytime. This limited dispersion increases the odour concentration even though the odour emissions have not changed.

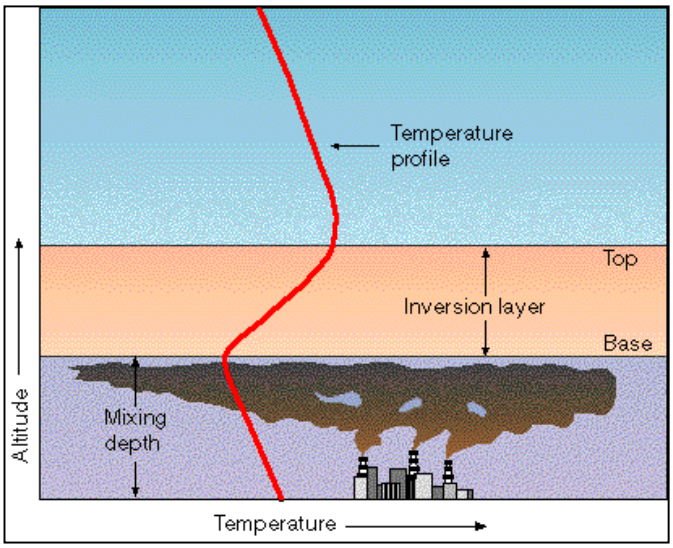


Figure 7-4: Graphical Representation of Inversions and Mixing Height

8 COMMUNITY CONSULTATION

This Section outlines the methods of community consultation and complaints procedure.

8.1 COMMUNITY CONSULTATION

The requirement to implement, maintain and follow a *Consultation and Communication Plan* (CCP) is outlined in Condition 12 of the EPL 131. NABL prepared version 1 of the CCP on the 1st June 2015.

The CCP outlines the scope of the Plan, identifies the stakeholders and their concerns and provides the following approach:

1. 24-hour phone line – a member of staff (Plant Manager or delegate) is contactable 24-hours a day, 7 days a week by mobile phone.
2. Community Reference Group – a monthly meeting with a group of local residents and chaired by the Plant Manager.
3. Website – a website provides access to information about facility operations, employment opportunities, the environment and community engagement.
4. Facility Tours – NABL have previously run Facility tours.
5. Complaints Register – NABL maintain a complaints register.
6. Publication of Environmental Data upon requestion.

The full CCP is presented in Appendix J. For information relating to community consultation after odour complaints, please refer to Section 2 of the Odour Management Plan.

8.2 COMPLAINTS PROCEDURE

The Environmental Incident Classification and Reporting Procedure (EICRP) written as part of the OEMP provide provision for the reporting of incidents, including odours. The EICRP provides information on the:

- Responsibilities of both staff and contractors;
- Record keeping of incidents and emergencies;
- Environmental incident Responses; and
- Reporting requirements which include a template of a report form for recording the incidents.

The EICRP does not provide a clear process which a member of the community can follow when making a complaint. When the Facility was first opened, staff at the Facility provided their telephone number and invited the public to contact them with complaints (as detailed in the CCP in Section 8.1). This practice continued until June 2015, when NABL directed the complainants to the NT EPA.

NABL have developed a new Complaints Handling Procedure in order to provide a robust approach to any odour complaints. The procedure is divided into two parts:

- Part 1 – Details how the complaints are to be handled by NABL and the personnel responsible. This includes a Community Complaint Form; and
- Part 2 – Ambient Odour Monitoring Survey which includes all procedures to be undertaken, personnel responsibilities, timeframes and forms to be completed during the surveys. There are two separate surveys to be carried out upon a complaint:
    - A Rapid Plant Assessment which is to be undertaken by trained NABL staff. This involves inspecting the entire plant for odour through sniff tests; and
    - An external investigation to be completed by the Environmental Officer and subsequent reporting.

The Complaints Handling Procedure is presented in Appendix K. The full procedure includes the Ambient Monitoring Procedure; this has not been included in Appendix K due to the size of the document. The full Complaints Handling Procedure including all its appendices is reproduced in the Odour Management Plan.

It is acknowledged that Community Reference Group monthly meeting may not suffice in some circumstances and NABL are currently developing a website for the community. It is proposed that this website will provide a range of information including planned maintenance of odour critical equipment; weather data; plant shut downs, environmental reports. Discussions relating to submitting odour complaints via this website are on-going. The proposed content and layout is currently being developed and NABL and in time will consult with the community to ensure that the website is a useful tool that benefits the community. NABL propose to discuss this at one of the monthly meetings when the website has been developed further.

9 ODOUR COMPLAINTS

This Section outlines the complaints received by the Facility and the NT EPA.

9.1 NABL COMPLAINTS REGISTER

NABL provided their complaints register which lists all the complaints, potential causes and corrective actions taken received 7/1/2015 – 16/7/2015 and the corresponding production data. Reviewing the data 58 complaints were made related to odour, three complaints related to the irrigation management and three related to noise nuisance as detailed in Table 9-1. Additionally, there were seven complaints to the NT EPA; these complaints were provided by the EPA to NABL and are discussed in Section 9.2.

Table 9-1: Odour Complaints Summary [NABL, 2015]

Complainant		Complaint Number	Reason for Complaint				Wind Directions
Name	Ref No.		Bio-filter	Irrigator Location	Abattoir, Other or Unknown	Non-Odour (Noise)	
Angelina Finn-Smith	C1	7 (12.1%)	1	5	1	-	WNW
Alistair Isberg	C2	1 (1.7%)	-	-	1	-	SE?
Sally Isberg	C3	32 (55.2%)	8	16	6	2	WNW, NNW, Calm
Liz Knox	C4	4 (6.9%)	-	2	1	1	NW
Rick Slater	C5	12 (20.7%)	1	5	6	-	NE, NNE and NE
Unknown	-	2 (3.4%)	-	-	2	-	-
Total		58 (100%)	10 (17.2%)	28 (48.3%)	17 (29.3%)	3 (5.2%)	-

The number of complaints for each month and the corresponding average temperatures and wind speeds at the time of the complaints is presented in Figure 9-1.

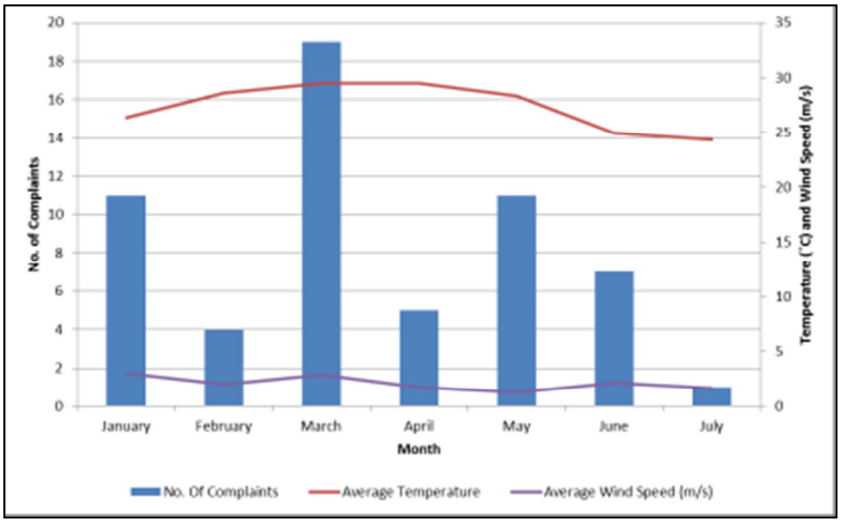


Figure 9-1: No. of Complaints Recorded by NABL and Average Weather Conditions

Most complaints received are related to odour issues. The main contributor to odour is the wastewater irrigation, which contributes 48% of the odour complaints as shown in Table 9-1. Under the EPL 131 conditions allow NABL to dispose treated wastewater into few designated irrigation areas within the boundary of the NABL facility, as shown in Figure 5-3.

Due to increase in the number of complaints received from residents to the south of the Facility, NABL have restricted irrigation in the southern irrigation plots since the 10th of June 2015 until further notice. For the time being NABL are irrigating at the Northern irrigation plots only.

Table 9-2 presents the production data and irrigation rates on the days when complaints were made.

Table 9-2: Production Data during Complaints

Date	No. of Complaints	Recorded Cause of Complaint	Production Data				
			Total Head Processed[2]	HSCW (kg)	DAF Sludge (Tonne)	Tallow (Tonne)	Irrigation Qty (L)
7/01/2015	1	Bio-filter	206	41,038	2.61	-	636
9/01/2015	4	Bio-filter	193	37,896	2.41	-	974
15/01/2015	2	Irrigation	133	25,396	1.62	-	942
19/01/2015	1	Bio-filter	220	41,901	2.67	-	761
23/01/2015	1	Bio-filter	223	41,840	2.67	-	991
27/01/2015	1	Bio-filter	224	40,107	2.55	-	524
29/01/2015	1	Bio-filter	251	47,272	3.01	-	1,013
3/02/2015	2	Irrigation	221	47,999	3.06	-	521
7/02/2015	**1**	**Irrigation**	**-**	**-**	**-**	**-**	**-**
11/02/2015	1	Irrigation	-	-	-	-	-
2/02/2015	1	Irrigation	251	50,623	3.22	-	361
3/03/2015	2	Irrigation	271	51,592	3.29	-	551
4/03/2015	1	Irrigation	179	33,723	2.15	-	1,133
5/03/2015	1	Irrigation	163	29,483	1.88	22.3	1,040
13/03/2015	1	Bio-filter	227	43,499	2.77	10.96	1,330
15/03/2015	1	Livestock	-	-	-	-	688
16/03/2015	3	Irrigation	236	44,435	2.83	-	-
17/03/2015	2	Irrigation	97	18,540	1.18	-	-
18/03/2015	1	Irrigation	223	43,782	2.79	22.06	921
19/03/2015	2	Irrigation	236	45,491	2.90	-	842
20/03/2015	2	Rainfall[3]	207	41,891	2.67	-	738
29/03/2015	**2**	**Irrigation**	**-**	**-**	**-**	**-**	**-**
30/03/2015	1	Irrigation	153	30,052	1.91	-	818
1/04/2015	1	Rendering	161	31,355	2.00	-	No data
4/04/2015	**1**	**Unknown**	**-**	**-**	**-**	**-**	**-**
7/04/2015	1	Unknown	227	44,267	2.82	-	No data
9/04/2015	1	Irrigation	208	41,236	2.63	-	No data
15/04/2015	**1**	**Rainfall**	**220**	**47,467**	**3.02**	**18.52**	**No data**

[2] The number of hides processed per day is the same as the total head processed value.
[3] The comment in the complaint database stated that odour was increased as a result of a rainfall event (see following section for more details)

Date	No. of Complaints	Recorded Cause of Complaint	Production Data				
			Total Head Processed[2]	HSCW (kg)	DAF Sludge (Tonne)	Tallow (Tonne)	Irrigation Qty (L)
5/05/2015	1	Unknown	253	57,028	3.63	21.9	863
10/05/2015	3	Unknown	-	-	-	-	-
19/05/2015	3	Irrigation	299	62,320	3.97	19.94	850
20/05/2015	2	Unknown	285	60,878	3.88	-	993
21/05/2015	1	Unknown	284	60,902	3.88	20.65	887
30/05/2015	**1**	**Unknown**	**-**	**-**	**-**	**-**	**30**
10/06/2015	2	Unknown	287	66,952	4.26	19.35	-
17/06/2015	1	Unknown	286	57,849.50	3.69	-	718
30/06/2015	5 (4 to EPA)	Unknown	339	65,706	4.19	20.5	5
16/07/2015	1	Unknown	318	66,151.50	32.56	20.59	704
25/03/2015	1 (EPA)	No details	144	27,763	1.77	-	796
29/03/2015	**1 (EPA)**	**No details**	**-**	**-**	**-**	**-**	**-**
12/04/2015	**1 (EPA)**	**No details**	**-**	**-**	**-**	**-**	**-**
5/05/2015	1 (EPA)	No details	253	57,028	3.63	21.9	863

From the review of the weather data and Table 9 2 the following can be concluded (excluding the EPA complaints shaded grey):

- Two of the complaints on the NABL register state the cause of complaint was due to a 'rainfall event'. No other information or reasoning was provided, however a review of the weather conditions stated that there was no rain prior, during or after the date and time of the complaint.
- Of the 17 complaints in Table 9-1 in the 'abattoir odour, other or unknown' column, there were 11 complaints where the cause of the odour was unknown, possibly coming from the abattoir:
  - During two 'unknown' complaints (4/4/2015 and 30/5/2015), the abattoir was not producing nor irrigating;
  - Of the remaining nine complaints, they all occurred during the evening (18:15 - 22:00 hours):
    - Five of these occurred during calm wind conditions; and
    - The remaining four complaints occurred during NNE or ENE weather conditions. These wind directions are not favourable to blow the odour in the direction of the residents who complained. This is inconsistent with the location of the complainant. As such these five complaints are considered invalid.
- Two complaints where irrigation was detailed as the cause (7/2/2015 and 29/3/2015), the abattoir was not irrigating.

Overall, six of the 11 complaints relating to unknown causes were deemed to be not caused by the abattoir, based on weather conditions at the time of the complaint and the location of the complainant in relation to the Facility.

The weather conditions (temperature, humidity, wind direction (blowing from), wind speed and rainfall) for the corresponding time and date of each complaint were obtained from Bureau of Meteorology (BoM) station at Noonamah, which is recorded every 30 minutes. Figure 9-2 shows the direction the wind was blowing from and the wind speed during the complaint events. It is acknowledged that the wind conditions can vary across the Facility site, and that spilt second changes in the wind direction may have occurred to cause the complaints (based on the one second response described in Section 3.2.3; however the consistent wind directions do not fully substantiate the complaints.

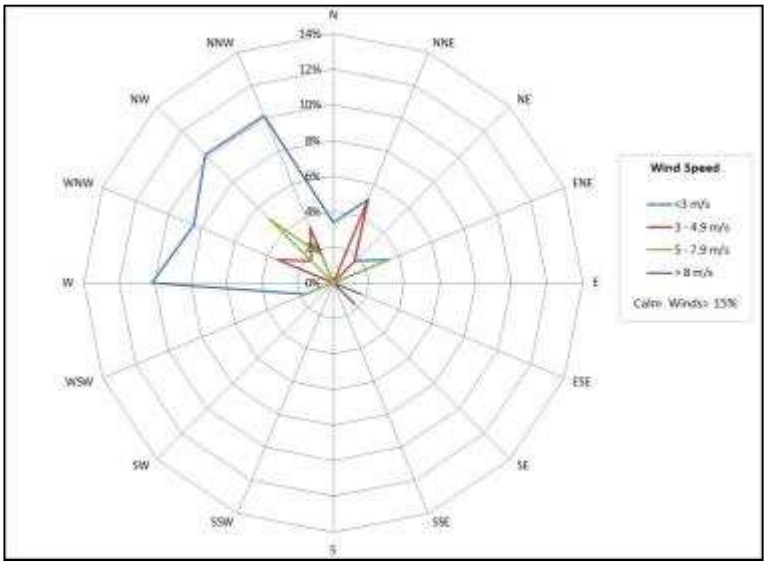
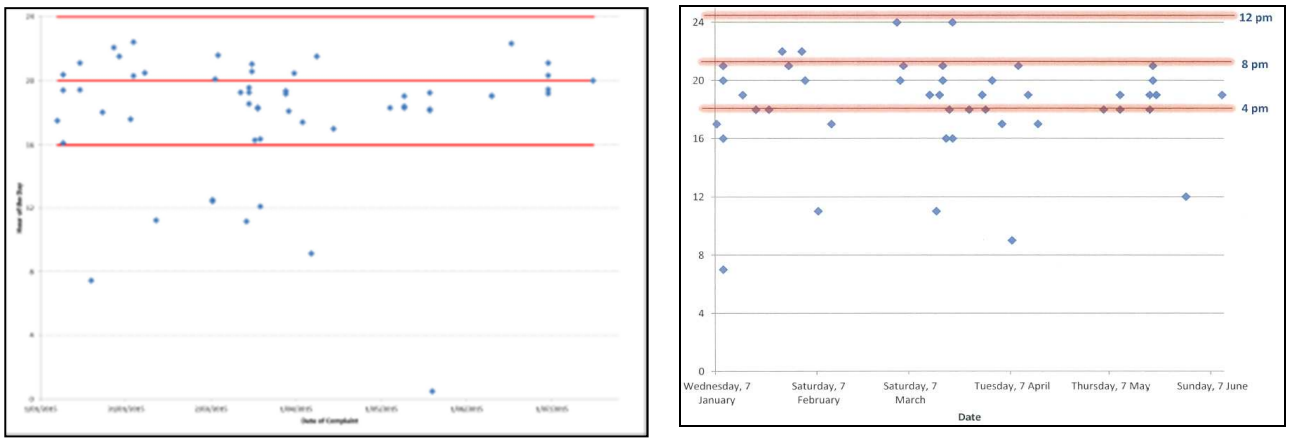


Figure 9-2: Windrose during the Complaint Events – Direction Wind Blowing From [BoM, 2015]

The majority of the complaints were received from the Cornock Road residents, who are located to the south of the plant boundary. The winds from the north westerly direction will disperse the odour from the irrigation areas and holding pens to these receptors.

The Notice from the NT EPA provided a time chart of the complaints; for consistency the complaints received by NABL have also been reviewed by the method and are presented in Figure 9-3.



NABL Complaints **EPA Complaints**

Figure 9-3: Complaints by Time of Day [NT EPA, 2015 and NABL, 2015]

It can be seen from the chart that the majority (68%) of the complaints have occurred after 18:00 hours and 81% of complaints occurred after 16:00 hours. The findings of the chart are consistent with the chart in the Notice.

In order to determine if the reasons for the complaints correspond to the time at which the complaint was made, a review of the main activities and the typical time frames has been undertaken; NABL provided time frames for the main activities:

- Processing (kill floor): 07:00-14:15;
- Rendering: 07:00 – 18:00 (approximate);
- DAF: 04:30 – 22:00 (approximate); and
- Irrigation: 04:30 – 22:00 (approximate).

Reviewing the time of complaints with the activities at the Facility there was only four complaints received after 22:00 hours, when the DAF and irrigation activities cease.

Detailed analysis of metrological conditions, including mixing height at the Facility is presented in the Air Quality Impact Assessment (Air Environment Consulting Pty Limited, 2015a):

> "The mixing height refers to the height above ground within which the plume can mix with ambient air. During stable atmospheric conditions at night, the mixing height is often quite low. During the day, solar radiation heats the air at ground level and causes the mixing height to rise through the growth of convection cells. The air above the mixing height during the day is generally colder. The growth of the mixing height is dependent on how well the air can mix with the cooler upper levels of air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions the air will be well mixed, resulting in a high mixing height".

The hourly distributions of mixing height at the Facility are presented in Figure 7-3, and it can be clearly seen that between 18:00 – 19:00 hours the average mixing height decreases from approximately 1,850 m to <100 m. This reduction in mixing height increases the concentration of odour due to the smaller air volume available for vertical dispersion.

Since 25th August 2015, NABL have undertaken sniff tests around the Facility at two hour intervals 06:30 – 14:30 hours to determine if the intensity of the odour in each area. The minimum, maximum and median values 25th August 2015 and 21st September 2015 are presented in Figure 9-4.

Whilst the sniff tests are informal the collation of information demonstrates a proactive response to better understanding the odour complaints. There spreadsheet provided did not detail any weather conditions nor Facility operational information at the time of the sniff tests. It is unknown if any of the sniff tests were taken downwind during irrigation activities. As a result it is difficult to use the information to correlate odour strength vs. time and thus provide an indication if it's the evening meteorological conditions that are affecting the odour strength or whether the evening complaints are due to people being at home.

Overall, the odour complaints reported to NABL, which are the result of normal operations, are made between 18:00 - 22:30 hours. As discussed previously, the only odour sources at this time are the DAF and irrigation. As both of these activities operate for most of the day, it appears that the significant decrease in mixing height after sun set is causing the odour concentration to increase and cause offense. Additionally, if people in the local area are at work during the daytime period, it could also be an indication of when people are at home.

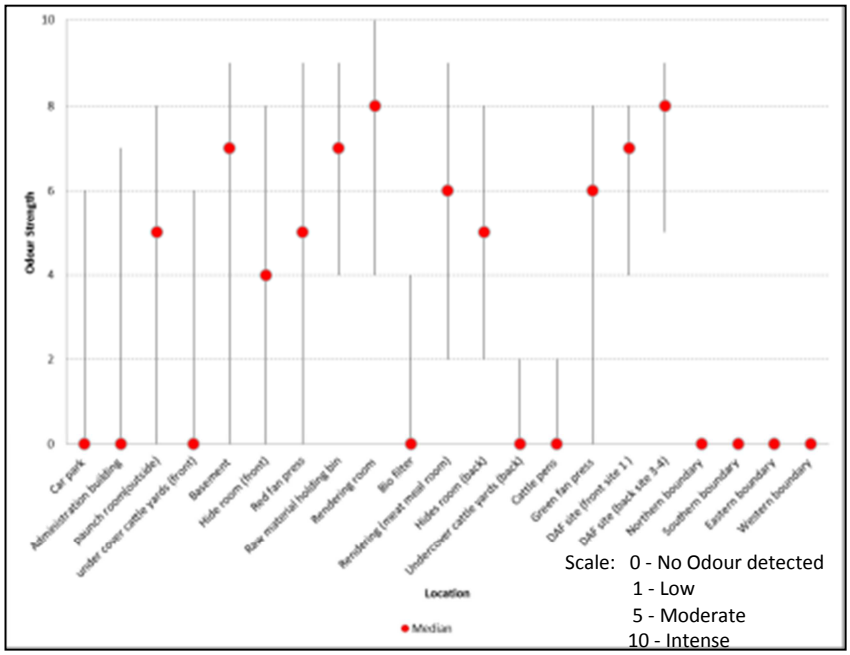


Figure 9-4: Minimum, Maximum and Median Odour Intensity through Sniff Tests [AACo, 2015]

9.2 NT EPA COMPLAINTS

The NT EPA has confirmed that as of 22nd September 2015, they had received 46 complaints about the Facility. NT EPA confirms that the number may be higher as some of the earlier complaints had multiple reports added against their file name whereas new complaints have a unique reference number now. NT EPA did not provide much data but they provided the number of complaints per month in 2015. The times and dates of the complaints were not provided so an analysis of the weather conditions, particularly the wind speed and direction could not be undertaken. The number of complaints per month is as follows February (1), March (8), April (5), May (6), June (7), July (7), August (8) and September (4). The location of the complaint roads is presented spatially in Figure 9-5.

