



WOLLONGONG CITY COUNCIL

Whytes Gully Waste and Resource
Recovery Centre –

Odour Investigation Assessment

Kembla Grange, NSW

Final Report

June 2021



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APPENDICES

APPENDIX A: ODOUR CONCENTRATION LABORATORY RESULT REPORTS: 10 & 11
MAY 2021

GLOSSARY

AS/NZS4323.3:2001	Australian Standard/New Zealand Standard 4323.3:2001 - <i>Stationary source emissions - Determination of odour concentration by dynamic olfactometry</i>
EPL	environment protection licence
FAOA	Field Ambient Odour Assessment
IFH	isolation flux hood
m/s	metres per second
m²	square metres
N₂	nitrogen gas
NSW EPA	New South Wales Environment Protection Authority
OER	odour emission rate, ou.m ³ /s
ou	odour units
ppm	parts per million, by volume
PTFE	polytetrafluoroethylene
SOER	specific odour emission rate, ou.m ³ /m ² /s
the Assessment	the odour investigation assessment conducted by TOU for Wollongong City Council
the Odour Review	<i>Wollongong City Council – Whytes Gully Operational Odour Review Assessment</i> dated 23 April 2021
the Whytes Gully WRRRC	Whytes Gully Waste and Resource Recovery Centre located Lot 502 Reddalls Road, Kembla Grange, NSW
TOU	The Odour Unit Pty Ltd
the 2012 Golder Associates Report	the PAEHolmes report <i>Air Quality Assessment: Whytes Gully New Landfill Cell</i> found in Appendix H of Golder Associates report <i>Volume III: Environmental Assessment – Whytes Gully New Landfill Cell</i>
WCC	Wollongong City Council

1 INTRODUCTION

In April 2021, Wollongong City Council (**WCC**) engaged The Odour Unit Pty Ltd (**TOU**) to conduct an odour investigation assessment (the **Assessment**) at the Whytes Gully Waste and Resource Recovery Centre located at Lot 502 Reddalls Road, Kembla Grange, New South Wales (the **Whytes Gully WRRC**).

1.1 RELEVANT BACKGROUND

The Whytes Gully WRRC operates under environment protection licence (**EPL**) 5862. In early-2021, odour complaints reported by the community in the surrounding region were received by WCC relating to the Whytes Gully WRRC. The New South Wales Environment Protection Authority (**NSW EPA**), in conjunction with the WCC staff operating the Whytes Gully WRRC, developed an odour assessment framework resulting in special conditions E1.4 and E1.5, which are outlined in **Figure 1.1**.

- | |
|--|
| <p>E1.4 The licensee must engage a suitably qualified and experienced odour specialist to assess odour emissions from the premises and on the performance and effectiveness of the odour mitigation measures. Provide the EPA with a copy of this assessment by 30 April 2021.</p> <p>E1.5 The licensee is required to undertake a detailed risk assessment of the premises including the following:</p> <ul style="list-style-type: none">a) The risk assessment must identify all significant odour-generating sources at the premises.b) The risk assessment must be informed by site-specific odour monitoring. All monitoring must be undertaken in accordance with the NSW EPA's Approved Methods for the Sampling and Analysis of Air Pollutants in NSW.c) Where measured site-specific odour emission rates are significantly different to those previously adopted in the odour modelling report by Pae Holmes (June 2012), the modelling must be revised to include site specific data.d) The Licensee must undertake a detailed feasibility study to consider and evaluate options to reduce odour emissions from the highest ranked odour generating sources.e) The feasibility study should evaluate the expected change in offsite odour impacts via a revised odour |
|--|

Figure 1.1 – A snippet of the EPL 5862 conditions relevant to the Assessment

Consequently, TOU was engaged to conduct an operational odour review assessment for the Whytes Gully WRRC. This was submitted to the WCC on 23 April 2021 in a report titled *Wollongong City Council – Whytes Gully Operational Odour Review Assessment* dated 23 April 2021 (the **Odour Review**). Following the Odour Review, correspondence between NSW EPA and WCC determined that *Section E1.4* (as seen in **Figure 1.1**) had been satisfied, but *Section E1.5* (also in **Figure 1.1**) remained outstanding. As a result, TOU developed a suitable scope of works that was aimed at addressing the requirement of *Section E1.5*, in particular;

- Identification of all significant odour-generating sources;
- The undertaking of site-specific odour sampling and testing to quantify all significant odour generating source; and
- A comparative analysis between site-specific measurements collected by TOU and the previous measurements (refer to **Section 4.2**).

Based on this quantitative information and the Odour Review, TOU has provided a series of recommendations that reflect proactive mitigation measures to manage the risk of adverse conditions that could lead to a higher than desirable degree of odour emissions from the activities at the Whytes Gully WRRC (refer to **Section 5**).

The purpose of this document is to present the results of testing of the aforementioned works, and to discuss the development of appropriate odour emission minimisation and mitigation strategies, where appropriate.

1.2 SCOPE OF WORKS

The Assessment consisted of the following scope of works:

- An on-site odour emissions assessment conducted on 10 May 2021. During this visit, odour samples to be collected from all key sources identified in the operational odour inspection conducted in the Odour Review; and
- All collected samples were analysed at TOUs NATA Accredited Odour Laboratory within the appropriate timeframe for odour concentration and character.