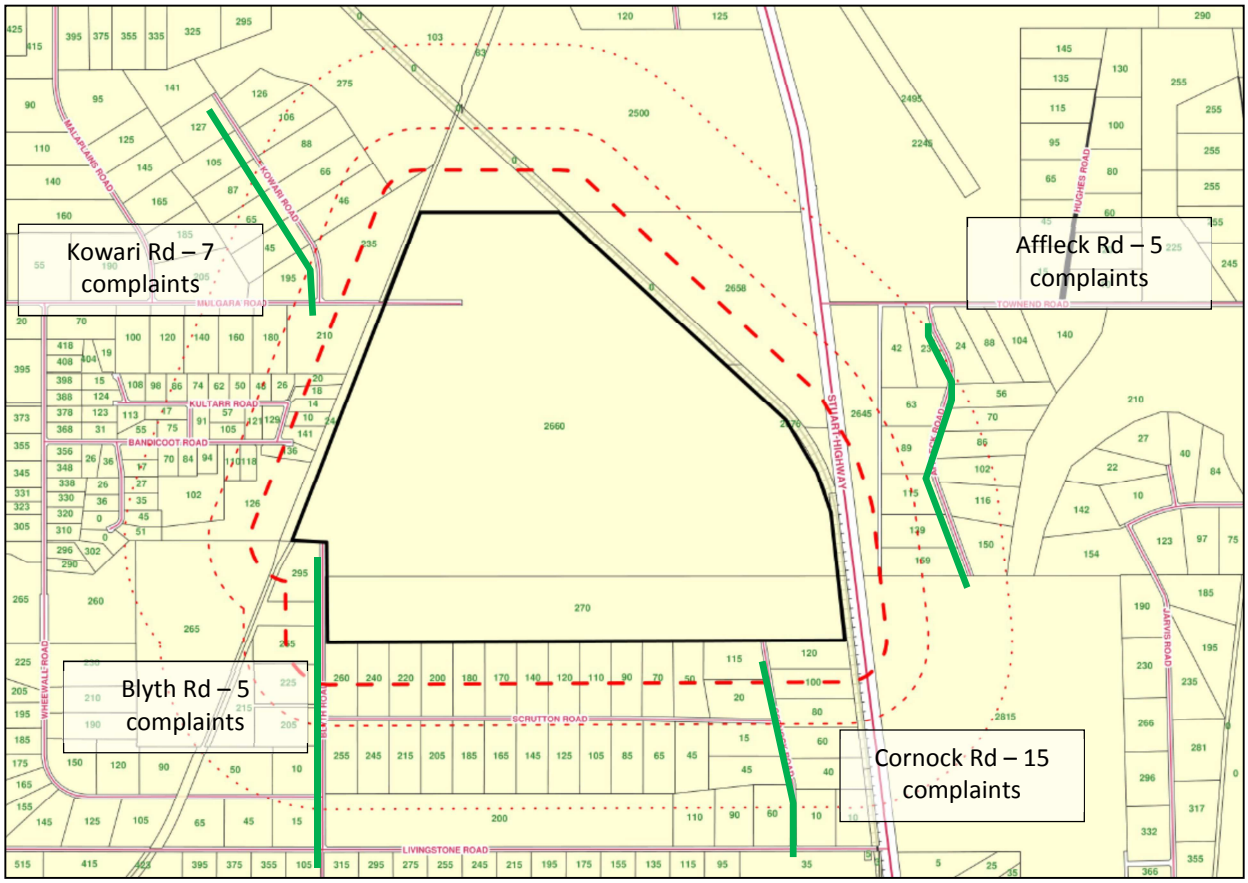


Figure 9-5: Number of Complaints by Road and Boundary Buffers at 250 m, 500 m and 1,000 m [NT Maps, 2015]

9.3 SUMMARY OF COMPLAINTS

A review of the production data, irrigation rates and weather conditions at the times of the complaints has identified that not all of the odour complaints made to NABL or NT EPA are valid. Some complaints have been made when there were no activities at the Facility.

It should be noted that there is a cattle feedlot, operated by Wellard, located approximately 530 m north of the Facility. At present, the NT EPA has refused to acknowledge that Wellard's operations may be a contributory factor to the odour complaints. The odour from the feedlot would primarily be from manure, whereas from the Facility the rendering plant (burnt/cooking smell) and irrigation (earthy/agricultural smell). To untrained personnel and nearby residents, the distinction between the odour characteristics from the two operations may not be apparent.

It should also be noted that an application to extend the Wellard operations from 4,000 to a 12,000 cattle capacity has recently been published. A news article in NT News on 3rd November 2015 quotes the NT EPA stating *"intensive animal husbandry can be a source of significant odour emissions which can have an adverse effect on the community amenity".* The submitted Odour Assessment as part of the feedlot application is based on distance separation principals and no odour sampling or modelling activities were undertaken.

10 ODOUR SAMPLING

This Section details the odour sampling information including the sampling plan, methodologies, analysis locations and weather conditions during the two site visits.

10.1 OBSERVATIONS AT SITE

John Fraser (a former Queensland EPA Pollution Inspector) provided an unbiased review of odour at the abattoir after two full days at the Facility. John has no prior knowledge of the Facility. John's observations are presented in Table 10-1.

Table 10-1: Observations at Site [John Fraser]

Area	Observations	Odour Discussion and Ranking
Irrigation water at the irrigation tank	Effluent water has an unacceptable variable quality and concerning characteristics (H_2S and flocculation).	The odour was not offensive in that location and had a strong treated industrial effluent smell. Due to the potential to release sulphidic odours a maximum intensity rating of 5 is allocated (see Figure 10-1 for explanation). .
	Testing showed that hydrogen sulphide is released in the irrigation tank from the water column (the odour was not detectable by the nose until a 24-hour sniff test was completed).	
	There is no agitation or aeration of contents. The pump outlet is 300 mm above the base.	
Irrigation water sprays and assessment	Irrigated soil was excavated to 150 mm. About 30 mm top sandy soil with some humus and no retained odours while sodic looking impenetrable clay appeared to underlay the top soil. There were no detectable odours residual in the soil while in use or in areas previously used.	Sampling Period = 6 minutes Intensity average = 1.25 Frequency per minute =2.5 (15 events /6 mins) Cumulative effect = intensity X frequency per minute = 3.1. The intensity chart (Figure 10-1). Indicates that the nuisance risk is low.
	The effluent odour is generally described as inoffensive in its location. Its character is that of a dank and earthy agricultural odour.	
Bio-Filter	Odour from the surface of the bio-filter was almost neutral except for the smell of the industrial fragrance spray. The odour was barky /organic in character. It appears unlikely to have off site issues under normal operation.	An overall 'nuisance' rating of 4 is allocated due to its observed inoffensive nature (see Figure 10-1 for explanation).
Skip storage areas	Activities here did not appear well considered. Rotting odour smells could be easily detected, even from empty skips. Plans are afoot to have a roofed area in the medium term. Rendering waste in skips must be stored in such a manner as not to cause fugitive offensive emissions including situations of auto-combustion which was observed and reported to the chief engineer for immediate action.	DAF sludge generally appeared to be inoffensive. However on the final day there appeared to be gassing occurring in a full DAF sludge skip, although the odour level appeared low.
Rendering operations	While the odour from the general render process was strong, the offensiveness normally associated with render was not present. It is understood all materials used are fresh from slaughter and may explain the character of odour. There is a definite roasting/browned in the oven type component which may be taken as a burnt odour.	Ammonia was not detected 100 m downwind but the render smell was strong. A rating of 5 is expected for intensity and offensiveness. While any rank rottenness or foulness is missing, people's perception of render odour easily brings it back to 5.
	The meal handling area needs further engineering to remove possibility of product or air from contact with product being discharged. The air from the meal cyclone discharges from a duct in the side of a west wall.	

Area	Observations	Odour Discussion and Ranking
	Apart from potential to discharge meal to external areas, the air carries odourous components.	
	On the blood run only, the ammonia level is at dangerous concentrations in the headspace of the primary render process building. It appears that the vertical extraction pipes (2 stainless 75 mm pipes) that discharge from the decanters have been disconnected (it should be noted that these pipes have now been reconnected). They appear to run through the wall to the rotary process.	
Hide Curing	Odours appear localised and are not generally detected at 100 metres.	N/A
Kill Floor	Gut and entrails well is located beneath the kill floor area. Daily spillage into this area is the norm. Product that is left there produces odours and contaminates any air running through the well.	N/A
Drains	Most drains appeared clear of process spillage / contamination. One underground pipe that flows from the plant process area to an open earth drain adjacent the skip storage area was highly contaminated with process liquids to the extent that anaerobic activity was noted.	Offensive sulphidic (H_2S) odours emanating from the drain with potential to cause off site problems. Intensity rating 5.
Earth Pits	Earth pits located outside the plant perimeter to the west. The engineer then advised that steps were being undertaken to remediate this odour source.	Offensive odours were clearly noticeable and have the capacity to cause impacts offsite.

John has developed a matrix chart (Figure 10-1) which identifies the risk of environmental nuisance based on the average intensity and number of odour events per minute (the number of events is considered to be 1 odour detection = 2.5% Sampling Period or 3 Seconds). The colour scheme classifies whether opinions can be formed to classify odour as environmental nuisance.

Average Intensity	Number of Odour Events per Minute (1 Detection = 2.5% Sampling Period or 3 Seconds)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	

Key: Green – No nuisance / Orange – Nuisance where an opinion could be formed / Red - Nuisance where environmental nuisance could be supported

Figure 10-1: Odour Intensity Matrix [John Fraser]

10.2 SAMPLING PLAN

Table 10-2 details the finalised sampling plan submitted to NT EPA on 23rd September 2015 (Vipac document reference 70Q-15-0248-GCO-518818-1 dated 23rd September) as proposed by Chris Clunies-Ross, Ian Brash and Andrew Balch and endorsed by the Auditor.

A provisional sampling plan was proposed and approved for the first site visit (15-17th September 2015) for the known components of the Facility. The unknown aspects would be discussed and approved by the Auditor separately and sampled during the second site visit (28th September to 1st October 2015). The sampling plan has considered all odour sources at the Facility, in accordance with the Notice.

Table 10-2: Final Sampling Plan as Submitted to NT EPA

Location/Process	Emission source type	Sampling Method	Number of Samples per Source	Issues /Access/ Production Requirements
Lairage				
Receival and Holding Yards	Fugitive: - Area (surface)	Flux chamber	4	
AQIS Yard	Volume (fugitive)	Point source	2	- Representative number of animals in the area and condition of area.
Rendering				
Red Fan Press: Screw Conveyor	Volume (fugitive)	Point source	1	
Red Fan Press: Tank/Sump	Volume (fugitive)	Point source	1	
Raw Material Bin	Volume (fugitive)	Point source	2	
Wet Rendering Building	Volume (fugitive)	Point source	2	- Production levels during sampling. - Building odour spatial and temporal variability. - Measuring building ventilation rates.
Rendering Cooker Room			0	Not considered odorous during scoping site visit.
Bio-filter	Area (active net outflow)	Flux chamber	6	- Sample while operating. - Does its intermittent use (on/off state) affect its performance? - Operating conditions: flows, back pressure, moisture content. - Are there any chimneys in the media? - Is the flow consistent across the bed?
Meat Meal Hammer Mill Cyclone	Point source (wall vent)	Point source	2	- Elevated wall vent. Require elevated platform.
Tallow transfer and storage	Point source - vent	Point source	2	Overflow vents. Only vents during filling. Otherwise headspace if there is an issue.
Hides building			0	Not considered odorous during scoping site visit.
Wastewater Treatment Plant				
Green Sump	Area source	Flux chamber	2	
Common Sump	Area source	Flux chamber	2	
Equalising Tanks (2)			0	No vent. Overflow goes to Common Sump.

Location/Process	Emission source type	Sampling Method	Number of Samples per Source	Issues /Access/ Production Requirements
DAF Inlet End	Area source	Flux chamber	2	- Production levels during sampling. - DAF tank odour spatial and temporal variability.
DAF Outlet End	Area source	Flux chamber	2	- Production levels during sampling. - DAF tank odour spatial and temporal variability.
Lamella	Volume (fugitive)	Point source	0	Not in use anymore.
In-ground tank			0	Tank used occasionally – as backup. Client has stated that this contains the same liquid used in Spray Irrigation.
Irrigation tank	Volume (fugitive)	Point source	2	This tank water is irrigated
Spray irrigation	Fugitive: - Volume (spray evaporation)	Point source	6	3 whilst irrigating, and 3 between irrigations at various times to see how it tails off
First Flush Dam	Area source (liquid surface)	Flux chamber	0	No water in dam
DAF Sludge Decanter Fresh material	Area source	Flux chamber	1	High concentration, small area source.
Sludge Storage (Hook) Bin on aged sludge (near WWTP)	Area source	Flux chamber	1	High concentration, small area source.
Sludge Storage (Hook) Bin with Contra Shear Scrapings – Day old (near WWTP)	Area source	Flux chamber	1	High concentration, small area source.
Paunch storage bins, Fresh material (near WWTP)	Area source	Flux chamber	1	Hook bin
Paunch storage bins, Day old material (near WWTP)	Area source	Flux chamber	1	Hook bin

Chris Clunies-Ross (Odour Testing)	Vic Natoli - Auditor (VIC EPA)
Airlabs Environmental Pty Ltd	**V&C Environment Consultants Pty Ltd**

10.3 SAMPLING AND ANALYSIS METHODOLOGIES

The Sampling Report prepared by Airlabs is presented in Appendix E; the report detailed the sampling and analysis methodologies, as detailed herein.

Odour samples were collected using the 'lung-in-the-box' technique in accordance with the *AS/NZ Standard 4323.3:2001 'Stationary Source Emissions – Part 3: Determination of Odour Concentration by Dynamic Olfactometry'*. The sample was drawn through a Teflon tube that fed into a Nalophan sample bag.

Area source samples were first isolated using a 'Five Senses' AC'SCENT emissions isolation flux hood in accordance with the AS/NZ Standard 4323.4:2009 'Area Source *Sampling – Flux Chamber Technique'*. The flux hood comprised a stainless steel constructed isolation flux chamber with a surface area of 0.13 m^2. The flux hood has a stainless skirt which ensures that the surface area enclosed by the hood is isolated.

The flux hood was operated using the standard operating parameters as specified in AS/NZS 4323.4:2009 for a USEPA Chamber. These were as follows:

- Sweep Air Flow = 5 Litres per minute;
- Sweep Air Velocity = 5.1 m/s; and
- Sample flow rate = 2.5 Litres per minute (max).

Odour samples were analysed in accordance with the *AS/NZ Standard 4323.3 'Stationary Source Emissions – Part 3: Determination of Odour Concentration by Dynamic Olfactometry'*.

Odour concentrations were determined using a dynamic olfactometer operating in the forced choice mode with a step factor of 1.5. The odour panellists were all familiar with the procedure and specially selected in accordance with the Australian Standard criteria. The total number of dilutions of the sample at which 50 percent of all responses of the panellists confirmed odour detection is reported as the panel threshold, and is expressed in odour units (OU).

Two ports were available to each panel member; one presenting the odorous gas and one presenting a neutral reference gas (carbon-scrubbed air). Each sample was analysed three times. Individual threshold estimates for each panel member were determined and the corresponding odour concentrations were calculated, with the average response of the second and third analyses reported. As specified in the standard, all analysis was completed within 30 hours of sample collection.

The precision of results obtained by the techniques described lies statistically within the 95% confidence interval. The methodology by which emission rates were determined is presented Appendix E.

10.4 WEATHER CONDITIONS

During the sampling periods, weather data at site was recorded. During the first trip the weather station duration was set at 10 minute intervals and 60 minute intervals during the second trip. The wind measurements (speed and direction) used for the measurements were obtained by using a handheld anemometer due to the variability of the winds across the site. The temperatures during the visit as recorded by the weather station were predominantly 30 - 39˚C during the sampling times. Only 0.6 mm of rainfall was recorded during the visits, this occurred on the final day of sampling. The weather conditions, as recorded by the weather station at the Facility are presented in Appendix F.

10.5 PRODUCTION RATES

NABL provided the production rates during the sampling period, as shown in Table 10-3.

Table 10-3: Production Rates during Site Visits

Date	Day	Category	Head	Total Hot Standard Carcase Weight (kg)
16-Sep-15	Wed	BULL	0	0
		COW	420	80,156.00
17-Sep-15	Thu	BULL	0	0
		COW	403	70,411.50
18-Sep-15	Fri	BULL	0	0
		COW	364	69,674.00
21-Sep-15	Mon	BULL	0	0
		COW	439	79,355.50
22-Sep-15	Tue	BULL	0	0
		COW	392	77,995.50
23-Sep-15	Wed	BULL	0	0
		COW	71	14,772.00
24-Sep-15	Thu	BULL	235	50,654.00
		COW	0	0
25-Sep-15	Fri	BULL	271	63,423.00
		COW	0	0
28-Sep-15	Mon	BULL	164	49,749.00
		COW	0	0
29-Sep-15	Tue	BULL	247	64,551.50
		COW	0	0
30-Sep-15	Wed	BULL	296	91,856.00
		COW	0	0
01-Oct-15	Thu	BULL	24	6,745.00
		COW	332	82,000.00

10.6 SAMPLING AND ODOUR EMISSIONS LOCATIONS

The odorous areas of the Facility where samples were obtained and photographs of each area are presented in Figure 10-2 to Figure 10-7. Additional photographs have been added for context. A full site layout is presented in Figure 5-3.