The following report summarises the methodology, results and findings from the Assessment conducted at the Whytes Gully WRRC. Based on the findings of the Assessment, recommendations have been provided on how odour management can be improved at the Whytes Gully WRRC.

2 ODOUR SAMPLING AND TESTING METHODOLOGY

2.1 AREA SOURCE SAMPLING METHOD

The objective of the area source sampling was to collect representative odour samples from both solid and liquid surface areas at the Site. This was undertaken using an isolation flux hood (IFH). All sampling using the IFH was carried out according to the method described in the United States Environment Protection Agency (US EPA) technical report 'EPA/600/8-86/008', from which Australian Standard 4323.4:2009 (AS4323.4:2009) is based and is considered an 'Other Approved Method (OM-8)' by EPA (DEC, 2007).

TOU's IFH adheres to the design specifications, materials of construction and supporting equipment that the US EPA report 'EPA/600/8-86/008' defines. The IFH has a diameter of 0.406 m, a chamber surface area of 0.126 square metres (m²) and a chamber volume of 30 litres (L), equivalent to 0.03 cubic metres (m³), when the skirt of the hood is inserted into the liquid or solid surface by the specified 25 millimetres (mm). Dry nitrogen is then introduced to the IFH at a sweep rate of 5 L/min.

As these area sources are open to the atmosphere, wind is a major factor in the release of odorous pollutants from the surface and conveying the pollutant from the source to areas beyond the boundary. The IFH system is designed to simulate the transfer of odorous pollutants by the wind, resulting in a controlled and consistent sampling environment. This is achieved by the flux of near pure nitrogen gas into the IFH that is positioned on the liquid or solid surface. On a liquid surface, this is achieved by floating the IFH within an inflated tyre inner tube. The nitrogen gas then transports the odour from the surface in the same way the wind does, albeit at a very low sweep velocity. This odorous air is then collected for odour and/or chemical analysis. As the IFH has a constant 5 L/min inflow of nitrogen gas to it, the sampling chamber remains under positive pressure and produces a net outflow through the vent on top of the IFH, therefore eliminating any chance of contamination of external air from the atmosphere.

The IFH's volume of 30 L and the 5 L/min nitrogen sweep rate results in a gas residence time of six minutes. The US EPA method prescribes a minimum of four air changes in order to achieve optimum purging and equilibrium conditions in the hood, and therefore a total of 24 minutes is allowed before sampling commences. The sample is then collected over a 10-minute period to obtain a 20 L sample for odour and/or chemical analysis.

The US EPA method followed by TOU may be summarised as follows (and as described in the schematic of the sampling equipment shown in **Figure 2.1**):

- Dry nitrogen is directed into the IFH via odour free PTFE tubing until it has reached equilibrium. The nitrogen is channelled to a manifold fitted with small outlets above the surface, which direct the air towards the centre of the surface;
- The nitrogen flow (5 L/min) purges the flux hood with a residence time of four times the chamber volume occurring before sampling begins; and

- The odorous sample is drawn through a Teflon tube, into a single-use, odour-free Nalophan sample bag secured inside a drum that is under vacuum. The balance of the gas flow is vented to the atmosphere.

The IFH is manufactured from acrylic resin to ensure it does not contribute to the odour sample. All other surfaces in contact with the sample are made from PTFE or stainless steel.