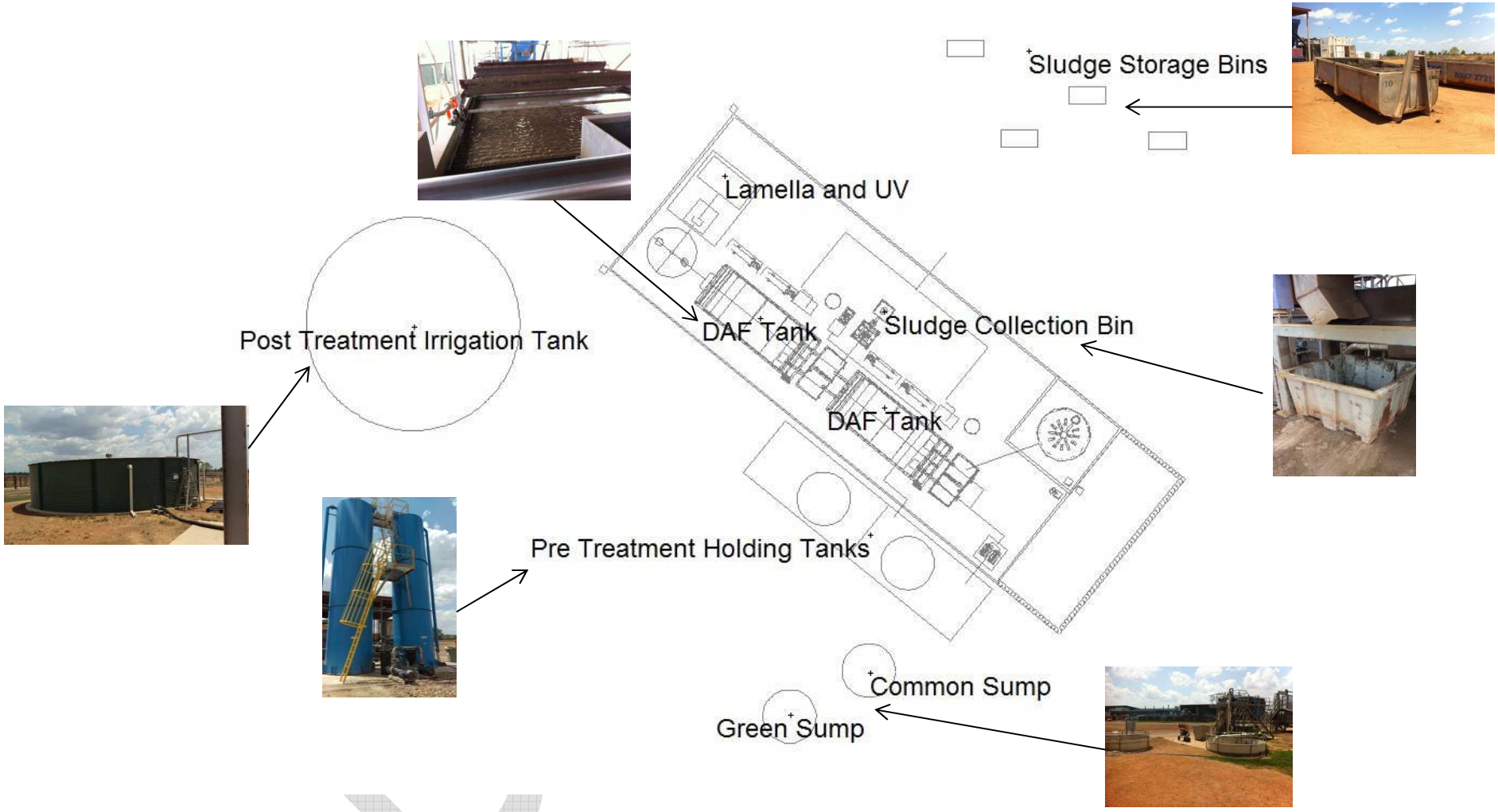


Figure 10-2: DAF and Wastewater Sampling Locations

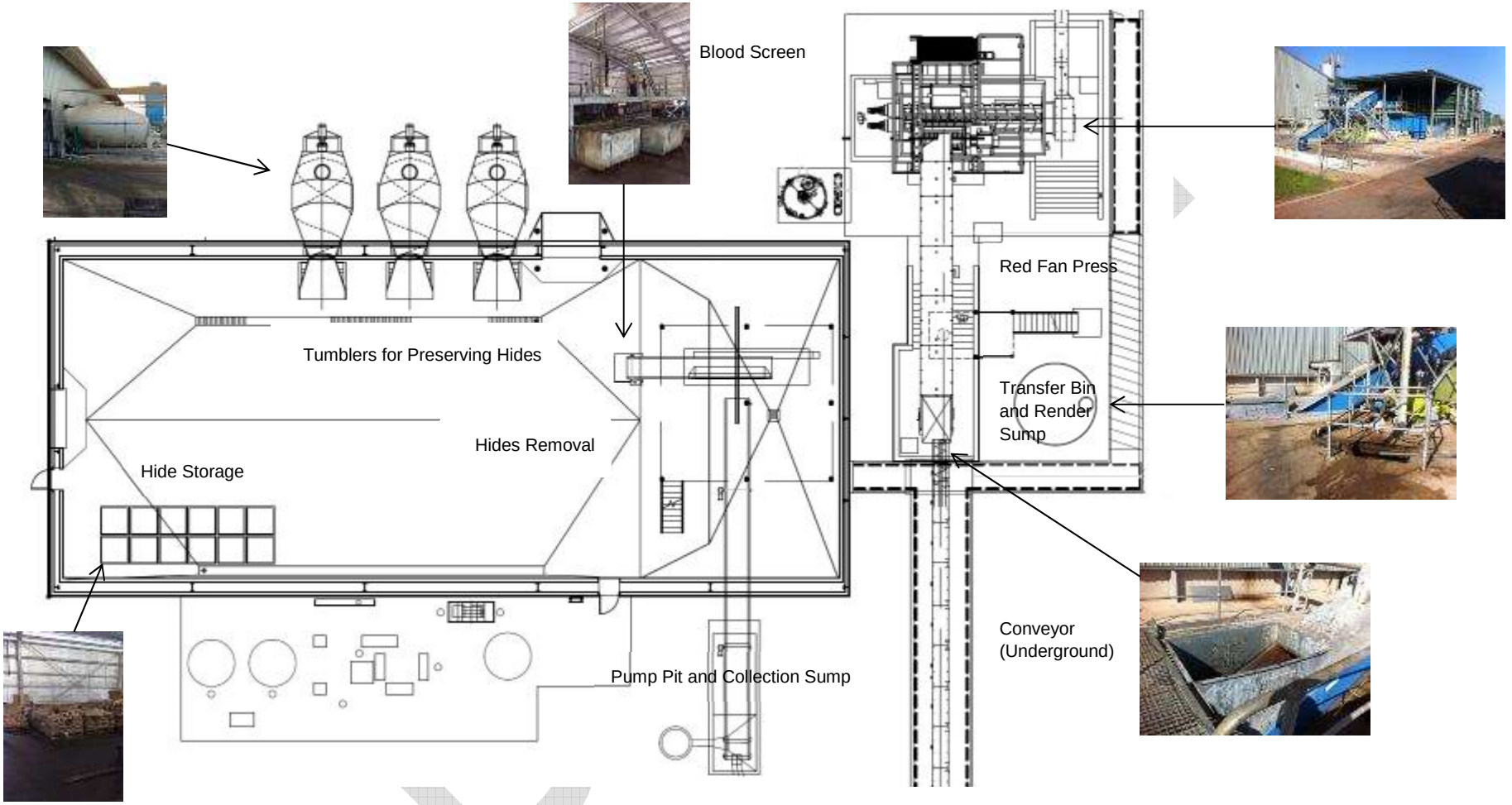


Figure 10-3: Hides Building Sampling Locations and Additional Photos for Context

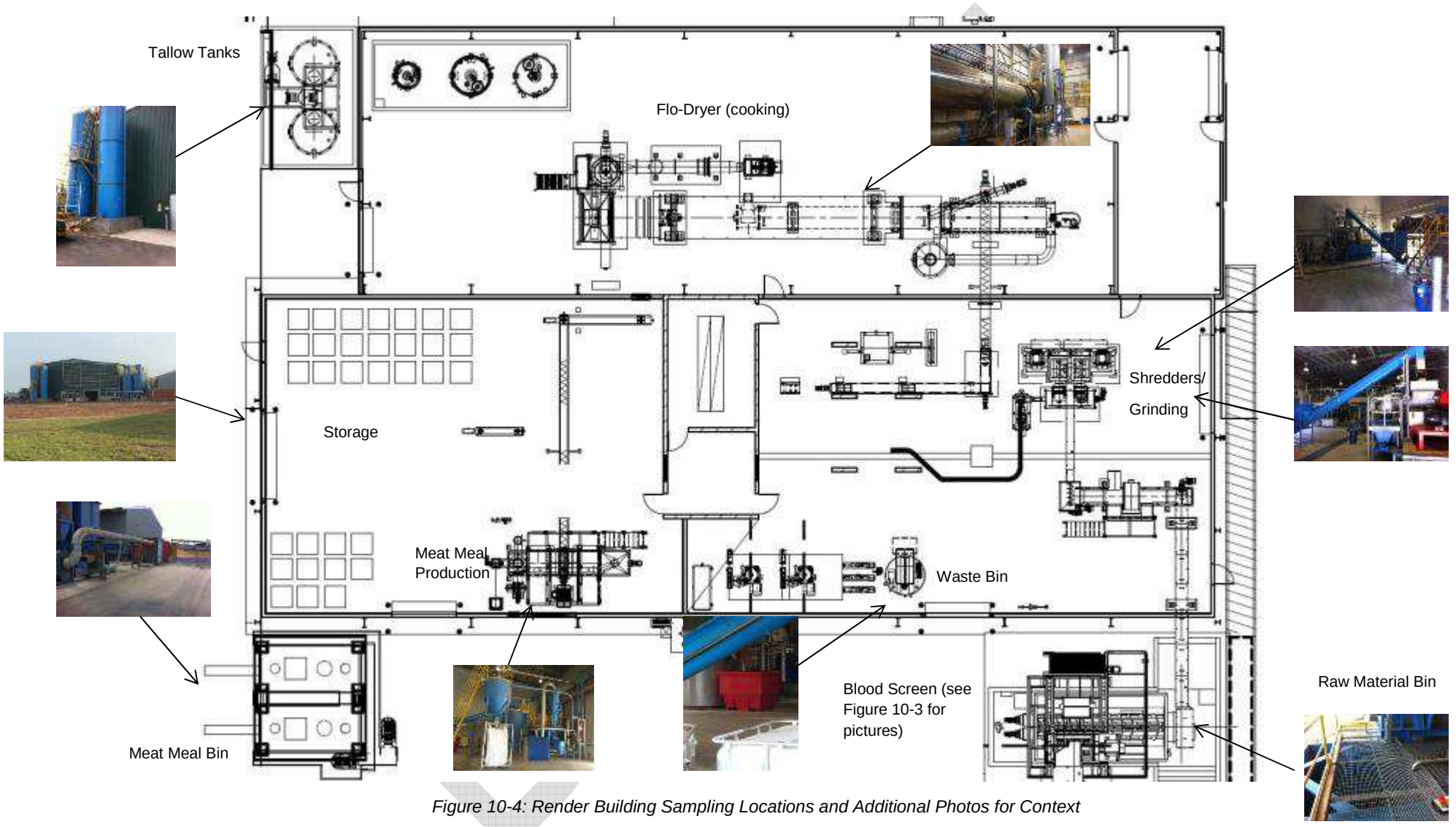


Figure 10-4: Render Building Sampling Locations and Additional Photos for Context

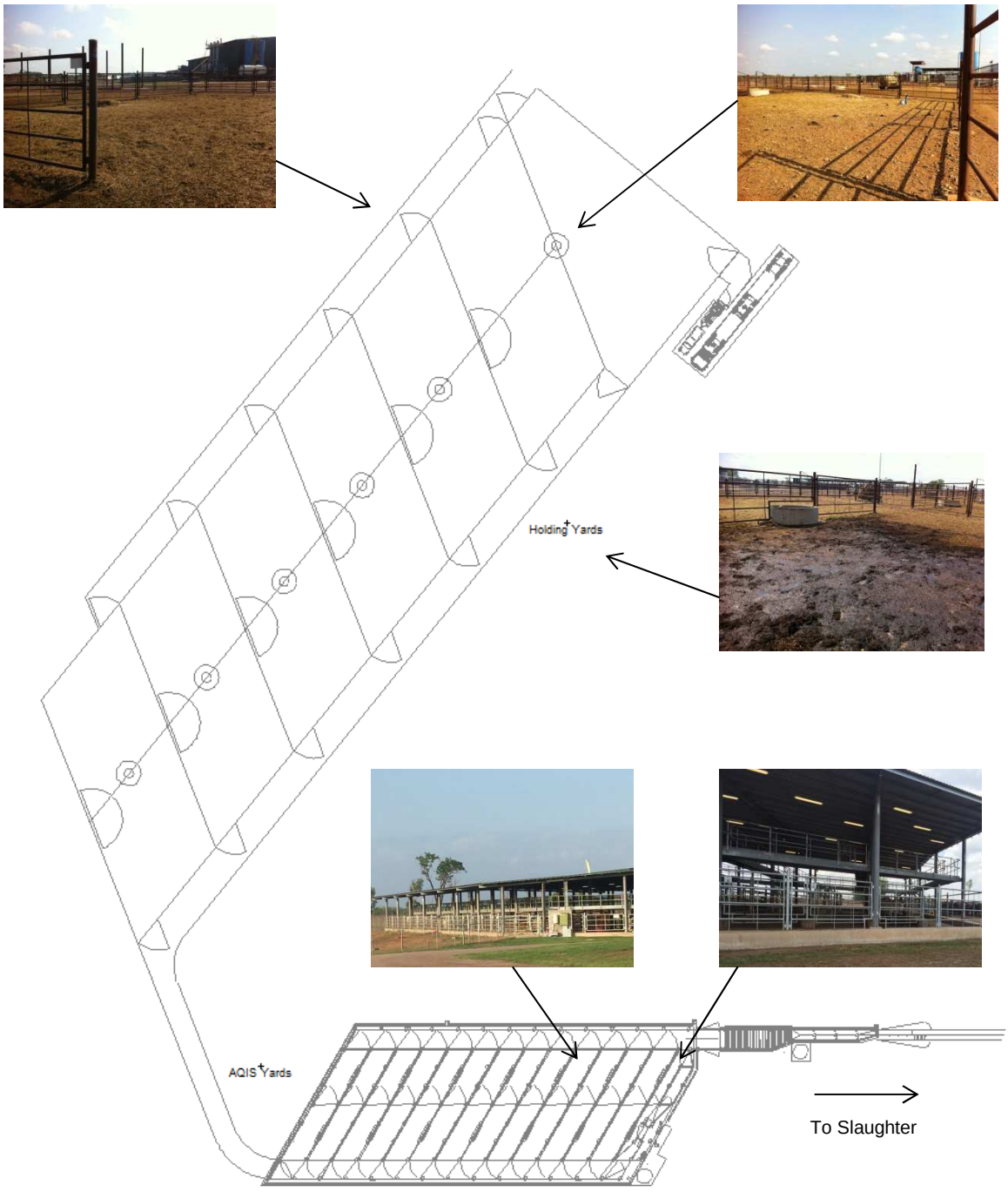


Figure 10-5: Holding Yard and Irrigation Sampling Locations and Additional Photos for Context

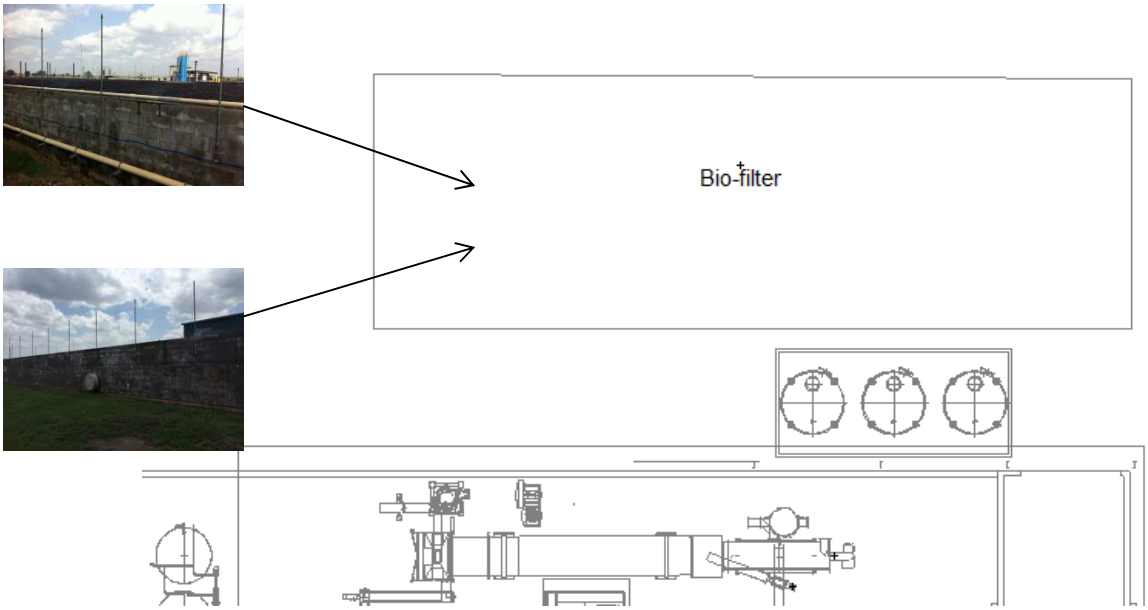


Figure 10-6: Bio-Filter Photos for Context

Figure 10-7: Irrigation Sample Locations with Transect [Google Earth]

10.7 AUDITOR'S EVALUATION OF SAMPLING QUALITY

Based on a review of the Air Labs Environmental odour test report No. SEP15166.1 and the odour calculation spreadsheet, the following conclusions can be arrived at:

- The sources which could potentially cause off-site odours have been identified-
- The sampling methodology was suitable and would allow the odour concentrations and emission levels to be determined.
- The analysis method was suitable in order to determine the odour concentration of each sample.
- The calculation method was logical and applied appropriately.
- As Air Labs Environmental is NATA accredited and are audited regularly by NATA, it can be assumed the flow, volume and temperature measurement devices used during testing and analysis are suitably calibrated.

11 ODOUR IMPACT ASSESSMENT

This Section reviews the original and revised Air Quality Impact Assessments prepared by Air Environment.

11.1 ORIGINAL ASSESSMENT SUMMARY

As mentioned in Section 4, an Air Quality Impact Assessment (AQIA) (document reference 1411.006 dated 10th March 2015) was completed in accordance with the EPL 131 by Air Environment Consulting Pty Limited.

The AQIA is a dispersion modelling study that combined site-specific details of the Facility with various assumptions and estimation techniques to simulate and assess the dispersion and impact of air pollutants in the local area. The AQIA includes air emission rate of the bio-filter, typical emission rates of other sources, source characteristics, local meteorology, land use, terrain and the location of sensitive receptors to assess the potential for future air quality to be affected. The AQIA approach complies with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005), in accordance with the EPL 131 requirements.

The odour impact assessment criterion of 2 OU was been selected for the assessment based on the population density of the area as prescribed in the *Technical Framework for Assessment and Management of Odour from Stationary Sources* (Department of Environment & Conservation, 2006). A summary of the criteria is presented in Table 11-1.

Table 11-1: Odour Impact Assessment Criteria Used in the Assessment [Air Environment Consulting Pty Limited, 2015a]

Pollutant	Averaging Period	Statistic (Percentile)	Assessment Criterion
Odour	1 second	99.0th	2 OU
Hydrogen Sulfide	1 second	99.0th	1.38 µg/m3
Ammonia	1 hour	99.9th	330 µg/m3

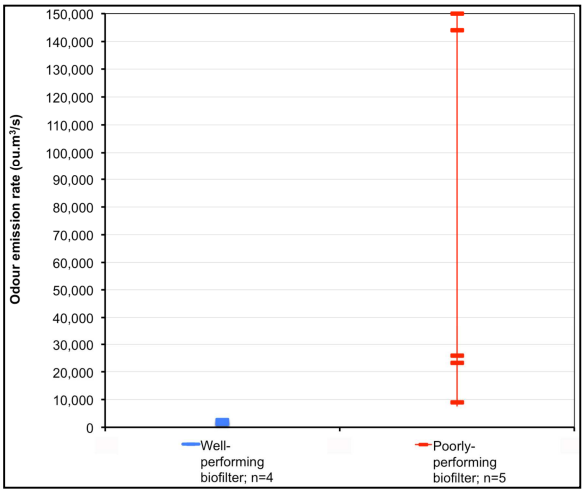
A detailed analysis of meteorogical conditions was undertaken as part of this assessment to determine a representative year of meteorological data was to be modelled. The assessment provides analysis and justification for the meteorological year chosen (1 September 2011 to 31st August 2012). The meteorological data was generated using TAPM, in accordance with the Approved Methods and the performance of TAPM output was evaluated and simulated in CALMET for use in the CALPUFF dispersion model.

The dispersion modelling was conducted in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for Inclusion into the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia (2011)* (Barclay, Jennifer and Scire, Joe, 2011).

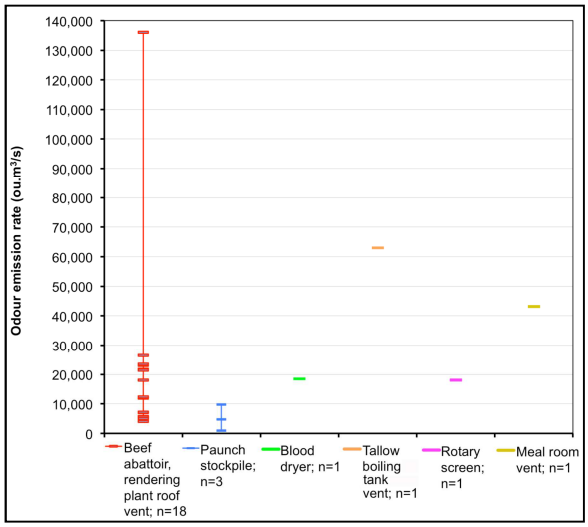
The odour emissions used in the model were taken from a database which is based on odour sampling and testing audits conducted at a number of abattoirs and rendering facilities in NSW, Queensland and South Australia. In lieu of sampling data, the odour emissions were back-calculated in order to determine the maximum odour emission rates which would allow the criteria to be achieved at the nearby receptors. Figure 11-1 shows the variability of Specific Odour Emission Rates. It was acknowledged in the AQIA that:

> "Odour emissions from each source can be highly variable on a daily, seasonal and annual basis due to many factors such as plant throughput, type of animal, animal feed, weather conditions and climate, design and age of plant and maintenance regimes. These factors also effect the estimation of emissions for the plant based on data collected at other facilities across Australia".

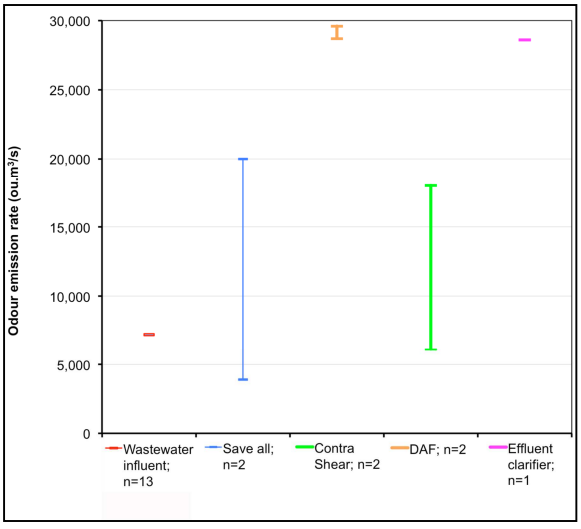
The assessment scenarios modelled in the AQIA include peak-to-mean adjustment to convert from one hour concentration to one second concentrations and an incremental assessment in accordance with the Approved Methods.