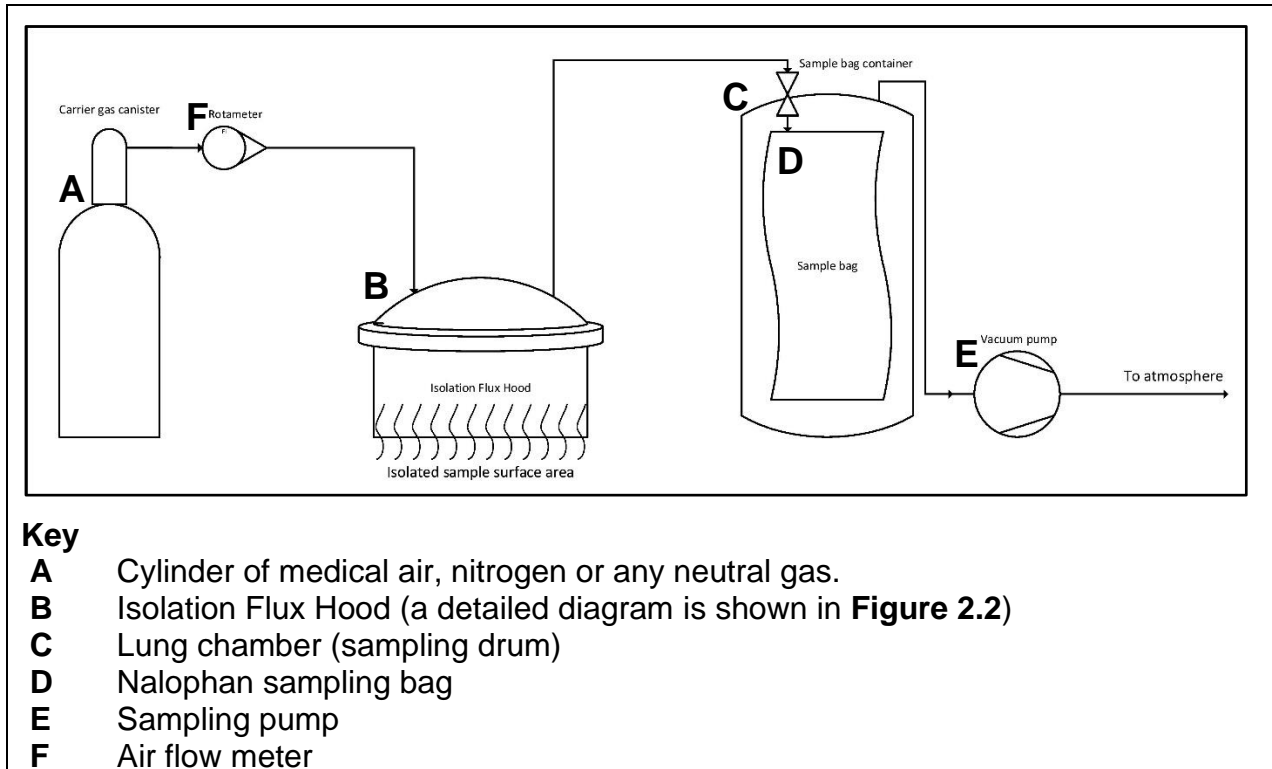


Figure 2.1 – Schematic of the isolation flux hood setup

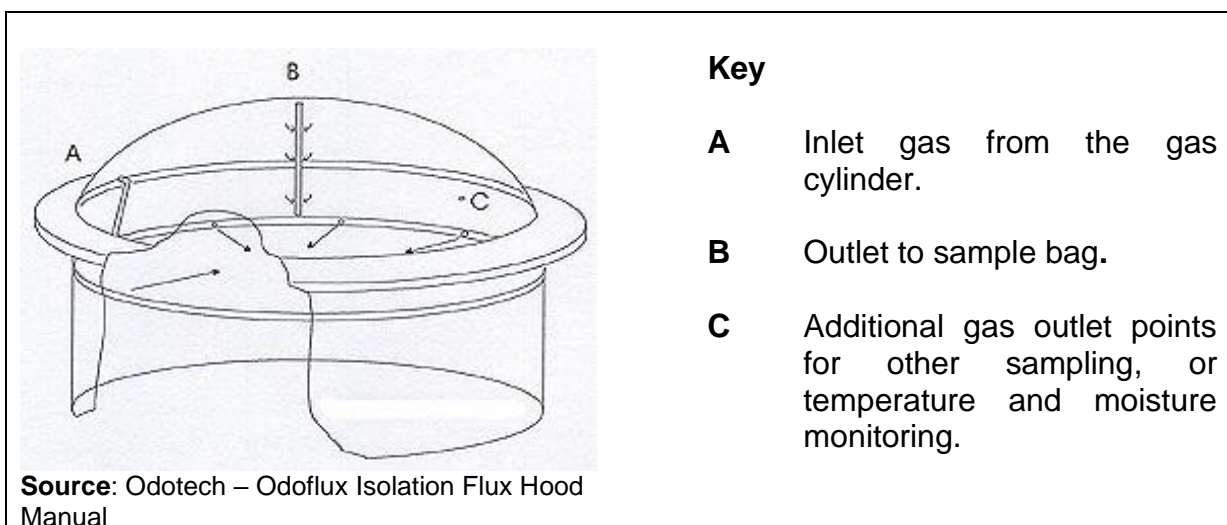


Figure 2.2 – Details of the isolation flux hood chamber

2.2 ODOUR MEASUREMENT LABORATORY

All odour samples collected for the Assessment were analysed at TOU's NATA Accredited Odour Laboratory in Sydney.

2.2.1 Odour Concentration Measurement

TOU's odour laboratory operates to the AS4323.3:2001 which prescribes a method for sample analysis that provides quality assurance/quality control and ensures a high degree of confidence in the accuracy, repeatability and reproducibility of results.

The concentration of the gaseous odour samples was measured using a technique known as dynamic olfactometry. Dynamic olfactometry involves the repeated presentation of both a diluted gaseous odour sample and an odour-free air stream to a panel of qualified assessors through two adjacent ports on the olfactometer (known as the Odormat™). TOU utilises four to six trained assessors (or panellists) for sample analysis, with the results from four qualified panellists being the minimum allowed under the Australian Standard AS4323.3:2001. For the Assessment, four panellists were used.

The method for odour concentration analysis involves the odorous gas sample initially being diluted to the point where it cannot be detected by any member of the panel. The assessor's step-up to the olfactometer, in turn, takes a sniff from each port, then choose which port contains the odour and enter their response. At each stage of the testing process, the concentration of the odorous gas is systematically increased (doubled) and re-presented to the panellists. A round is completed when all assessors have correctly detected the presence of the odour with certainty. The odour is presented to the panel for three rounds and results taken from the latter two rounds, as stated in AS4323.3:2001.