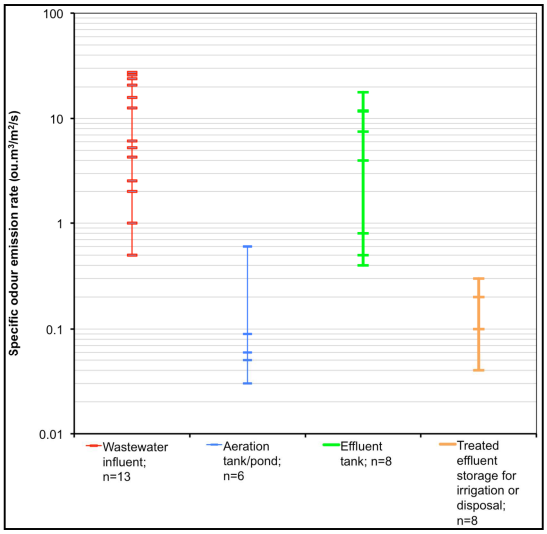
Bio-filter



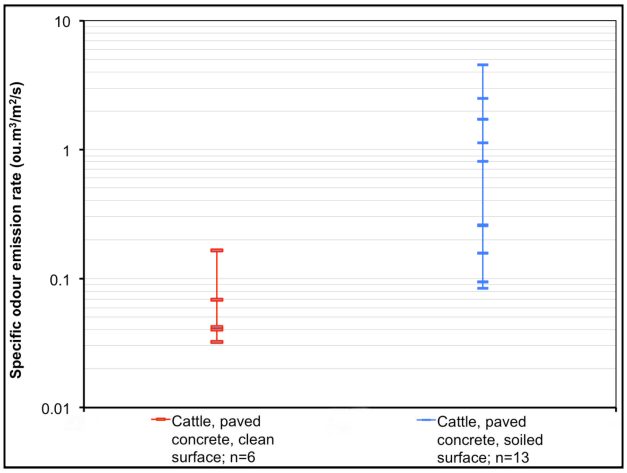
Rendering and waste stream processing



Wastewater treatment



Wastewater treatment tank and pond



Cattle Lairage

Figure 11-1: Variability of Specific Odour Emission Rates [Air Environment Consulting Pty Limited, 2015a]

Table 11-2: Assessment of Potential for Odour Impacts [Air Environment Consulting Pty Limited, 2015a]

Source	Minimum OER predicted to generate 2 ou at most affected receptor (ou/s)	Predicted most affected receptor due to source	Wind conditions predicted to affect receptor	Frequency of wind condition (%)	Range of OERs from source (ou/s)
AQIS and holding yards[1]	6,080	2	NNW-NNE <2 m/s	5.1	440 - 23,700; mean 5,200; n=13
Render building	6,270	2	NNW-NNE <2 m/s	5.1	4,100 – 26,400; mean 11,900; n=18
Paunch bin	6,730	2	NNW-NE <2 m/s	6.8	1,000 – 9,700; mean 5,100; n=3
Tallow tanks[2]	7,120	2	NNW-NE <2 m/s	6.8	63,000
Hides Building	6,290	2	NNW-NE <2 m/s	6.8	ND
Green Waste Holding Tank	8,580	2	NNW-NNE <2 m/s	5.1	ND
DAF building	6,850	2	NNW-NNE <2 m/s	5.1	28,700 – 29,600; mean 29,200; n=2
Treated effluent holding tank[1]	7,070	2	NNW-NNE <2 m/s	5.1	33 – 1,500; mean 570; n=8
First flush dam[1]	6,940	2	NW-NNE <2 m/s	8.1	ND
Holding dam[1,4]	6,580	2	NW-NNE <2 m/s	8.1	130 – 1,260; mean 660; n=8
Spray irrigation[1,4]	6,100	7	NW-NE <2 m/s	9.8	6,000 – 60,000; mean 34,200; n=8
Biofilter – performing well Biofilter – performing poorly	6,950[5]	2	NW-NE	5.1	1,280 – 2,250; mean 1,770; n=4 9,060 – 150,000; mean 70,400; n=5

Table note: ND: No data available.
[1] OER based on SOER database and AACo source area dimensions (total lairage area of 5,215 m²).
[2] Only based on one data point.
[3] Based on SOERs for treated recycled water and pond/tank area dimensions.
[4] Based on SOERs for treated recycled water used for irrigation and pond/tank area dimensions.
[5] Biofilter OER predicted to generate 2 ou at most affected receptor.

Table 11-2 is an extract from the March AQIA, which shows the minimum odour emission rate required to generate 2 OU at the most affected receptor and the range of odour emission rates for each source (which are graphically presented in Figure 11-1).

It can be seen in Table 11-2 that the irrigation activities were predicted to cause an off-site odour above 2 OU at an emission rate of 6,100 ou/s, while the potential range of emission rates for irrigation was 6,000 - 60,000 ou/s. As such, the original report therefore concluded that irrigating poor quality wastewater had a very high potential for excessive off-site odour.

The initial report stated:

> "The assessment has shown that an odour emission flux of between 6,000 – 9,000 ou/s from any of the fugitive sources is sufficient to cause odour impact at nearby sensitive receptors. This is a

relatively moderate level of odour emission considering the type and capacity of the plant and its operation. The odour emissions presented have shown an example of the potential range in OERs from similar facilities in Australia, and they indicate that the OERs required to generate an impact at nearby receptors is near the lower bound of the emissions data in some cases. Hence, the need for a proactive management strategy."

The AQIA also identified that once the Facility is fully commissioned and operating at full capacity, a plant-wide odour audit should be undertaken to collect odour emissions data for odour guideline compliance.

Overall, the AQIA provides a comprehensive assessment of the Facility in accordance with the appropriate Approved Methods and Technical Framework as well as best practice modelling guidance. The conclusions and the recommendations for maintenance, housekeeping and monitoring are also still valid.

11.2 UPDATED ASSESSMENT REVIEW

The AQIA has been revised to include the odour inventory based on the sampling data undertaken at the site in September 2015 (refer to Section 10). The revised report is Appendix G of this Audit.

11.2.1 CRITERIA

The revised odour impact assessment has used a criterion of 3 OU; after the site visit the Project Team agreed that this odour criterion would be more suitable based on the population density, in accordance with the *Technical Framework for Assessment and Management of Odour from Stationary Sources* (Department of Environment & Conservation, 2006). It should be noted that the odour impact criteria is a planning tool, however the criterion has been applied as it provides a benchmark. A summary of the criteria is presented in Table 11-3.

Table 11-3: Odour Impact Assessment Criteria Used in the Revised Assessment [Air Environment Consulting Pty Limited, 2015b]

Pollutant	Averaging Period	Statistic (Percentile)	Assessment Criterion
Odour	1 second	99.0th	3 OU

11.2.2 ODOUR EMISSIONS INVENTORY

Air Environment Consulting Pty Limited provided the emissions inventory as modelled along with the associated odour contours. The emissions inventory is divided into three types based on the characterisation of the odour source (i.e. point (stack) sources, area sources and volume sources).

Several adjustments to the odour emission rates and source characteristics were made by AEC in agreement with the project Auditor, Vic Natoli, due to the methods used in the odour sampling and other complexities observed during the site odour emissions audit. The emission rates were calculated using the sampling data and adjusted for a number of parameters, including but not limited to:

- Odour emission rates for the AQIS area were calculated by the back trajectory modelling method, based on odour concentration sampling five metres downwind of the AQIS area and the wind velocity measured at the time of sampling.
- The specific odour emission rates applied to the Spray Irrigation Area modelling was based on the odour emissions measured at the outlet of the DAF.
- As specified in the Australian standard, AS4323.3 (2001), (Air Labs Environmental, 2015) reported all odour emission rates at normal temperature (i.e. 0°C). However, olfactometry testing is conducted at

room temperature, nominally 25°C, and it is more appropriate to assess the impact of odour concentrations at actual source temperature based on the conversion from the temperature at which the sample is tested. This has the effect of slightly increasing the reported test odour concentration (in OU).

- The Specific Odour Emission Rate (SOER) tested for dry and wet surfaces were modelled based on season for the whole holding yard area;
- The wind speeds and direction at the time of sampling were used for the AQIS and raw material bin sources; and
- Area/type of source.

Once the emission rates have been modelled, the source duration is determined based on operating hours and activities (i.e. irrigation location and quantity). The basic source parameters are presented in to Table 11-4, Table 11-5 and Figure 11-2.

Table 11-4: Stack Source Characteristics [Air Environment Consulting Pty Limited, 2015b]

Odour source	Coordinates		Stack height (m)	Stack diameter (m)	Stack velocity (m/s)	Stack gas temperature (°C)	OER (OU/s)	Hours
Meat meal hammer mill cyclone (post-rendering) vent	725.920	8593.834	3	0.44	9.58	64.5	962	7 am to 6 pm

Table 11-5: Fugitive Volume Source Characteristics [Air Environment Consulting Pty Limited, 2015b]

Odour source	Centre co-ordinates		OER (OU/s)	Hours
Red fan press sump	725.955	8593.857	71	7 am to 6 pm
Red fan press screw conveyor	725.950	8593.854	609	7 am to 6 pm
Raw material bin	725.941	8593.861	7475	7 am to 6 pm
Wet rendering building	725.928	8593.857	956	7 am to 6 pm
Tallow tanks 1 & 2 combined	725.894	8593.851	2.3	Continuous
Bio-filter	725.891	8593.876	741	Continuous
Irrigation tank	725.794	8593.872	5991	Continuous

Table 11-6: Fugitive Area Source Characteristics [Air Environment Consulting Pty Limited, 2015b]

Odour source	Area SW corner X	Area SW corner Y	Area source SOER OU/m^2/s	Hours
AQIS	725.926	8593.737	6.4156	Continuous
Holding pens (mean) during dry season	725.858	8593.715	0.03	Continuous
Holding pens (mean) during wet season	725.858	8593.715	0.13	Continuous
WWTP Green sump	725.827	8593.869	0.66	4 am - 10 pm
WWTP Common sump	725.830	8593.876	0.50	4 am - 10 pm
DAF	725.807	8593.887	1.88	4 am - 10 pm
Paunch storage bin (fresh)	725.811	8593.906	0.65	Continuous
Paunch storage bin (aged)	725.812	8593.898	0.20	Continuous
DAF sludge decanter bin (fresh)	725.808	8593.889	1.52	Continuous
DAF sludge storage (fresh)	725.803	8593.907	1.52	Continuous
DAF sludge storage (aged)	725.804	8593.899	0.38	Continuous
Contra shear scrapings (aged)	725.802	8593.913	116.70	Continuous
Spray irrigation Plot C	725.208	8594.781	variable (See Figure 11-2)	

Spray irrigation Plot D	725.200	8594.630	variable (See Figure 11-2)

Of the odour emissions inventory presented in Table 11-7, Air Environment noted:

> "The odour emissions inventory shows that the Spray Irrigation Area is the primary source of the odour and likely to be responsible for the odour complaints generated by the NABL operations. The Irrigation Tank is also a significant source of odour and also reflects the odour in the effluent being irrigated. Other important odour sources are the AQIS area and the Raw Material Bin at the Rendering Plant.
>
> The AQIS area odour emissions appear to be very high and may be a function of their calculation method, i.e. through their calculation by back trajectory modelling of downwind odour sample collection. It was reported that there was approximately 450 head of cattle in the AQIS area at the time of sampling and NABL indicated that the area is kept clean after cattle pass through. Anecdotal comments from the sampling team at the time of sampling indicated that the odour in the AQIS area was low. The mean odour concentration of 46 OU, measured five metres downwind of the area supports this observation. The key point to make in terms of the lairage area as a whole is the significant discrepancy between the AQIS and Holding Yard odour emission rate. Even assuming wet surface conditions, the Holding Yard odour emission rate appears to be quite low. This may be a function of good housekeeping and low production capacity at the time of sampling
>
> Also of note is the relatively low odour emission rate of the Wet Rendering Building by comparison to the Raw Materials Bin. Material processed through the Raw Materials Bin is further processed in several open top processes in the Wet Rendering Building. The odour emissions may have been a function of the throughput of the plant on the day of sampling, as odour was considered to be higher, than that measured, on the day of the initial site investigation."

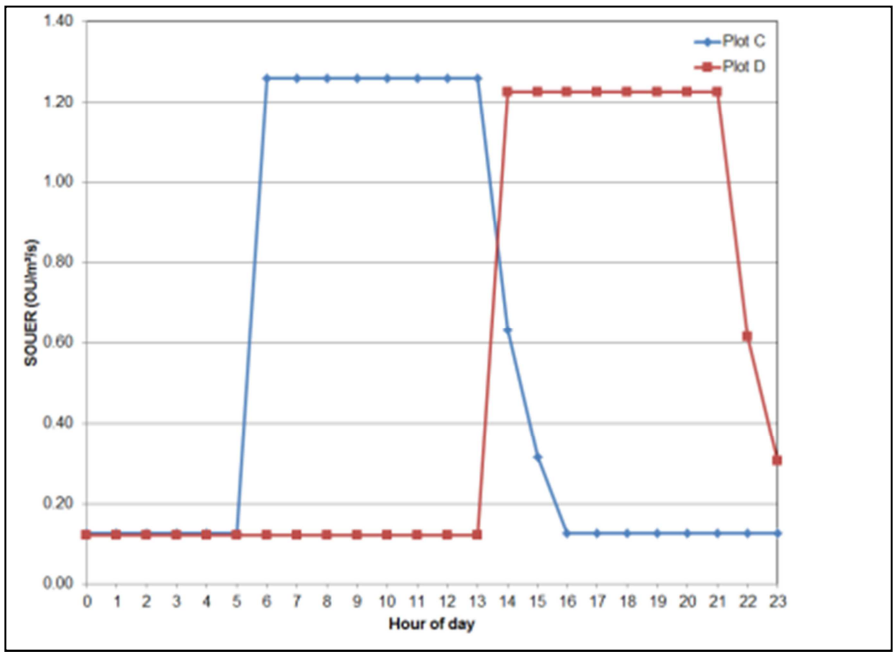


Figure 11-2: Spray Irrigation Odour Emission Rates (OU/m²/s) [Air Environment Consulting Pty Limited, 2015b]

Table 11-7: Current Odour Emissions Inventory [Air Environment Consulting Pty Limited, 2015b]

Odour source	Odour emission rate (OU/s)	Proportion of total plant emissions (%)
Lairage		
Cattle receival and holding yards, maximum during wet season	682	0.6%
AQIS Area	10,586	9.0%
Rendering Area		
Red fan press: tank/sump	71	0.1%
Red fan press: screw conveyor	609	0.5%
Raw material bin	7,475	6.4%
Wet rendering building	956	0.8%
Meat meal hammer mill cyclone wall vent	962	0.8%
Tallow transfer & storage tanks 1 and 2	2	0.0%
Biofilter	741	0.6%
Wastewater treatment area		
Green Sump	7	0.01%
Common Sump	5	0.005%
DAF	81	0.1%
DAF sludge decanter	3	0.003%
Irrigation Tank	5,991	5.1%
Sludge storage bins	321	0.3%
Paunch storage bins	7	0.01%
Spray Irrigation	88,640	75.7%
Total plant odour emissions	**117,140**	**100.0%**

11.2.3 ODOUR MODELLING

Odour impact has been assessed based on the cumulative ground-level odour concentrations of sources with similar odour character and emission source type. Based on differences in odour character, intensity and hedonic tone at concentrations above the odour detection threshold, different sources will stand out and be recognised independently of one another. Consequently, the odours have been combined in this way.

Air Environment state:

> "In AEC's experience, odour sources such as the lairage can be clearly recognised from the rendering or wastewater odour. Similarly, the bio-filter will have an earthy odour that is quite different from these sources. It is not considered appropriate to aggregate the predicted ground-level odour concentrations from the bio-filter with the wastewater treatment plant or lairage. These odours are composed of a different suite of odorous chemical compounds and cannot simply be added together to provide a meaningful odour impact."

The odour emission source combinations modelled and assessed in the impact assessment are:

- Holding yards across wet and dry seasons - holding pens during dry season, holding pens during wet season and AQIS yard;
- Rendering plant - red fan press sump, red fan press screw conveyor, raw material bin, wet rendering building, tallow tanks 1 & 2 combined and meat meal hammer mill cyclone;

- Bio-filter;
- Waste handling bins - paunch storage bins (fresh and aged material), DAF sludge decanter (fresh DAF sludge), DAF sludge storage bins (fresh and aged material with aged Contra Shear Scrapings);
- Wastewater treatment plant area - green sump, common sump, DAF and Irrigation tank;
- Spray irrigation – plot C and plot D; and
- Wastewater treatment plant and spray irrigation combined.

The predicted 99.9th percentile, one second average ground level odour concentration contours are presented in Figure 11-3 to Figure 11-9. The red contour line represents the criterion of 3 OU which was considered appropriate for this surrounding population density in accordance with the Approved Methods. Additional contours for the maximum one second average ground level odour concentration are presented in the revised AQIA report (Air Environment Consulting Pty Limited, 2015b).

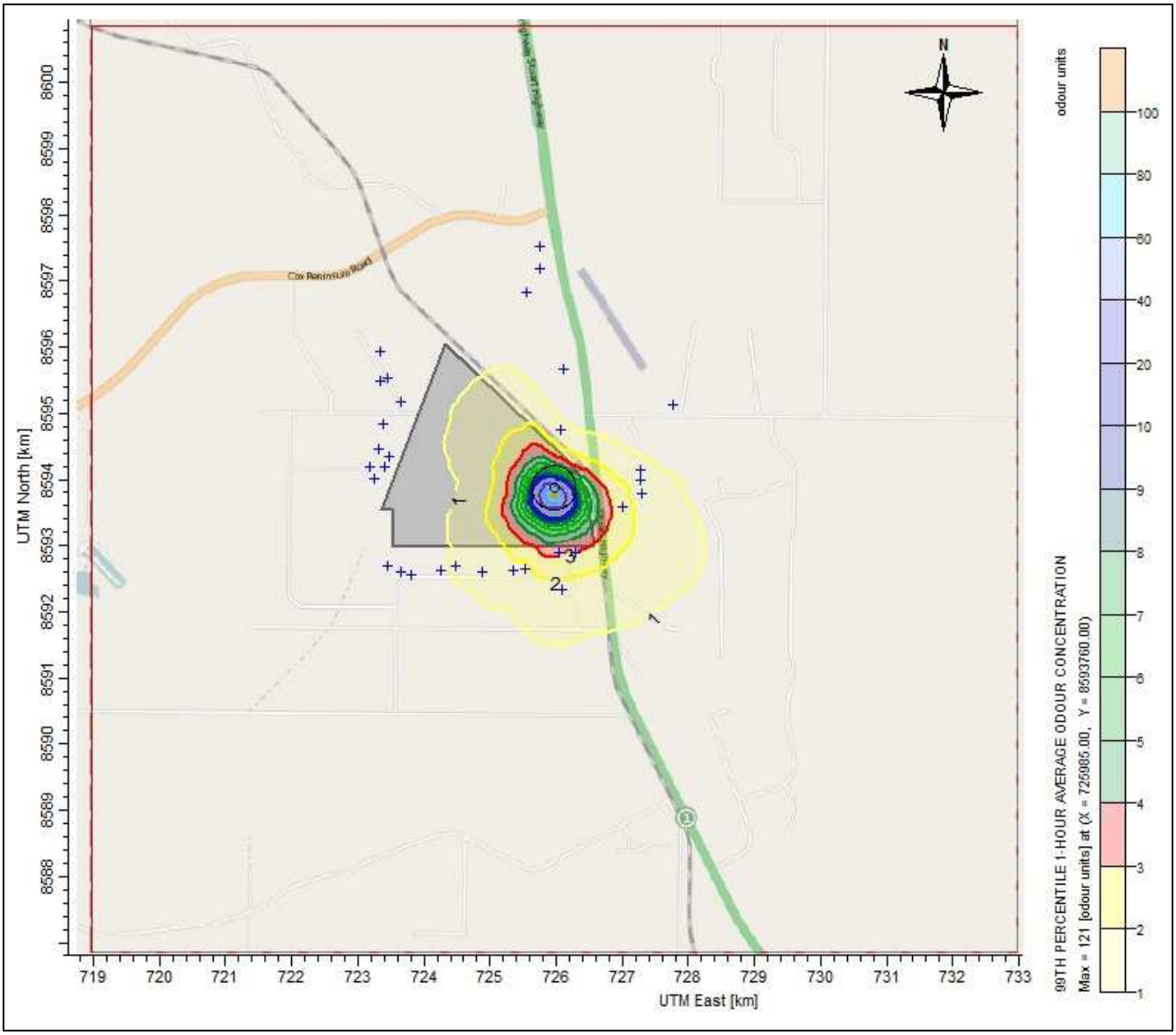


Figure 11-3: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Holding Yards and AQIS Building (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

Figure 11-3 illustrates that the lairage area was predicted to slightly exceed the odour impact assessment criterion at the nearest receptors adjacent to the site's southern boundary (R2 and R7). Based on conservative, but standard, buffer calculations for level 1 cattle feedlot assessment, the separation of the NABL lairage areas and the receptors to the south would be considered sufficient. This indicates that the model's prediction of ground-level odour concentrations associated with the lairage may be an over-estimate due to the calculation method adopted.

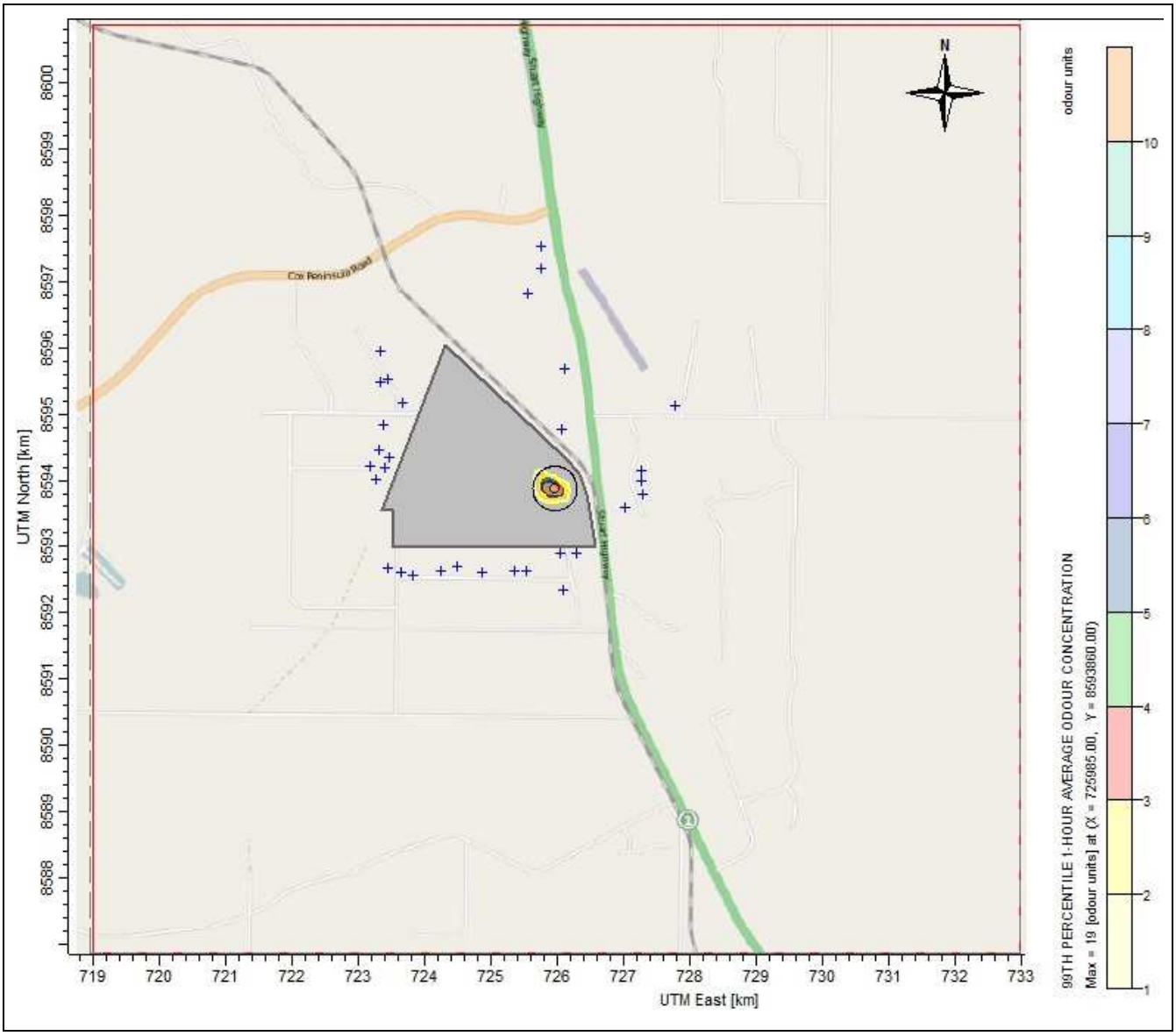


Figure 11-4: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Wet Rendering Waste Bin, Red Fan Sump, Red Fan Conveyor, Tallow Tanks 1 & 2 and Meat Meal Hammer Mill Cyclone (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

All other odour sources including the rendering plant area, bio-filter and waste management area (i.e. the DAF sludge and paunch storage bins) were predicted to be well below the odour impact assessment criterion, as shown in Figure 11-4.

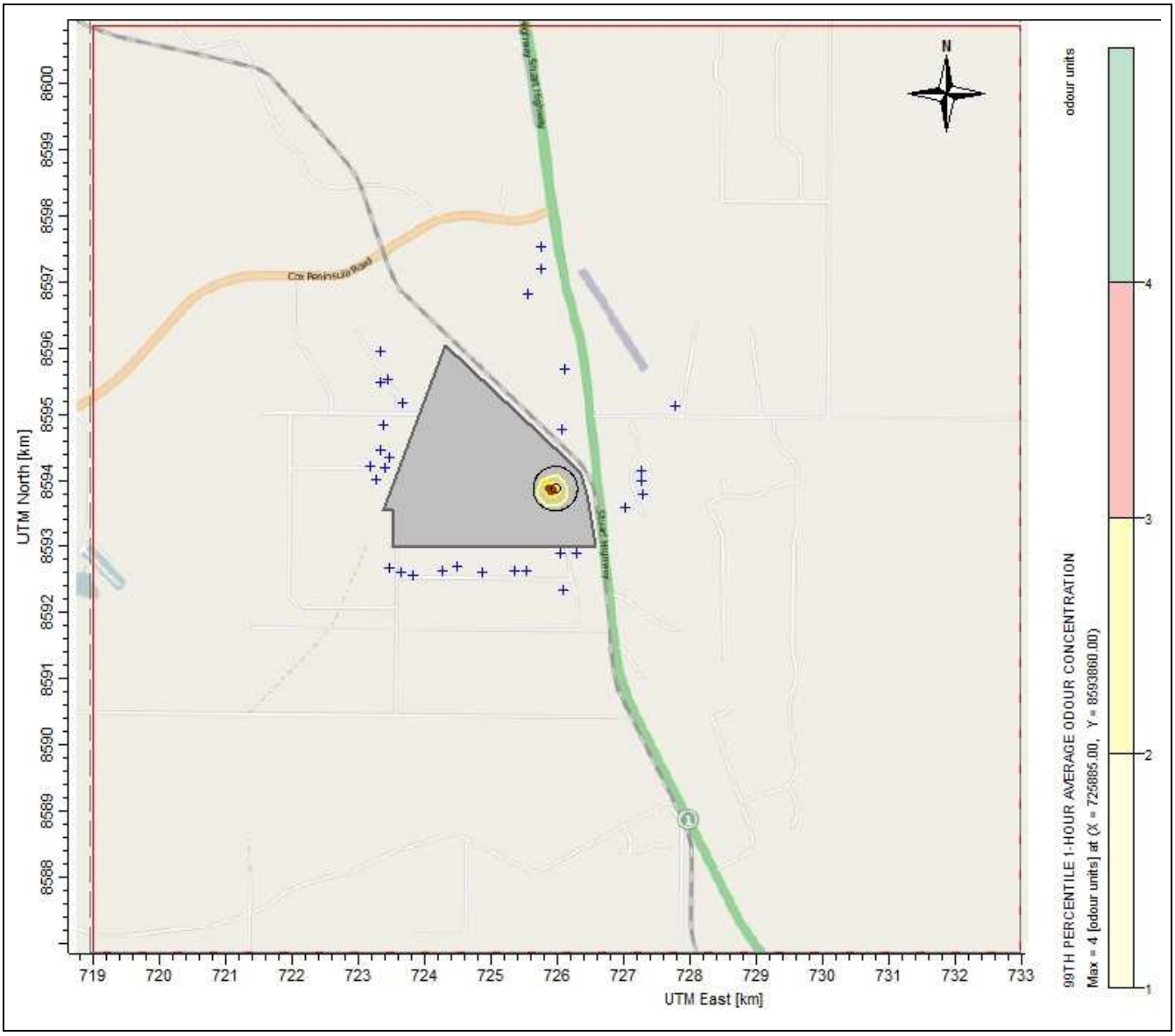


Figure 11-5: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Bi-filter (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

Figure 11-5 illustrates that the bio-filter is operating well and is unlikely to require the use of the odour neutralising sprays situated around the walls of the cells.

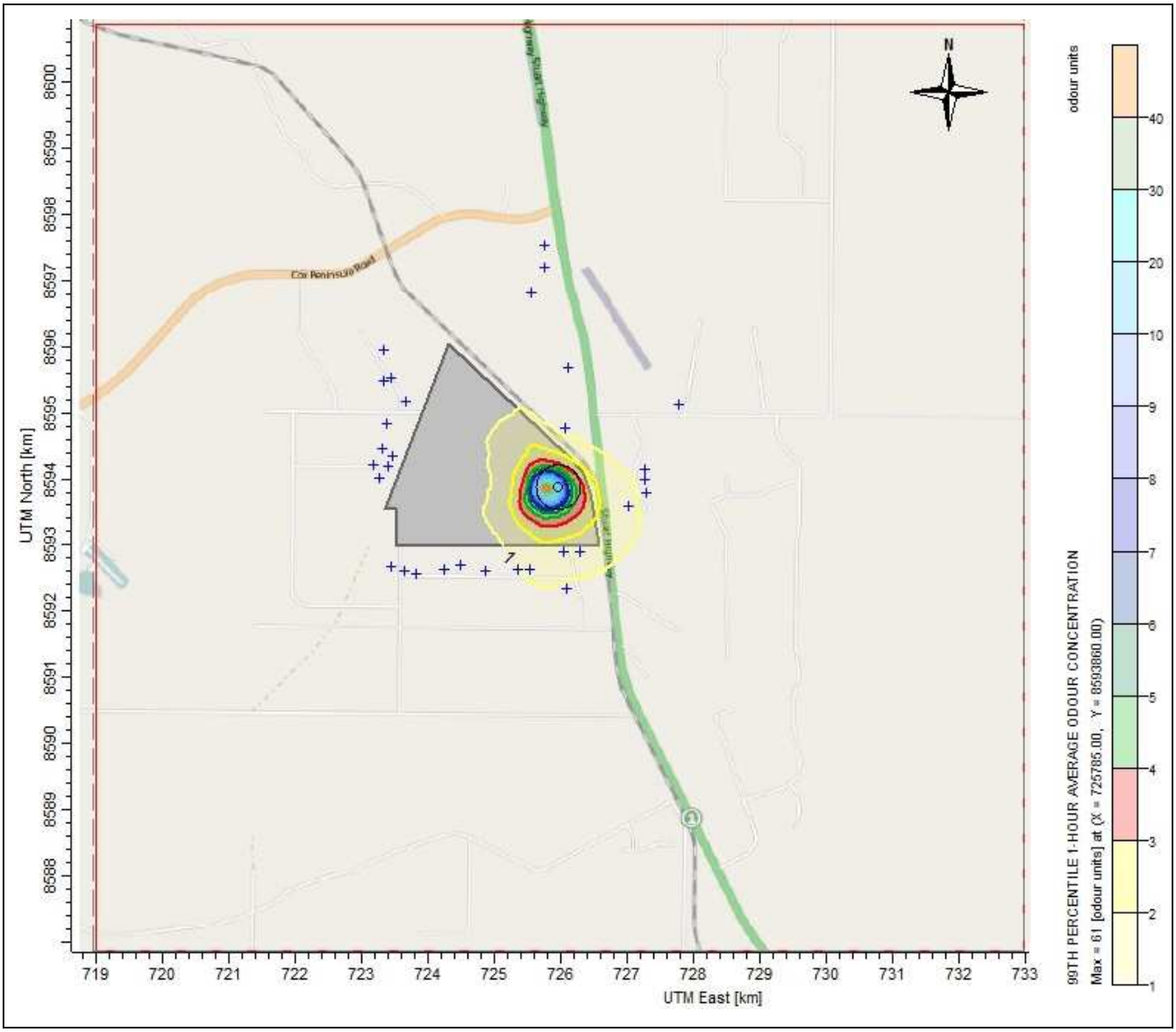


Figure 11-6: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the WWTP including DAF and Irrigation Water Storage Tank (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

Figure 11-6 shows that when considered in isolation, the wastewater treatment plant was not predicted to exceed the odour impact assessment criterion.

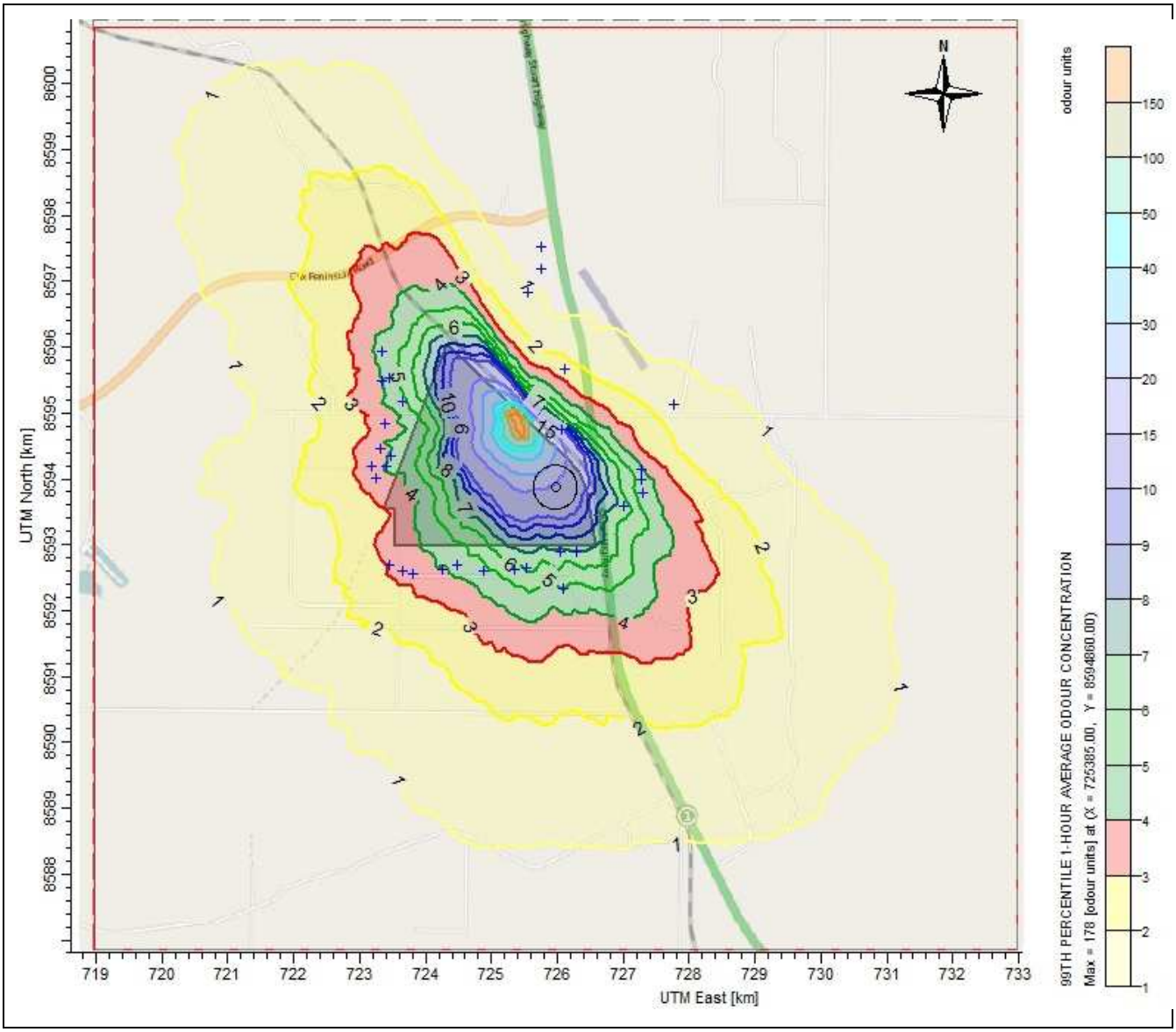


Figure 11-7: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Spray Irrigation Area Only (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

In its current location adjacent to the northern boundary of the plant (at the time of the odour sampling program), Figure 11-7 shows the spray irrigation area, was predicted to generate significant odour impacts at almost all of the receptors identified in the areas nearest the plant and in all directions.

Offsetting this area of odour impact based on the southern spray irrigation area used during the first half of 2015, it is likely that the spray irrigation was responsible for the odour complaints received by NT EPA.

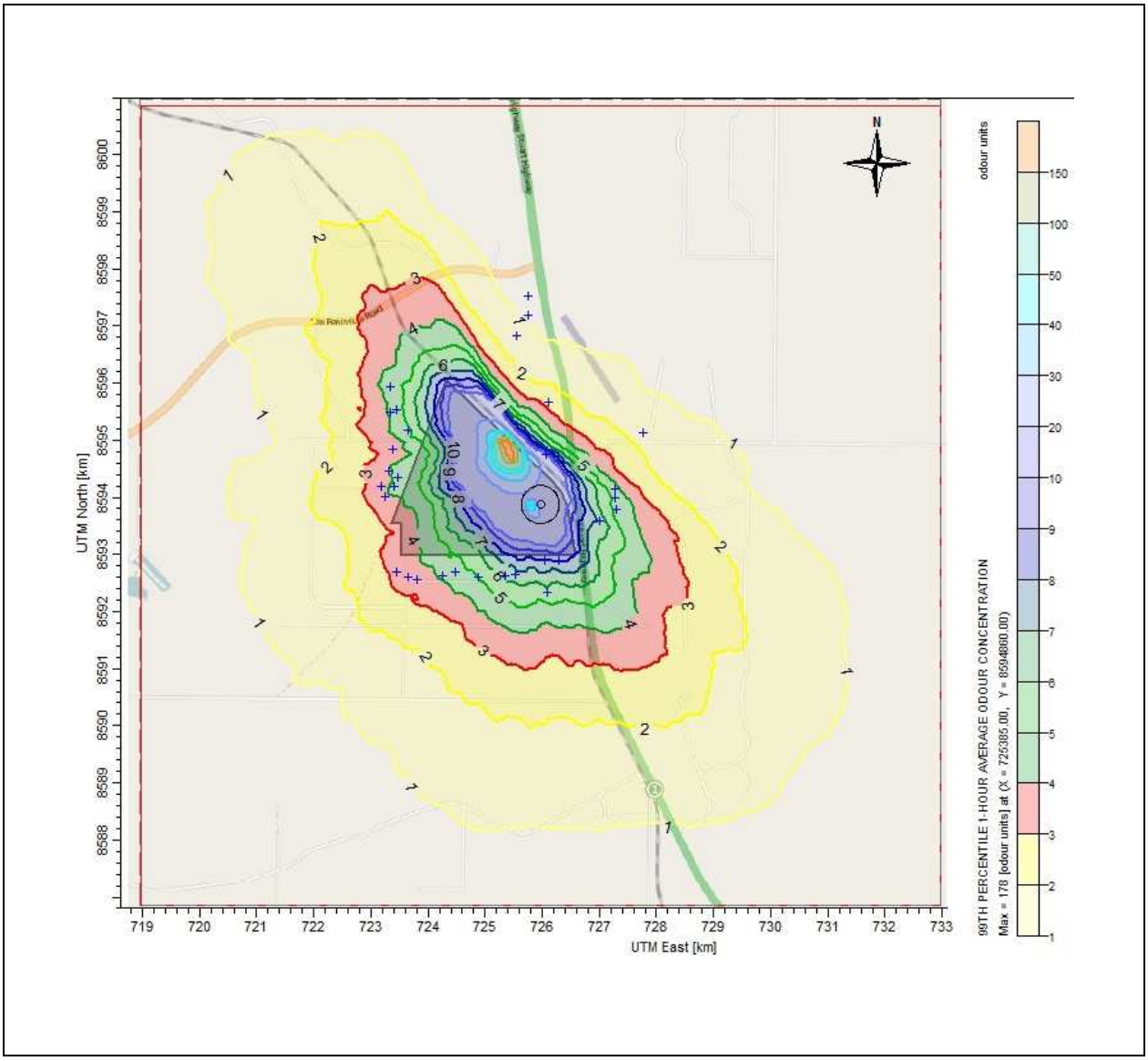


Figure 11-8: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the WWTP and Spray Irrigation Area Combined (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

Figure 11-8 shows that the most significant source of odour predicted in the area surrounding the NABL site is the wastewater treatment and spray irrigation area sources. Combined, sources with a wastewater type odour character were predicted to exceed to the odour impact assessment criterion at almost all of the receptors identified in the areas nearest the plant and in all directions.

The modelling determined that 26 sensitive receptors modelled would experience exceedances of the odour concentration criterion of 3 OU (99.9th percentile, 1 second average) as a result of the combined wastewater treatment plant and spray irrigation area.