The results obtained give an odour measurement measured in terms of odour units (**ou**). One (1) ou is the concentration of odorous air that can be detected by 50% of members of an odour panel (persons chosen as representative of the average population sensitivity to odour). It is effectively the concentration of an odour at detection threshold level. The odour concentration of a sample expressed in odour units is the number of times the sample must be diluted to elicit a physiological response (the detection threshold level) from a panel. For example, twenty (20) odour units would mean that the odour sample will need to be diluted 20 times for the concentration to be at detection threshold level. This process is defined within AS/NZS 4323.3:2001. This process is defined within AS4323.3:2001. The odour units can be subsequently multiplied by an emission rate or volumetric flow to obtain an Odour Emission Rate (**OER**, $\text{ou.m}^3/\text{s}$) or a specific odour emission rate (**SOER**, $\text{ou.m}^3 \text{m}^{-2} \text{s}^{-1}$) for area source samples collected using the IFH method (see **Section 2.1**).

2.2.2 Specific Odour Emission Rate

For area source samples collected using the IFH method, the results from odour concentration testing, derived in odour units (see **Section 2.2.1** for details), is multiplied by an emission rate to obtain a SOER. SOER is a measure of odour released from a representative point at a source. The SOER is multiplied by the area of the source to obtain the OER or the total odour released from each source, that is:

- $SOER (ou.m^3 m^{-2} s^{-1}) = OC \times Q / A$; and
- $OER (ou.m^3 s^{-1}) = SOER \times \text{area of source } (m^2)$

where:

- OC = odour concentration of compound from air in the chamber (ou)
- Q = sweep gas volumetric flow rate into chamber ($m^3 s^{-1}$)
- A = sample source total surface area (m^2)

The SOER is presented in the units $ou.m^3/m^2.s$ as per convention, and as referred to in the document – Klenbusch, M.R., 1986. USEPA Report No. EPA/600/8-86/008 ‘*Measurement of gaseous emission rates from land surfaces using an emission isolation flux chamber, - Users Guide*’. The OER is presented in the units’ $ou.m^3/s$ as referenced in the AS/NZS 4323.3.

2.3 WHYTES GULLY SAMPLE LOCATIONS

As outlined in **Section 1.2**, odour sampling at the Whytes Gully WRRRC was undertaken on 10 May 2021. During this visit, odour samples were collected and analysed from all key sources identified in the operational odour inspection, as follows:

1. Primary, secondary and back-up leachate ponds, known to the Whytes Gully WRRRC staff as P-1, S-1 and B-1 respectively (refer to **Photo 2.1** as an example location for leachate pond samples);
2. Stormwater collection ponds (refer to **Photo 2.2** as an example location for stormwater pond samples);
3. Lined landfill cell with 150 mm intermediate cover: refer to **Photo 2.3** as an example location for samples taken in a lined, intermediate cover area from this source;
4. Unlined landfill cell with 150 mm intermediate cover: refer to **Photo 2.4** as an example location for samples taken in an unlined, intermediate cover area from this source; and
5. Active tipping face: refer to **Photo 2.5** regarding the methodology of active tipping face sample collection.



Photo 2.1 – An example of IFH sampling on P-1 dated 10 May 2021



Photo 2.2 – An example of IFH sampling on the stormwater pond dated 10 May 2021



Photo 2.3 – An example of IFH sampling on the lined intermediate cover area (150 mm) dated 10 May 2021



Photo 2.4 – An example of IFH sampling on the unlined intermediate cover area (150 mm) dated 10 May 2021



Photo 2.5 – An example of IFH sampling on the active tipping face material dated 10 May 2021

3 ASSESSMENT RESULTS

The testing results from the samples collected at the WRRC 10 May 2021 are summarised in **Table 3.1**.

3.1 WASTEWATER SOURCES

The results in **Table 3.1** indicate that the leachate ponds, including P-1, S-1 and B-1, and the stormwater ponds have relatively low SOERs, suggesting that the current leachate treatment and stormwater management protocols are effective under normal operating conditions from an odour perspective.

3.2 LANDFILL SOURCES

The unlined and lined intermediate cover areas also indicate low SOERs. It should be noted that, during the 10 May 2021 visit, sampling locations identified to be of higher odour risk were selected, to provide a more conservative and representative assessment of the odour emissions profile for this source (e.g. vegetative versus non-vegetative areas for the intermediate cover areas). The active tipping face SOER is consistent with other putrescible landfills in Australia, based on TOU's internal database.

Table 3.1 – Odour testing results for the Whytes Gully WRRC: 10 May 2021

TOU Sample ID	Sample Number	Sample description	Odour concentration (ou)	Specific Odour Emission Rate (ou.m ³ /m ² .s)	Odour character
SC21341	1	S-1 (1 of 2)	69	0.042	musty
SC21342	2	S-1 (2 of 2)	16	0.010	musty
SC21343	3	P-1 (1 of 2)	140	0.086	dirt
SC21344	4	P-1 (2 of 2)	128	0.079	dirt
SC21345	7	Stormwater pond (1 of 2)	17	0.070	musty water
SC21346	8	Stormwater pond (2 of 2)	<16	0.064	dirt, water
SC21347	5	B-1 (1 of 2)	118	0.010	dirt
SC21348	6	B-1 (2 of 2)	108	0.010	dirt
SC21349	9	Unlined intermediate cover (150 mm) (1 of 2)	32	0.019	musty
SC21350	10	Unlined intermediate cover (150 mm) (2 of 2)	35	0.021	musty
SC21351	11	Lined intermediate cover (150 mm) (1 of 4)	256	0.111	sweet, dirt
SC21352	12	Lined intermediate cover (150 mm) (2 of 4)	38	0.022	sweet, dirt
SC21353	13	Lined intermediate cover (150 mm) (3 of 4)	279	0.163	sweet, fermented
SC21354	14	Lined intermediate cover (150 mm) (4 of 4)	35	0.021	musty
SC21355	15	Active tipping face (1 of 2)	4,100	2.45	garbage
SC21356	16	Active tipping face (2 of 2)	4,470	2.67	garbage