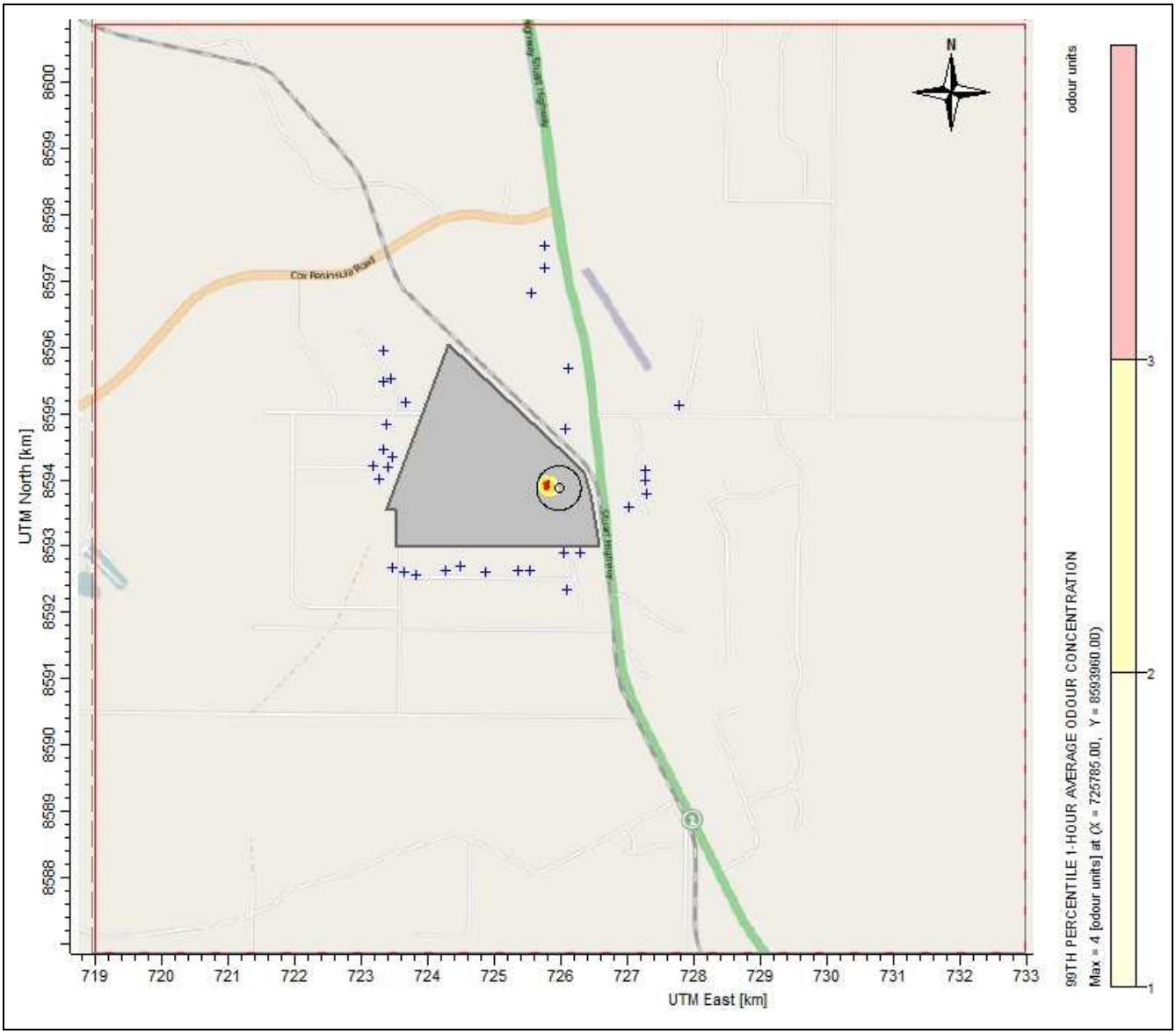


Figure 11-9: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Waste Handling Area including DAF Sludge and Paunch Storage Bins (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

Overall, (Air Environment Consulting Pty Limited, 2015b) have identified that the majority of the elevated ground-level odour concentration impacts were predicted in the evening between sunset and midnight. This is likely to the time when residents are at home and complain about odour nuisance.

11.3 CUMULATIVE IMPACTS

Section 9.3 states that there is a proposal to extend the Wellard Darwin Integrated Livestock Export Facility cattle feedlot operations by increasing the cattle holding capacity from 4,000 to 12,000. Wellard is located approximately 530 m to the north of the Facility. This is currently a small facility but has recently prepared an Environmental Impact Assessment including a Level 1 Odour Impact Assessment (EnviroAg, 2015) for a significant expansion of its capacity. Reviewing the report, Air Environment (2015b) state:

"The current facility is considered to be well separated from the NABL site and cumulative odour impacts are very unlikely to occur due to the unlikelihood of simultaneous plume merging from both sites. It is acknowledged that residences between the NABL and Wellard sites may experience low levels of cattle-type odour under various wind conditions from time to time. As a result, a cumulative modelling-based odour impact assessment of the Wellard facility has not been conducted in this report.

Notwithstanding this, the EnviroAg (2015) Level 1 Odour Impact Assessment indicates that the proposed fully expanded Wellard site buffer of 497 metres would overlap on the NABL site in the vicinity of the current NABL northern irrigation area and the proposed site of the stage 2 wastewater treatment ponds. It is also noted that the Level 1 S-Factor based Odour Impact Assessment report does not consider odour impact from their proposed anaerobic pond wastewater treatment system and the irrigation of primary treated effluent between the Wellard feedlot and the Stuart Highway. It is expected that this would provide a significant cumulative impact with the NABL wastewater treatment and irrigation system and should be considered not by the existing NABL operations but the yet to be approved and built Wellard operation.

11.4 COMPARISON OF THE SAMPLING RESULTS WITH THE ORIGINAL AQIA

One requirement of the Notice is to compare the measured odour samples and compare the results with the emissions applied in the Air Quality Impact Assessment by Air Environment in March 2015.

Odour sampling was not carried out as part of the original AQIA due to the low production rate of the plant at the time the AQIA was prepared. The odour emissions used in the original model were taken from a database which is based on odour sampling and testing audits conducted at a number of abattoirs and rendering facilities in NSW, Queensland and South Australia. The AQIA identified that once the Facility is fully commissioned and operating at full capacity, a plant-wide odour audit should be undertaken to collect odour emissions data for odour guideline compliance. This is discussed further in Section 11.

As a result of no site specific odour emissions, the AQIA prepared in March was not a definitive assessment based on the actual operations, therefore a comparison between the emissions modelled and the sampling data is not viable.

The original AQIA only modelled the bio-filter emissions (along with NO_X) to determine the downwind impact. The bio-filter odour emission rate modelled in the original report was 1,390 ou/s, while the measured value used in the revised AQIA was 741 ou/s.

The original report identified that other odour sources could potentially cause off-site impacts based on typical emissions. The other odour sources were back-calculated to determine the emission rate at which each odour source would exceed the 2 OU criteria (as detailed in Table 11-2).

For example, Table 11-2 shows that the irrigation activities were predicted to cause an off-site odour above 2 OU at an emission rate of 6,100 ou/s, which "is a relatively moderate level of odour emission considering the type and capacity of the plant and its operation", while the potential range of emission rates for irrigation was 6,000 - 60,000 ou/s.

11.5 AUDITOR'S EVALUATION OF ODOUR MODELLING ASSESSMENT QUALITY

The odour concentration, flow rates and temperatures from point source discharges were measured and the downwind ground level odours calculated. The process used is straight forward and suitable. However, as it is not possible to directly measure the odour emission rate from fugitive sources, various methods were reviewed to determine the best means of calculating the odour emission rates from each fugitive odour source.

The emissions inventory developed as the model inputs appeared to be a fair representation of the odours present at the time the samples were taken.

The methods used to model each of the emissions sources were the most suitable for each circumstance and the results were consistent with the observations made during the odour sampling. The modelling identified the irrigation activities as the largest source of odour by a significant margin and the likely cause of most complaints. Additional sources of potential odour complaints were found to be the cattle holding areas and the waste water treatment plant. The modelling report concluded that a reduction in odour from the treated waste water would have the largest effect on the off-site odour level. In the auditor's opinion, there can be a high degree of confidence placed on these findings and conclusion, as they are consistent with the odour complaints received by the NT EPA and the odour sampling results.

12 REVIEW OF LICENCE CONDITIONS

EPL 131 lists 78 conditions and Condition 34 contains the only quantifiable limits within the EPL 131 which are concerned with the quality of the wastewater for irrigation purposes. These licence conditions were issued post approval of the development and installation of the wastewater treatment plant.

In terms of odour conditions, BOD levels in the wastewater are the only quantifiable wastewater parameter which may indicate odour is issue. A BOD test is a five day procedure which has to be undertaken by a laboratory; by the time results are known, it is too late to take any remediation. The EPL 131 conditions that relate to the emissions of odour are listed in Table 12-1.

Table 12-1: Table of EPL 131 Conditions and whether they were met

Condition Number	Description	Condition Met?	Justification
34	BOD limit of 20 mg/L after 1/5/2015	No	Plant not designed to achieve this level of BOD. The lowest achievable based on full capacity is 800 mg/L.
36	The licensee must conduct an Air Quality Assessment for all point and diffuse air emission sources at the premises.	Yes	AQIA (Air Environment, 2015a) provided a comprehensive review of the Facility
37	The Air Quality Impact Assessment must be conducted in accordance with the *"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"* and include:	Yes	AQIA (original and revised) was carried out in accordance with the NSW Approved Methods
	37.1 Identification of all sources of air emissions from the development including all point source and fugitive emissions	Yes	Detailed odour emissions inventory
	37.2 Details of the project that are essential for predicting and assessing air impacts	Yes	Methodology is comprehensive but includes back-calculations for most sources. This is This is rectified in the revised AQIA.
	37.3 Meteorological and climatic conditions in the area	Yes	Detailed analysis of the weather conditions and correlation to TAPM
	37.4 Topography of the surrounding area	Yes	Images of modelled topography and discussion
	37.5 A description of existing air quality and meteorology, using existing information and site representative ambient monitoring data	Yes	Appropriate level of discussion for the type of assessment
	37.6 Identification of all pollutants of concern and an estimation of emissions by quantity (and size of particles), source and discharge points	Yes	Detailed odour emissions inventory
	37.7 An estimation of the resulting ground level concentrations of all pollutants of concern	Yes	Only odour contour was bio-filter. The remaining sources were back-calculated to achieve 2 OU criteria. All odour sources modelled in the revised AQIA.
	37.8 A description of the effects and significance of pollutant concentration on the environment, human health and amenity of nearby receptors and regional ambient air quality standards or goals	Yes	The original AQIA considered other pollutants as well as odour
	37.9 For potentially odorous emissions provide the emission rates in terms of odour units;	Yes	The emission rate for the bio-filter was estimated, but due to the large possible

Condition Number	Description	Condition Met?	Justification
			variations in other sources, emission ranges were provided, along with the emission rate which would exceed 2 OU off-site. The revised AQIA has emission rates based on measurements.
	37.10 A detailed description of all air mitigation measures that will be implemented as a result of the Air Quality Impact Assessment	Yes	The plant was not at full capacity when the AQIA was conducted. Mitigation measures were recommended
	37.11 Monitoring that will be undertaken	Yes	Recommended odour measurement survey
38	The licensee must ensure the Air Quality Impact Assessment is reviewed by a qualified person who must produce a written report about their review.	Yes	Golder Associates reviewed the report (letter dated 20 March 2015)
39	The Air Quality Impact Assessment must be submitted to the NT EPA, with a copy of the written review by the qualified person, by 28th February 2015.	Yes but not within the timeframe	Submitted on 27th March. The AQIA was not finalised until 26th March.
40	The licensee must implement and follow all mitigation measures, controls and recommendations specified in the Air Quality Impact Assessment and written review by a qualified person by 30th June 2015.	Yes	The mitigation measures proposed were mainly housekeeping procedures, maintenance and odour complaint recording. A weather station was installed in response to the report.
41	The activity must not cause or release, beyond the boundary of the premises; visible steam, smoke, offensive odour, dust or particulate or noise which unreasonably interferes with or is likely to unreasonably interfere with the enjoyment of the area by persons who occupy a place within the area	No	The complaints register identifies that the irrigation of the southern plot caused the majority of the complaints. Irrigation of this area has ceased.

The remaining licence conditions do not relate to odour; however during the process of this Audit several documents and databases were reviewed:

- Listed Waste Database including quantity and destination were reviewed as part of this Audit and the information is detailed and referred to in this Audit (i.e. production data in relation to complaints);
- Information relating to non-compliance was discussed in relation to equipment breakdown such as the bio-filter commissioning issues in response to the analysis of the complaints register;
- The EPL 131 conditions require that some documents were to be independently reviewed and kept up-to-date. The original and revised OEMP has been seen and referenced in this Audit alongside variations of the Irrigation Management Plan and Water Quality Management Plan.

13 WASTEWATER TREATMENT PLANT UPGRADE

AACo presented an Action Plan in April 2015 to NTEPA and agreed to deliver an upgraded WWTP in a 2-stage upgrade process. It is understood that the upgrade to the WWTP has been given approval; however the most suitable location has yet to be finalised:

- Stage 1: an interim aeration dam would be installed to generate odour-free treated effluent for irrigation on at least 60 ha. An aeration dam achieves microbial breakdown of organic material under aerobic conditions; the air for the dam will be provided mechanically. Aerated dams are considered reliable, simple to use and have a low odour risk.
- Stage 2: subsequently, an additional Covered Anaerobic Lagoon (CAL) with downstream biological nitrogen removal (BNR) activated sludge treatment plant would be constructed to produce treated effluent suitable for sustainable irrigation. This would replace the interim Stage 1 aeration dam. The anaerobic lagoon will achieve microbial breakdown of organics to mainly gas in the absence of oxygen. CALs are capable of handling variations in the wastewater load and they form a crust which minimises odour emission. Approximately 99% of gases will be captured and incinerated in an enclosed flare.

The new WWTP design will:

- Apply proven and robust treatment technologies to meet the objectives of the Stage 1 upgrade;
- Achieve the necessary removals of organic loads to achieve non-odorous irrigation of the treated effluent during the wet season;
- Ensure there is negligible offensive odour, noise and light emitted to the surrounding neighbourhood; and
- Allow recycling of treated effluent for non-potable uses at the Facility.

The primary objectives of the Stage 1 upgrade are:

- To eliminate odour impacts on neighbours associated with inadequately treated effluent processed through the current WWTP by upgrading it with an aerated pond system; and
- To implement an improved wastewater irrigation system.

The design final effluent quality is presented in Table 13-1. This effluent will have been treated by the primary treatment train and the aeration dams. It is not proposed to operate either the lamella clarifier or UV disinfection system on the effluent of the aeration dam since the quality will be inadequate for effective disinfection. The effluent will be treated to ensure negligible odour on storage and irrigation year round. An updated WWTP flow diagram is presented in Figure 13-1 whilst Figure 13-2 and Figure 13-3 illustrate the layout for Stage 1 and 2 respectively.

Table 13-1: Expected Stage 1 Average Treated Effluent Composition [Johns Environmental, 2015]

Parameter	Units	Final Stage 1 Concentration	Design Removal (%)	EPL 131
COD	mg/L	15	90	-
BOD_5	mg/L	<50	93	20
Total Nitrogen	mg/L	120	4	15
Total Phosphorus	mg/L	20	16	0.5
Oil and Grease	mg/L	<10	-	-
Total Suspended Solids	mg/L	<100	67	30
pH	-	6.5 – 7.5	-	6.5 – 8.5

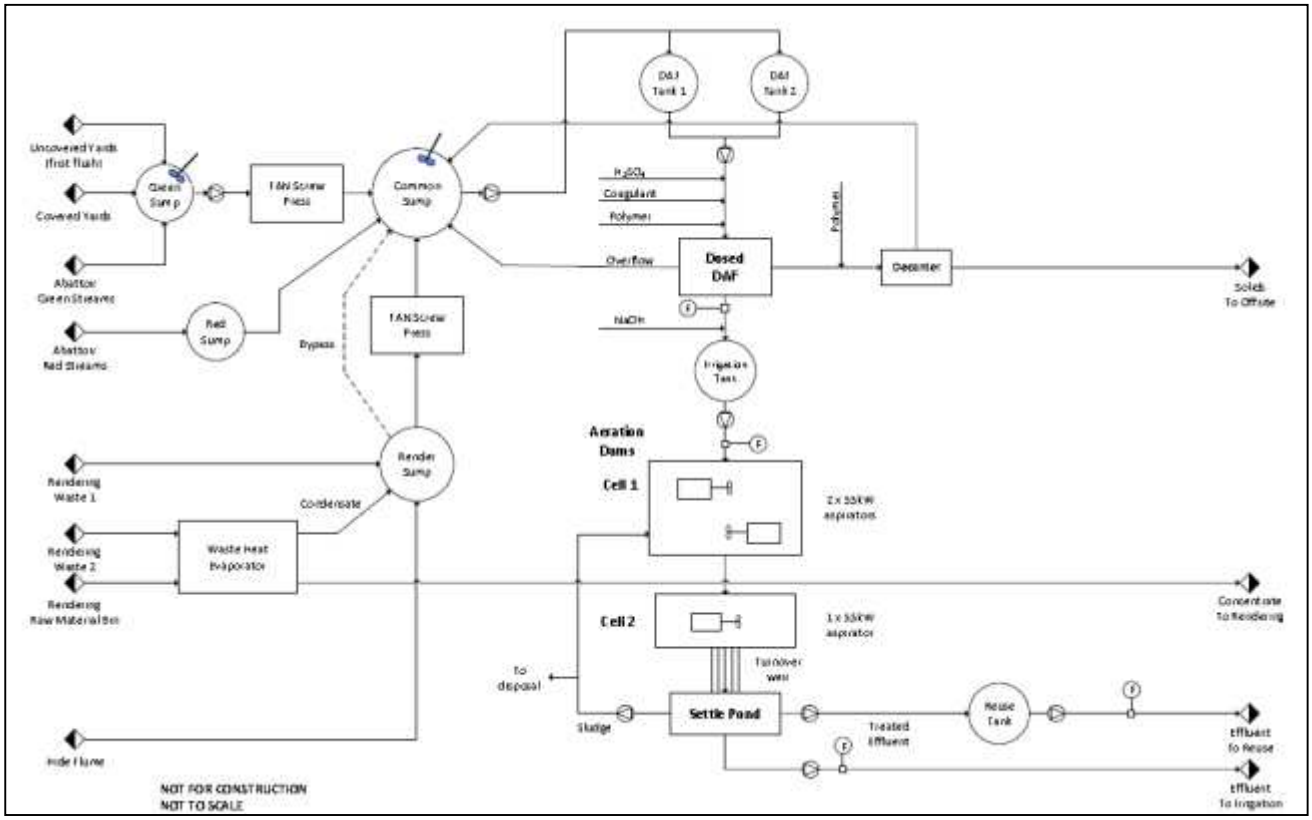


Figure 13-1: Proposed WWTP Process Flow Diagram for Stage 1 [Johns Environmental, 2015]

The Stage 1 and Stage schematic drawings are presented in Figure 13-2 and Figure 13-3 whilst the proposed location of the WWTP is outlined in Figure 13-4. For more details on the proposed upgrade please refer to Johns Environmental Pty Ltd (2015).

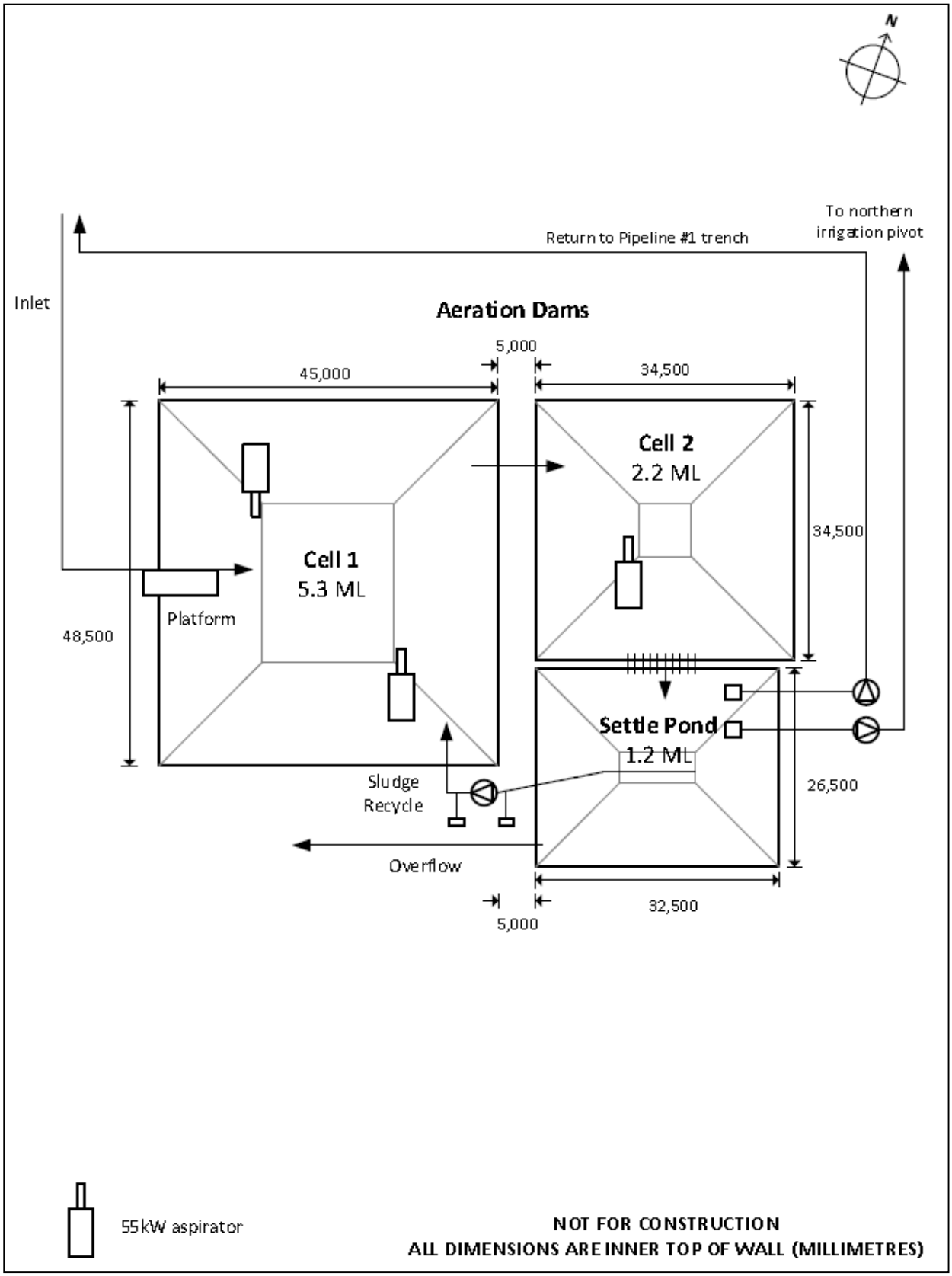


Figure 13-2: Proposed WWTP Stage 1 Layout [Johns Environmental, 2015]