Table 3.2 – Odour emission rate comparison: TOU May 2021 and Golder Associates June 2012

Location	Area of emissions (m ²)		Specific odour emission rate (ou.m ³ /m ² .s)		Odour emission rate (ou.m ³ /s)	
	2021 Estimates	2012 Stage 1 model	TOU 2021 (mean result)	Golder Associates Stage 1 2012	TOU 2021	Golder Associates Stage 1 2012
Active tipping face	250	1,100	2.56	1.115	640	1,227
Intermediate cover (150 mm) - Unlined	66,000	19,800	0.020	1.023	1,320	20,255
Intermediate cover (150 mm) - Lined	158,750		0.079		12,600	
Leachate pond P-1	4,000	5,000	0.026	0.153	104	765
Leachate pond S-1	2,500		0.082		206	
Leachate pond B-1	2,000		0.067		135	
Stormwater ponds	29,000	-	0.010	-	290	-
Total odour emission rate					15,000	22,247
Percentile difference					67.4 % of total modelled emissions	

4 ASSESSMENT FINDINGS

4.1 OPERATIONAL ODOUR REVIEW DISCUSSION

Operationally, based on current management practices and protocols and confirmed by odour testing results, the landfill operation and related management systems are considered to present a low to medium risk of leading to odour impact and nuisance on the nearby community under normal operating conditions. Whilst the odour testing was completed under the conditions prevailing on 10 May 2021 at the Whytes Gully WRRC, there is potential for off-site odour from operational activities during undesirable meteorological conditions such as; heavy rainfall, thermal inversions, variations to atmospheric pressure, or upset conditions such as those caused by mechanical failure of critical equipment or infrastructure, which can affect the efficacy of the current landfill gas extraction management infrastructure and consequently leachate management, as this impacts landfill gas capture efficiency. Under these circumstances, the risk of odour impact on the community would be classified as medium-high.

Moreover, it is understood that the surrounding area of the Whytes Gully WRRC and the industrial estate is subject to a growth corridor consisting of the expansion and intensification of residential dwellings and communities. This will increase the sensitivity of the area to odour impacts over time. As such, both the current and future management and monitoring protocols will need to be aligned with this degree of sensitivity in the future. This is outlined in **Section 5**.

4.2 DISCUSSION OF QUANTITATIVE ODOUR EMISSIONS DATA

OERs from the Assessment were compared with modelled OERs in *Table 6.1* of the PAE Holmes report *Air Quality Assessment: Whytes Gully New Landfill Cell* found in *Appendix H* of Golder Associates *Volume III: Environmental Assessment – Whytes Gully New Landfill Cell (the 2012 Golder Associates Report)*. The total OER measured by TOU was 15,000 ou.m³/s, compared with the total OER modelled in the 2012 Golder Associates Report was 22,247 ou.m³/s. This represents **67.4 %** of total modelled emissions, suggesting all quantifiable emissions are lower than modelled and that the odour impact assessment ground level criteria predicted in the 2012 Golder Associates Report is achieved.

Figure 4.1 displays that the primary source of odour emissions was the lined intermediate cover area, which accounted for 82% of quantifiable odour emissions during the 10 May 2021 visit. The secondary source of odour emissions was the unlined intermediate cover, which accounted for 9% of quantified odour emissions during the same visit. As seen in **Table 3.2**, the SOERs of the lined and unlined intermediate cover areas and leachate ponds P-1, S-1 and B-1 were comparable to each other, suggesting that the difference in OER between these sources (intermediate cover areas and leachate ponds) is due to the area of emissions.

Figure 4.2 shows the total measured quantified odour emissions during TOUs 10 May 2021 visit in comparison to the modelled emissions from the 2012 Golder Associates Report. The measured emissions were 67% of the modelled emissions for all quantifiable sources.

Figure 4.3 shows the ratio of emissions of the key quantifiable odour sources, namely the active tipping face, intermediate cover areas, and leachate ponds. From the 2012 Golder Associates Report, the ratio of emissions from the active tipping face, intermediate cover areas and leachate ponds are 5.5%, 91.0% and 3.4%, respectively. From TOUs 10 May 2021 visit, the ratio of emissions from same areas are 4.3%, 92.8% and 3.0% respectively, closely resembling the modelled ratios of the 2012 Golder Associates Report. This validates the modelling results from the 2012 Golder Associates Report to a reasonable degree in relation to the contribution from each significant odour generating source at the Whyte Gully WRRC.