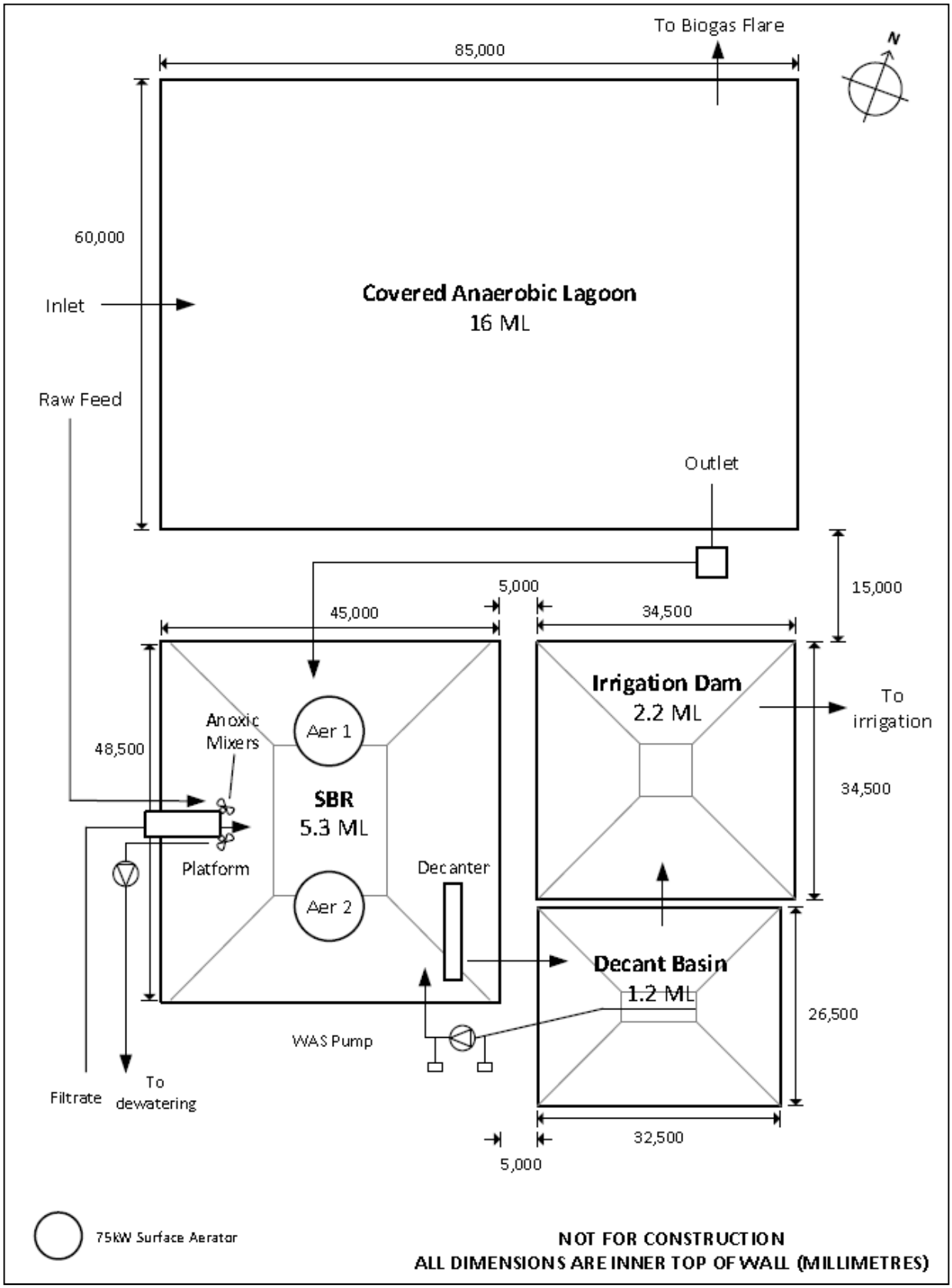


Figure 13-3: Proposed WWTP Stage 2 Layout [Johns Environmental, 2015]

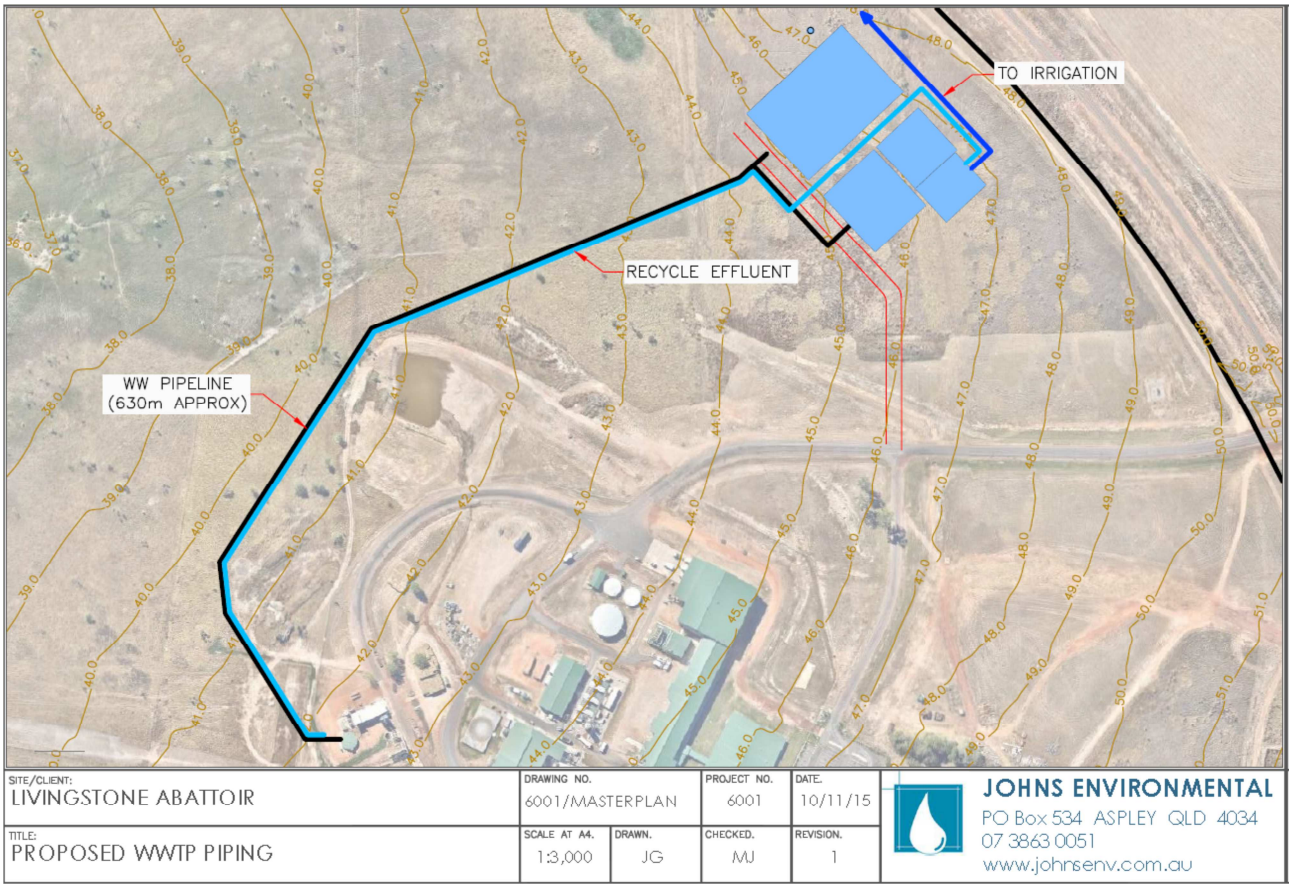


Figure 13-4: Potential WWTP Upgrade Location [Johns Environmental, November 2015]

The WWTP upgrade was modelled by Air Environment Consulting in the potential location identified in Figure 13-4. The Specific Odour Emission Rates modelled have been taken from a database of Australian WWTP as detailed in (Air Environment Consulting Pty Limited, 2015a).

Air Environment (2015b) state:

> "The odour emissions used, were considered to be in the middle of the distribution of aeration pond sources and it is expected that a well-managed wastewater treatment pond system would achieve lower odour emissions than those used in the assessment. The specific odour emission rates have been selected as a conservative approach and the same emission rate was used for each of the two aeration cells and the settling pond. The specific odour emission rates would be expected to diminish as the quality of the treated water improved through the pond system. The specific odour emission rate of the covered anaerobic lagoon is based on an uncovered pond with a specific odour emission rate of 4 OU/m2/s, with 99 percent capture efficiency from the cover and gas extraction system."

These SOERs modelled are as follows:

- Covered Anaerobic Lagoon is 0.04 OU/m^2/s based on 4 OU/m^2/s with 99% capture from the cover;
- Aeration Cell 1 is 0.16 OU/m^2/s based on mean of SOERs in the odour database and used in the original AQIA;
- Aeration Cell 2 is 0.16 OU/m^2/s as for cell 1;

- Settling Pond is 0.16 OU/m^2/s based on Aeration cell; and
- Irrigation Area is 0.16 OU/m^2/s based on odour in settling pond.

The updated odour emissions inventory (Table 13-2) based on potential mitigation options as detailed in Section 14 shows how the plant odour emissions could be significantly abated. The wastewater treatment and irrigation system is estimated to be reduced by 82,679 OU/s, a reduction of more than 87%.

Table 13-2: Current and Potential Future Mitigation Scenario Odour Emissions Inventory [Air Environment Consulting Pty Limited, 2015b]

Odour source	Odour emission rate (OU/s)	Proportion of total plant emissions (%)	Potential odour mitigation scenario (OU/s)	Proportion of total plant emissions (%)
Lairage				
Cattle receival and holding yards, maximum during wet season	682	0.6%	682	2.8%
AQIS Area	10,586	9.0%	10,586	44.0%
Rendering Area				
Red fan press: tank/sump	71	0.1%	0	0.0%
Red fan press: screw conveyor	609	0.5%	0	0.0%
Raw material bin	7,475	6.4%	0	0.0%
Wet rendering building	956	0.8%	0	0.0%
Meat meal hammer mill cyclone wall vent	962	0.8%	0	0.0%
Tallow transfer & storage tanks 1 and 2	2	0.0%	0	0.0%
Biofilter	741	0.6%	741	3.1%
Wastewater treatment area				
Green Sump	7	0.01%	7	0.03%
Common Sump	5	0.005%	5	0.02%
DAF	81	0.1%	81	0.3%
DAF sludge decanter	3	0.003%	3	0.01%
Irrigation Tank	5,991	5.1%	5,991	24.9%
Sludge storage bins	321	0.3%	0	0.0%
Paunch storage bins	7	0.01%	0	0.0%
Spray Irrigation	88,640	75.7%	5,120	21.3%
Proposed stage 2 wastewater treatment plant expansion				
Covererd anaerobic lagoon	0	0.0%	163.93	0.7%
Aeration cell 1	0	0.0%	349.2	1.5%
Aeration cell 2	0	0.0%	190.44	0.8%
Settling pond	0	0.0%	137.8	0.6%
Total plant odour emissions	**117,140**		**24,057**	

The predicted 99.9th percentile, one second average ground level odour concentrations for the WWTP in isolation as well as the improved spray irrigation water are presented in Figure 13-5.

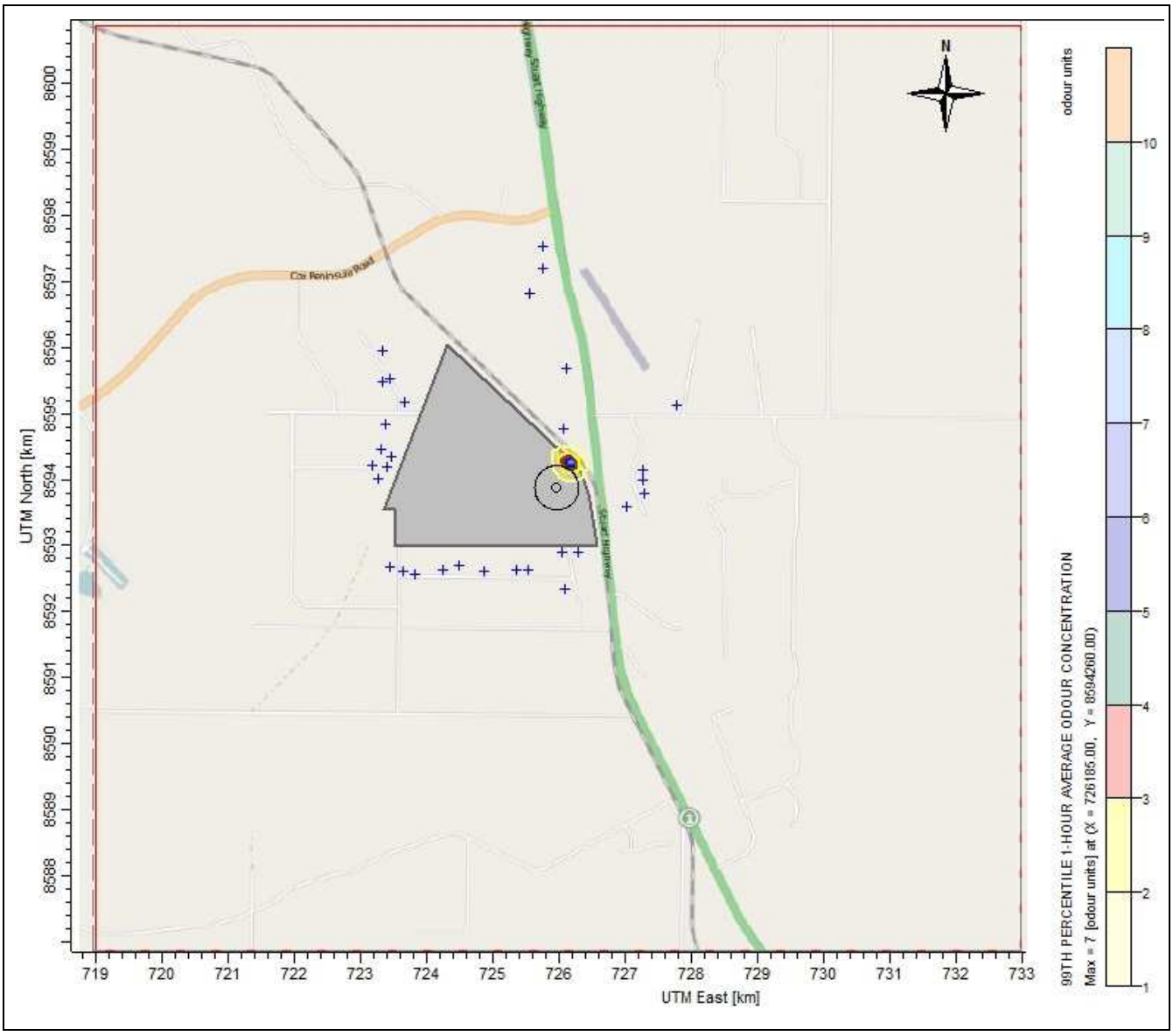


Figure 13-5: Predicted 99.9th Percentile, 1-Second Average Ground Level Odour Concentrations for the Proposed Stage 2 Wastewater Treatment Pond System (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

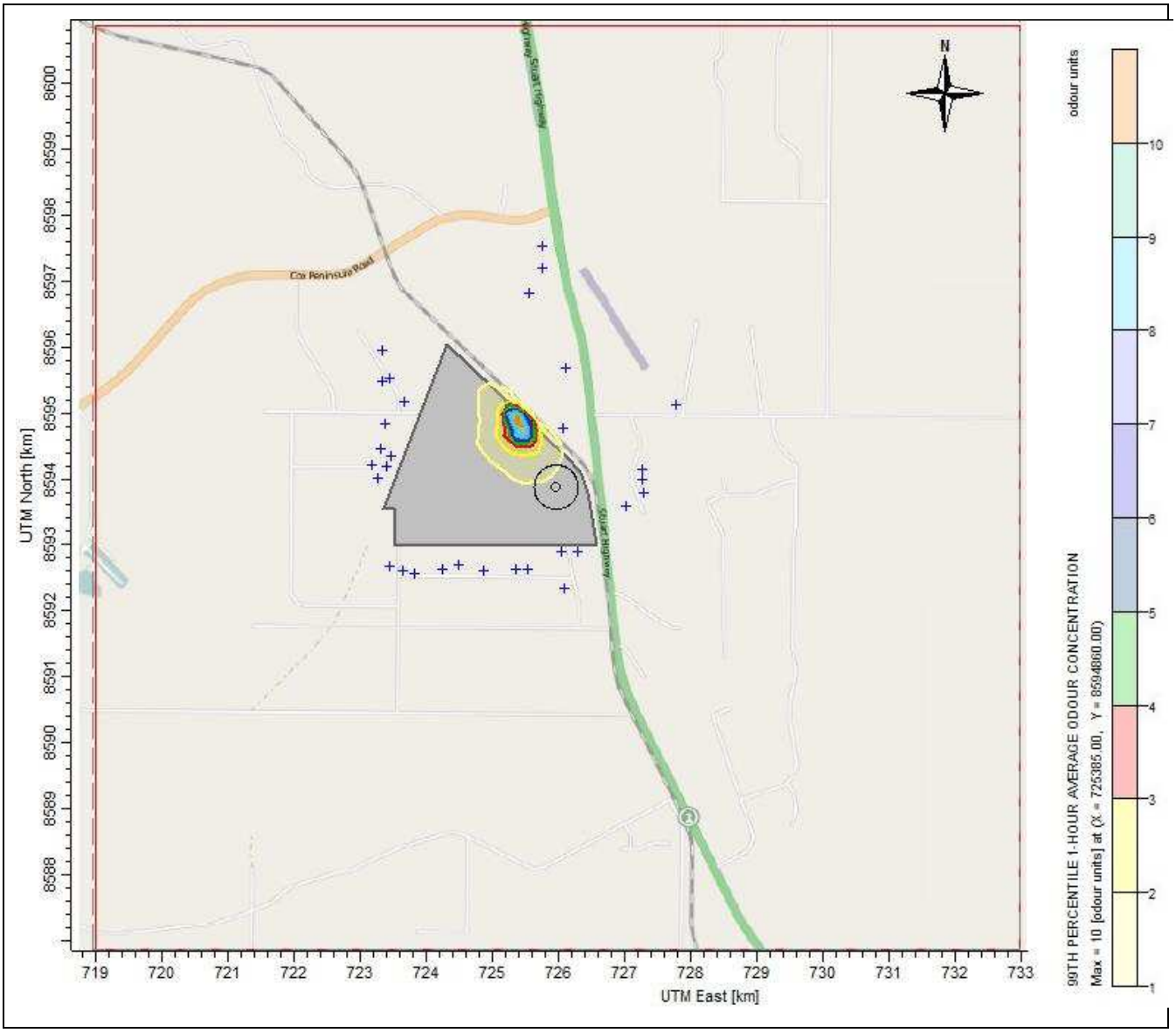


Figure 13-6: Predicted 99th percentile 1-Second Average Ground-Level Odour Concentrations for the Improved Spray Irrigation System Based on Improved Water Quality (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

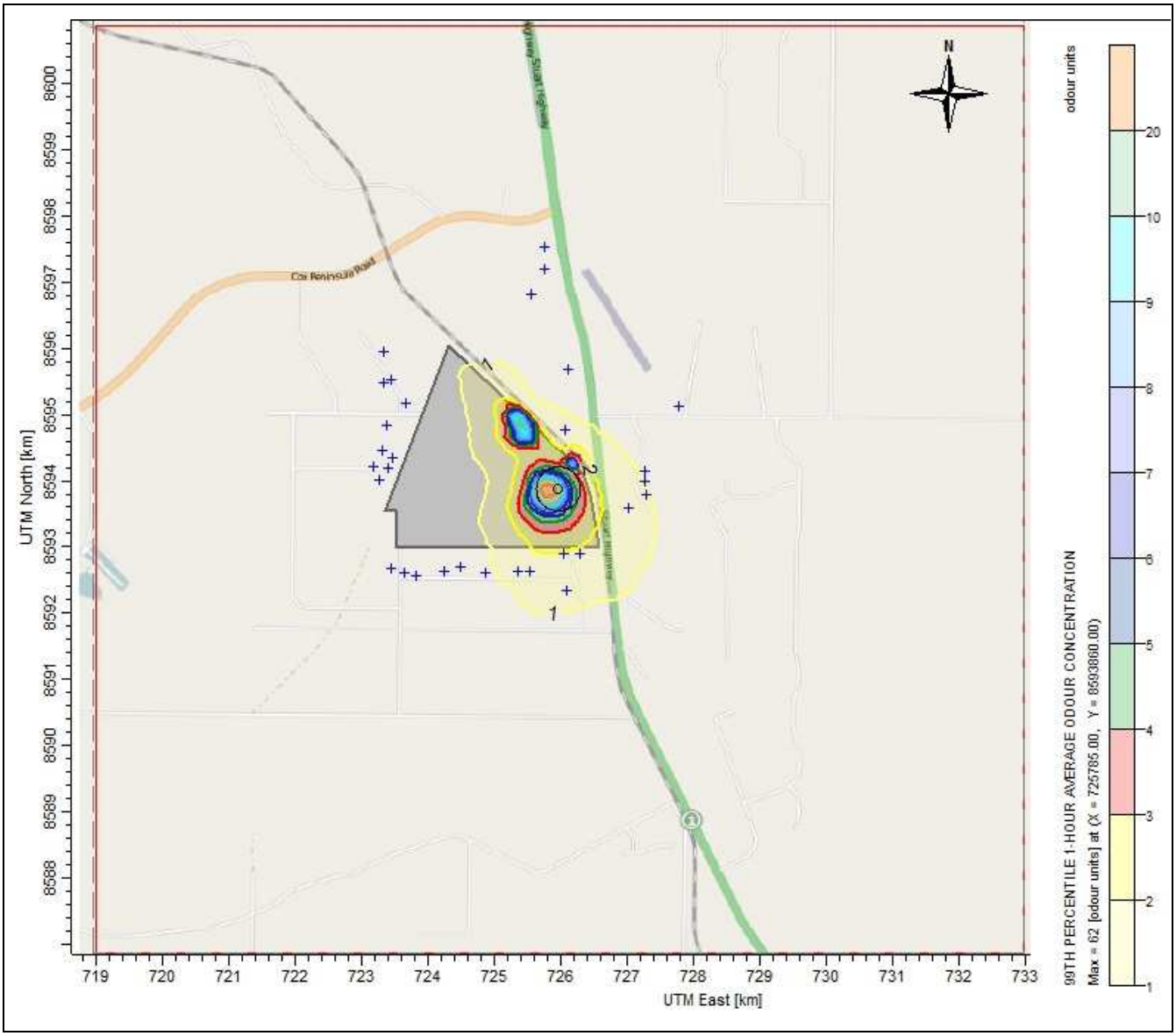


Figure 13-7: Predicted 99th percentile 1-Second Average Ground-Level Odour Concentrations for the Existing Wastewater Treatment Plant, Proposed Stage 2 Wastewater Treatment Pond System and Spray Irrigation System Based on Improved Water Quality (Criteria – 3 OU marked by a red line) [Air Environment Consulting Pty Limited, 2015b]

14 MITIGATION MEASURES, RECOMMENDATIONS AND MONITORING SYSTEMS

When considering the options for NABL to reduce the likelihood of odour complaints, there are three types of paths to address:

1) Engineering controls – these are typically expensive mitigation measures that would provide the greatest reductions in odour;
2) Operational improvements – these a typically small changes to day-to-day activities and procedures that can reduce odour; and
3) Monitoring systems – this would assist in demonstrating compliance.