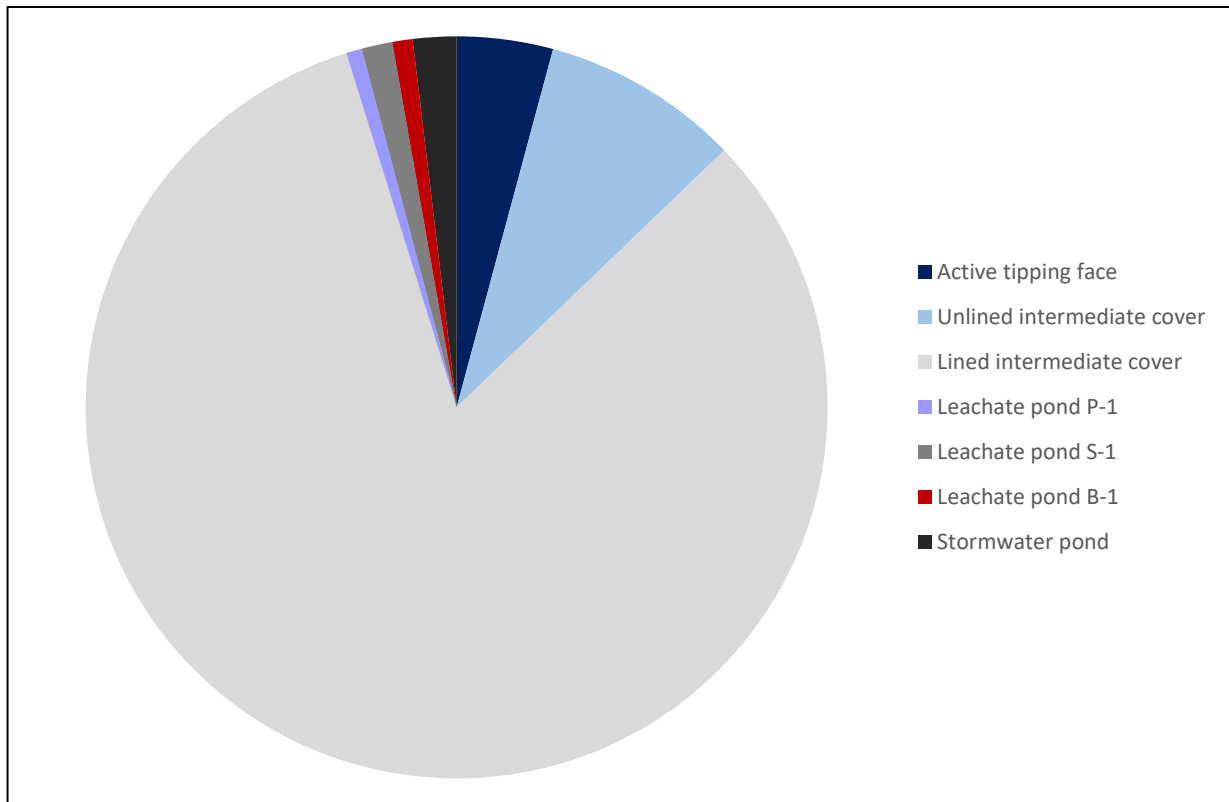


Figure 4.1 – TOU odour investigation emissions breakdown: May 2021

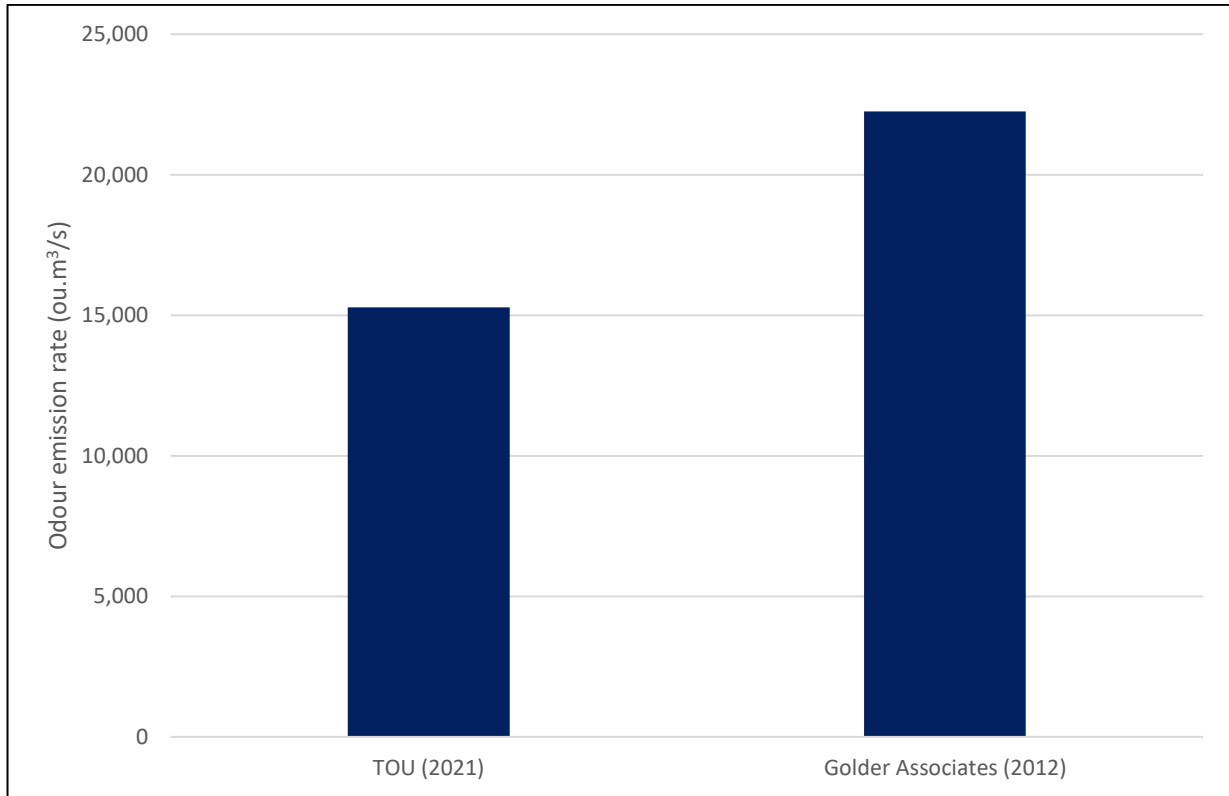


Figure 4.2 – Comparison of Total Quantified Odour Emissions by TOU 2021 and Golder Associates 2012

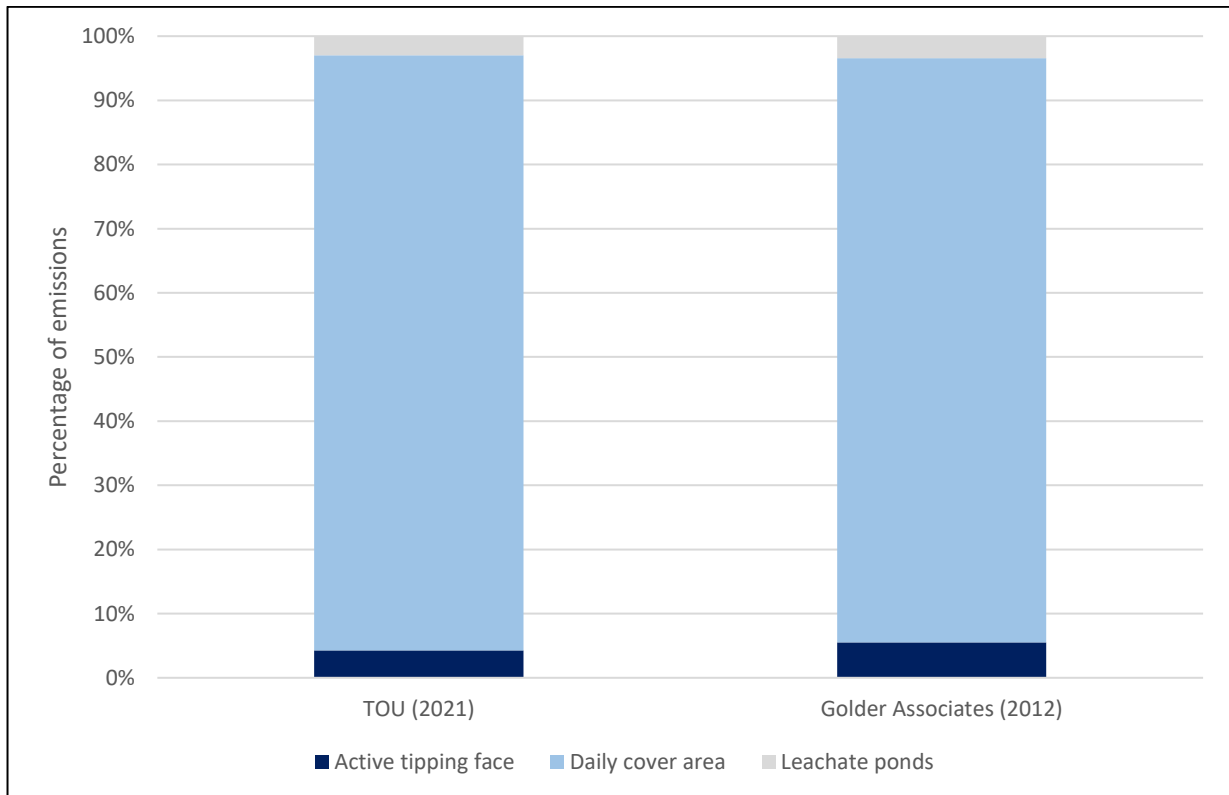


Figure 4.3 – Ratio of emissions from quantifiable odour sources from TOU (2021) and Golder Associates (2012)

4.3 DISCUSSION OF UNQUANTIFIABLE ODOUR EMISSION SOURCES

Given the operational complexity (both spatial and temporal) and large surface area of the landfill cell forms at the Whytes Gully WRRRC, the results documented in **Section 4.2** represent all significant odour generating sources that were quantifiable. However, upset/atypical conditions resulting in fugitive emission source from the landfill surface were not quantifiable due to the difficulty in assigning an appropriate emission area for these sources to calculate an OER derived from the SOER and the area. These fugitive pathways are expected to represent a higher risk in causing off-site odour impact compared with the quantifiable sources under normal conditions. This is a typical facet of odour sampling and testing in a landfill environment. As such, the Assessment recommendations is focused on a risk-based assessment process intended to reflect the on-going proactive mitigation measures required to manage the risk of adverse conditions that could lead to a higher than desirable degree of odour emissions from the activities at the Whytes Gully WRRRC (refer to **Section 4.3**).