The current practices and mitigation measures for each area within the Facility are detailed at length in the Odour Management Plan. This Section presents additional reasonable and feasible measures that may improve odour control at the Facility. Recommendations and implementation priority ranking are also discussed.

14.1 ENGINEERING CONTROLS

As discussed in Section 13 the upgrade of the wastewater treatment plant will provide a significant reduction in odour concentrations compared to the current situation. Whilst the upgrade has been approved, the location of the upgrade has not been finalised. In the meantime it is not considered reasonable to implement additional engineering controls.

Other engineering options are available to reduce the odour emissions and include:

- **Designing bin covers** – As discussed in previous sections of this document, the DAF sludge bins are not covered and can be a source of odour. NABL are currently designing their own covers for these bins as the waste transfer company does not have this option. It is recommended that these covers are designed and implemented as soon as possible. If the timeframe is greater than one month, it is recommended that a temporary cover such as tarpaulin is used. Whilst this would not be ideal for operators loading the bins as they would have to uncover and recover the bin manually, it is a cheap solution.
- **Enclosing the DAF** - In the event that odour complaints continue 12 months post installation and commissioning of the upgraded WWTP, consideration should be given to enclosing the DAF. It may not be possible to fully enclose due to the current set-up. Vents and fans would need to be installed and the gases would need to be directed to the bio-filter.
- **Irrigation tank aeration** - If the location of the WWTP is not finalised soon, it is recommended that the addition of an air sparge or aeration be added to the irrigation tank. This will increase the ability of the tank to hold effluent safely for an extended period of time. The gases released from the tank would need to be fed to the bio-filter. This would be beneficial during cessation of irrigation or pump failure. The overall reduction cannot be determined, however if the wastewater was continuously mixed and oxygenated, the BOD levels would decrease and should prevent the contents becoming anaerobic.
- **Rending building** – Mitigation of the render plant odour emissions could be easily achieved through small scale engineering controls and housekeeping such as:
  - Replacement of the lid on the red fan press;
  - Replacement of the lid on the red fan press screw conveyor; and
  - Covering of the raw material bin or extraction of air from the bin and treat through the bio-filter.

- **Enclose render building and the meal dryer building**– In the event that odour complaints continue 12 months post installation and commissioning of the upgraded WWTP, consideration should be given to redesign the render building in order for the building to be under negative pressure. This would allow all of the fugitive emissions to be forced through the bio-filter or even the bio-gas flare. This option would be considered the least viable option as it would entail a significant redesign of the Facility to include the provision of vents and fans in the roof space for mechanical ventilation of the building air. However, the additional reduction in odour emissions would be low compared to other engineering controls.
- **DAF Dosing Agent** – Currently the DAF is dosed with sulfuric acid. When the WWTP is upgraded, the DAF will no longer be dosed. If the upgrade does not occur within a suitable timeframe, consideration should be given to changing the dosing chemical so that additional sulphur is not added to the process to reduce odour.

14.2 OPERATIONAL AND COMMUNICATION IMPROVEMENTS

The following operational and communication improvements are recommended:

- **Housekeeping** - The easiest, quickest and cheapest form of odour control mitigation currently available to NBAL is to ensure that all housekeeping procedures are adhered to. These procedures are discussed in Section 6 of this Audit and the Odour Management Plan (Vipac document number 70Q-15-0248-518855-1).
- **Training Requirements** – During a site visit, NABL staff were observed analysing wastewater samples. Whilst wastewater testing was being conducted frequently, it appeared that when the results of a particular parameter were not optimal, no immediate actions were taken to rectify the situation. It is acknowledged that the ability to rectify such results maybe outside of the capabilities of current staff and therefore training is a necessity in building technical understanding and confidence. As such it is recommended that a review of skills, abilities and training of the current waste water treatment plant should be undertaken by an external wastewater specialist provides training in relation to:
    - The correct procedures when undertaking samples and analysis of the wastewater to ensure that quality assurance is being achieved;
    - Derive step-by-step procedures for staff to follow;
    - An understanding of how and why to rectify procedures/processes when undesirable wastewater test results occur; and
    - Documenting potential wastewater results with required actions that will remedy the results.

  This recommendation should be implemented urgently as the quality of the BOD levels wastewater is variable. The odour modelling results show the wastewater has the largest effect on the off-site odour impacts.
- **Re-treat (recycle) Wastewater** – The current wastewater treatment plant has the ability to recycle any unfavourable wastewater. This system is used regularly, especially when purging the irrigation tank. It is recommended the Facility increase the frequency of wastewater recycling through the DAF in response to high wastewater contaminant results. The success of this recommendation will be determined by:
    - Undertaking the wastewater sample tests promptly and to respond accordingly as per the training detailed above; and
    - The decision to recycle the water through the DAF would be made by the Chief Engineer in response to incoming wastewater flows from the plant.

- **Communication with NT EPA** – It is recommended that NABL and NT EPA develop a form of transmission whereby information relating to complaints, plant performance and ambient odour field surveys can be shared. A level of openness, especially during the WWTP upgrade process is essential. At present, the NT EPA is only notified if there is an exceedance or if they receive an odour complaint from the community.
- **Community Engagement –** It is important the NABL actively engage with the community and it is acknowledged that the Community Reference Group monthly meeting may not suffice in some circumstances. If NABL are seen to be proactive and responsive to concerns there will be long-term benefits (for example during unforeseen plant breakdowns). Two ways in which NABL can engage with the community in the short term are:
    - It is recommended that an information leaflet is distributed to local residents which summarises the new Complaint Handling Procedure. This leaflet should identify how to make an odour complaint and explain how NABL will respond and the timeframes associated. This is a low cost measure as the majority of the information is contained in the new Complaints Handling Procedure.
    - Discussions relating to creating a community-centred website are on-going. It is recommended that this process is given more priority. It is proposed that this website will provide a range of information including planned maintenance of odour critical equipment; weather data, plant shut downs, and environmental reports. NABL must consult the local community in terms of content to ensure that the website is a useful tool that is updated regularly.
    - Once approved by EPA and the NABL, the upgrade program to control the odours be provided to the community in a simple form along with the proposed implementation timetable. Regular updates of progress made should then be provided along with a summary of the odour monitoring results. Providing cost estimates for the upgrades would also assist the community in understanding the efforts the company is making.

14.3 AMBIENT MONITORING SYSTEM FOR TRIAL

Whilst mitigation measures have been proposed alongside the upgrade of the WWTP, it is important that NABL can verify their operational and compliance performance. The best method to assist with this is the combination of a continuous ambient monitoring system and field odour surveys. Table 14-1 presents the proposed monitoring system. Full details of the equipment are presented in Appendix L.

Table 14-1: Proposed Monitoring Systems

Equipment	Application	Maintenance Level	Cost
Scentroid Scentinal	Near source and continuous ambient monitoring of odorous gases and correlation with odour concentration	Low Maintenance	High
SM100i Field Olfactometer	Backs up the in-field ambient odour surveys using the odour intensity 'sniffing' method (Section 10.1) and can be correlated with Scentinal measurements	Time intensive during surveys	Low

The Scentroid Scentinal real-time ambient monitor can detect a number of gases at high or low concentrations (H_2S (standard sensor), NH_2, SO_2, CO_2, CO, CL, C_2HO_4, H, HCl, HCN, NH_3, O_3, NO_2, PH_3, H_2S, O_2, SO_2, CH_4, NO and VOCs) as well as temperature, relative humidity and GPS location. The unit can be 'trained' to match the odorous compounds to odour concentration using field olfactometry data.

It is acknowledged that H_2S is not the only odourous compound emitted from the site; however H_2S was tested in the irrigation tank during the site visit and the value correlated well with the odour concentration as determined by laboratory analysis.

The Scentroid Scentinal system can also be used alongside the existing meteorological station to review the potential odour sources in certain wind directions; this will be valuable when determining the validity of odour complaints.

Due to the cost of the system, a trial period is recommended in the first instance, consisting of one unit installed downwind of an odour source (i.e. WWTP). If this is successful and that the unit is working well (i.e. sensors selected and their ranges are appropriate) and correlating with the SM100i Field Olfactometer additional units can be added and the most appropriate location(s) can be determined. If the system is successful, the data can be downloaded from the manufacturer's website and reports can be generated.

14.4 BENEFIT/COST ANALYSIS AND IMPLEMENTATION

Benefit/cost analysis is a simple method for evaluating possible improvement options as discussed. A full benefit/cost analysis is presented in Table 14-2. The ambient monitoring system is not included in this analysis as its implementation will not reduce odour, but assist in verifying odour complaints.

This analysis is based on estimated benefits and costs using a scale 1 – 10; with 1 being low and 10 being high. Once the benefits and costs have been ranked, the ratio is calculated and the following is determined:

- Greater than 1 - benefits are greater than costs. Action should be given a high priority;
- Equal to 1 - benefits are equal to costs. Action should be given a lower priority; or,
- Less than 1 - costs are greater than benefits; actions should only be implemented on compelling, non-financial grounds.

The implementation of measures has been ranked based on the resultant ratio. The rows have been shaded based on the implementation timeframe:

- Green rows can be implemented or actioned immediately;
- Orange rows can be considered within the specified timeframe; and
- Red rows should be the last resort as these are engineering controls which will require a redesign of the processes and/or Facility. Therefore the red rows are not considered viable to provide additional mitigation due to the cost.

There is one row which has not been shaded; this is the wastewater treatment plant upgrade. It has been included to demonstrate the benefits and cost ranking associated with its implementation.

Table 14-2 identifies that there are five mitigation measures that can be implemented or actioned immediately:

1) Ensuring that housekeeping and the OMP is adhered to for all areas of the Facility;
2) Using temporary covers such as tarpaulin to cover the DAF sludge bins;
3) Recycling the wastewater through the DAF depending on test results and incoming wastewater flows;
4) Wastewater training by an third part specialist; and
5) Design and install long term covers for the DAF sludge bins.

Table 14-2: Benefit/Cost Analysis and Implementation Ranking

Potential Action	Potential Issues	Benefits		Costs		Ratio (Benefit/Cost)	Priority Rank	Timeframe for Implementation**
		Description	Ranking*	Description	Ranking*			
Housekeeping	None	See Odour Management Plan	1	No costs	0	10.0	**1**	At all times
Temporary covers for the DAF sludge bins (i.e. tarpaulin)	May hinder efficiency in DAF sludge management	The odour from the bins with and without DAF sludge will be contained.	1	Very low	0	10.0	**2**	Immediately
Recycling the DAF wastewater	Requires understanding of equipment, procedures and prompt testing of wastewater	Undesired wastewater quality will be improved prior to storing and irrigation	9	Third party training would benefit this option	1	9.0	**4**	Immediately
Wastewater training	Timing of training	Staff understand how to carry out tests correctly and how to improve wastewater performance	9	Third party training required	1	9.0	**3**	Immediately
Changing DAF dosing chemical	Require a large amount of research on most suitable chemical. Would it be compatible with the unit? What are the optimal dosing rates?	If the dosing chemical is changed and the dosing rates are understood and applied, wastewater odour emissions may reduce	7	Research time and manufacturer involvement.	2	3.5	**4**	Review this within 6 months if WWTP upgrade is not progressing. Dosing not required after upgrade
Designing bin covers for the DAF sludge bins	Reliant on a third party to design/manufacture	The odour from the bins with and without DAF sludge will be contained.	2	Low, but costly as a number of covers need to be manufactured	1	2.0	**5**	ASAP
Irrigation Tank Aeration	Gases would need to be vented and directed to the bio-filter	Reduction in BOD levels therefore lower odour	6	Potential redesign of the tank/new tank	4	1.5	**6**	Last resort

Potential Action	Potential Issues	Benefits		Costs		Ratio (Benefit/Cost)	Priority Rank	Timeframe for Implementation**
		Description	Ranking*	Description	Ranking*			
Upgrade the WWTP	Location is yet to be finalised. Construction required this may be hindered by the wet season	Significant benefits in the wastewater treatment quality thus reducing odour from irrigation	10	NABL do not wish to reveal the upgrade cost. Typically, these systems cost several million dollars	10	1.0	**7**	ASAP
Enclosing the DAF	May not be possible to fully enclose due to the current set-up. Gases would need to be directed to the bio-filter	A high reduction in fugitive odour from the DAF unit	5	Potential redesign of the DAF due to redirection of the gases to the bio-filter	8	0.6	**8**	Last resort
Enclosing the render building	Gases would need to be vented and directed to the bio-filter	A high reduction in fugitive odour from the rendering building	4	Potential redesign of the building to redirection of the gases to the bio-filter	10	0.4	**9**	Last resort

*Ranking is based on 1 – 10 with 1 = low and 10 = high

**From finalisation of this audit

14.5 ANNUAL ODOUR AUDIT

As part of the Notice, an annual odour audit needs to be undertaken. Based on the information in this document, it is recommended that the next audit is carried out once the WWTP upgrade is operational (in this context, operational means that the CAL has formed a natural crust or has an artificial cover).

As mentioned before, the location of the upgrade has not been finalised and it is unknown when the WWTP will become operational. If the plant becomes operational within six months, it is recommended that only the WWTP and spray irrigation odour samples are to be collected. Additionally, any processes that may have changed since the original survey should also be sampled.

If the WWTP is not operational within one year of this Audit, the annual odour anniversary should be undertaken before the end of September each year. This date correlates with the one-year anniversary of the odour samples used in this report and ensures that the samples are carried out during the dry season.

If the trial period of the ambient monitoring unit determines that the a full monitoring system can be installed, and the monitoring data shows low odour level and/or odour complaints have ceased, an annual odour audit may not be necessary. Until such time as this can be determined, an annual odour audit is required.

14.6 AUDITOR'S EVALUATION OF PROPOSED MITIGATION ACTIONS

Based on the modelling results, the planned installation of a new water treatment process, along with improvements in housekeeping, should on their own reduce the off-site odour to acceptable levels. The additional measures, such as covering bins and training wastewater plant personnel should further reduce odours. The proposed actions to control the odours from the site therefore appear appropriate.

The use of the portable olfactometer is supported as a method to assess the success of the odour reduction actions and identify odour sources. The possible use of the Scentinal monitor would allow the odour monitoring process to be partially automated; therefore investigating its use is also supported.

15 CONCLUSIONS

The NT EPA issued its Notice to Carry Out Environmental Audit Program (the Notice) to NABL on 17th August 2015. The Notice was issued on the basis that EPA considered that the Activity is (or was) generating odour that is likely to cause nuisance. The Notice was issued pursuant to Section 48 of the Waste Management and Pollution Control Act (the Act).

Licence Conditions

The EPL 131 was issued on 31st October 2014, six weeks after the testing phase commenced. These conditions are stringent in order to protect water quality; these appear to have been issued without consideration of the achievable wastewater loadings for the equipment installed.

One condition of the licence was to undertake an AQIA in accordance with the NSW Approved Methods; a sub condition was to have the AQIA independently reviewed, these requirements were complied with.

Performance

The only wastewater parameter which has a direct correlation to odour is BOD; the expected DAF outlet concentration is 800 mg/L based on maximum design production, which is significantly higher than the long-term 20 mg/L licence condition. The DAF is the only wastewater treatment process at present; when reviewing the performance of the DAF unit against the designed wastewater loadings it is clear that in most instances the BOD inlet limits (4,000 mg/L) have been achieved. The median BOD reduction of the DAF is 72%, which is just below the 80% reduction stated in design documentation; however the level of removal can vary and this has been observed at site. This variation in BOD reduction may be attributed to high wastewater generation; until recently the incoming water for the DAF was higher than the design capacity. It should be noted that wastewater generation has been reduced in recent weeks to ensure DAF capacity is not exceeded due to a change in operational procedures.

During the commissioning of the bio-filter, three issues were encountered which resulted in inadequate bacteria count and led to odour complaints and the subsequent installation of a masking agent. The revised AQIA identified that this masking agent may not be necessary as the odour sampling results and modelling predictions were low.

This Audit has reviewed the current processes, practices and production data at the NABL in relation to odour generation, the effectiveness of current odour controls and the ability to reduce odours further. Overall, there is a tiered level of inspections, checklists, testing requirements and procedures in place that would identify any issues which may lead to increased odour generation. The level of cleaning at the end of the day is very high as demonstrated by the current state of the processing equipment however, additional cleaning of the cattle holding yards and AQIS area should decrease odour from these areas.

Complaints

A detailed review of the available odour complaints was undertaken and it was determined that not all of the complaints were valid as some of the complaints were made on days when there was no production or irrigation at the Facility. The information collected for each complaint record varied; some were detailed whilst others did not provide any vital information that could be used to assess the validity of the complaint at the time.

As part of this Audit, the Complaints Handling Procedure has been revised as part of the company's Quality Assurance program of continuous improvement. This new procedure outlines all the relevant information

required at each stage of the process, which will assist NABL in determining if the odour complaint is valid based on the type of questions and supporting information to be recorded. As part of the complaints handling process, a trial phase of real-time ambient monitoring equipment has been recommended and if successful, an ambient odour monitoring network will be implemented, allowing NABL to verify their odour emissions using their recently installed weather station.

A review of the metrological conditions has identified that during the evening hours when most odour complaints have been made the atmospheric conditions are stable therefore odour dispersion is limited. These complaints could also be due to the fact more people are at home during the evening and therefore more likely to complain.

Irrigation of the southern irrigation area has resulted in odour complaints. In response irrigation in this area has ceased.

Site observations

Some issues were noted during the site visits including:

- A pipe associated with the air extraction system was disconnected, however once identified the pipe was reconnected immediately;
- The waste skips provided by an external company do not have covers and odour emissions can be high from full and empty containers. NABL are currently designing their own covers to prevent the odours from being released; and
- An open drain was identified which was filled with wastewater. This drain has been covered to ensure that odours are contained.
- During the site visits, it was apparent that the staff responsible for the operation, maintenance and environmental aspects of the Facility have agreed with expert advice and are being co-operative in addressing any odour concerns. The willingness to adopt new practices and a positive attitude demonstrates that NABL are committed to addressing odour concerns raised by NT EPA and the local community.

Odour Sampling and Predictions

An odour sampling plan was drafted in two stages by Airlabs, Air Environment and the Auditor. The first stage sampled the known odour emissions whilst the second stage testing was drafted after the first visit; allowing detailed discussions to be undertaken to determine the most appropriate sampling method. The odour results were used to determine the odour emission rates used in the revised model by Air Environment. These emission rates have been calculated in discussion with the Auditor and modelled to represent activities at the Facility.

The odour modelling has determined that the wastewater treatment plant and the spray irrigation are the odour sources which will cause off-site odour emissions. The approved upgrade of the wastewater treatment plant was modelled in the most recently proposed location. The results show an 87% reduction in the total odour emissions from the Facility.

A number of mitigation measures have been presented along with a benefit/cost analysis and implementation schedule; some of these measures can be implemented or actioned immediately.

Auditor's Final Conclusions

The odour audit appears to have identified all major odour sources on site that could result in offensive off-site odours. Sampling and testing of the on-site odour sources was carried out using suitable methods for each type of odour emission source. Estimation of emission rates for each odour source used a logical and conservative approach. The modelling was also carried out using appropriate methods and took into consideration circumstances of each odour emissions source.

The proposed actions and the odour sources to be addressed are consistent with the major odour sources identified by the odour emission modelling. The Auditor must therefore conclude that the process to identify and address the odour sources of concern was carried out appropriately and that the proposed actions should result in a significant decrease in the odours from the site.

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