5 ASSESSMENT RECOMMENDATIONS

Based on the Assessment findings and in the context of industry best practice, the following recommendations are made, which are considered to reflect proactive mitigation measures to manage the risk of adverse conditions that could lead to a higher than desirable degree of odour emissions from the activities at the Whytes Gully WRRC. Significantly, the findings and recommendations of the previous Odour Review have not been impacted by the outcomes from the Assessment. As such, these recommendations are reproduced in this report for comprehensiveness, namely;

- **Recommendation 1:** Adopt the use of biocover material for the management of problematic areas where fugitive gas leakage pathways are identified. A biocover layer is designed to reduce landfill gas emissions of targeted areas, with its efficacy at reducing odour emissions well-documented by TOU at other landfill operations. It can be applied as either a temporary or permanent layer on the targeted area. A site-specific biocover management strategy will need to be developed to determine how the biocover material can be integrated into the existing operations and ensure its effective application;
- **Recommendation 2:** Upgrade the capacity and capability of the current leachate management system. This includes upgrading the existing aeration capability of the leachate management system to provide enhanced leachate treatment flow capacity for future growth. This will assist in the optimisation of landfill gas capture;
- **Recommendation 3:** Undertake an evaluation of the existing efficacy of the landfill gas management system as a means of identifying opportunities for improvement and optimisation. It is understood that this is already being undertaken by an external contractor. The intent of this exercise is to increase the landfill gas capture rate as a means of actively minimising fugitive landfill gas emissions. This is also part of a continuous improvement program and commensurate with the future waste volumes landfill cells may be assigned. This improvement program should encompass all existing landfill cells, where technical capability and economically achievable;
- **Recommendation 4:** Continue to implement the current Vegetation Management and Landscape Plan to create and maintain a vegetate buffer screen to conceal the waste management operations and as a means of future odour management;
- **Recommendation 5:** Update the current air quality and odour management plan to ensure that it is in-line with industry best practice and reflects the current and future management protocols. A key component of this update will be, amongst others, the enhancement of the current landfill gas monitoring strategy by increasing the resolution of the monitoring plan to best practice according to *Environmental Guidelines: Solid Waste Landfills* (NSW EPA, 2016)¹; and

- **Recommendation 6:** If community complaints persist, develop, and implement a monitoring program consisting of field ambient odour assessment (**FAOA**) surveys conducted at both on-site and off-locations using calibrated assessors. If triggered, the assessment area will include the localities of community odour complaints, during different weather conditions, including potential worst-case scenarios (i.e. early mornings, late-evenings). The monitoring program can also include additional on-site odour emissions assessments to evaluate the odour generating sources under different scenarios (e.g. seasonal conditions or during high odour complaint periods).

The adoption of these recommendations in the context of the odour generating sources, in order of highest to lowest, is provided in **Table 5.1**.

Table 5.1 – Prioritisation of odour generating sources and recommendations			
Odour Source Rank	Odour Source Description		Applicable Recommendation
1	Intermediate Cover	Lined	<ul style="list-style-type: none"> ▪ Recommendation 1 ▪ Recommendation 3
		Unlined	<ul style="list-style-type: none"> ▪ Recommendation 4 ▪ Recommendation 5 ▪ Recommendation 6
2	Active tipping face		<ul style="list-style-type: none"> ▪ Recommendation 5 ▪ Recommendation 6
3	Leachate Management System	Leachate pond P-1	<ul style="list-style-type: none"> ▪ Recommendation 2
		Leachate pond S-1	<ul style="list-style-type: none"> ▪ Recommendation 5
		Leachate pond B-1	<ul style="list-style-type: none"> ▪ Recommendation 6
4	Stormwater Pond Management System		<ul style="list-style-type: none"> ▪ Recommendation 5 ▪ Recommendation 6

BIBLIOGRAPHY

1. New South Wales Environment Protection Authority, 2016. *Environmental Guidelines: Solid waste landfills (2016)*. NSW Environment Protection Authority (EPA), pp. 31-40.
(<https://www.epa.nsw.gov.au/your-environment/waste/waste-facilities/landfill-sites>)



WOLLONGONG CITY COUNCIL

Whytes Gully Waste and Resource Recovery Centre –

Odour Investigation Assessment

Kembla Grange, NSW

Appendix

June 2021



WOLLONGONG CITY COUNCIL

Appendix A –

Odour Concentration Laboratory Result
Reports: 10 & 11 May 2021

THE ODOUR UNIT PTY LTD



THE ODOUR
UNIT

Level 3 Suite 12
56 Church Ave
Mascot, NSW 2020

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Email: info@odourunit.com.au
Internet: www.odourunit.com.au
ABN: 53 091 163 061



Accreditation
Number: 14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Wollongong City Council	Telephone	+61 2 4227 8176
Contact	C. Hayne	Facsimile	--
Sampling Site	Whytes Gully Waste & Resource Recovery Park	Email	CHayne@wollongong.nsw.gov.au
Sampling Method	Isolation Flux Hood	Sampling Team	TOU

Order details:

Order requested by	C. Hayne	Order accepted by	M. Assal
Date of order	April 2021	TOU Project #	N2307L
Order number	PO1029912	Project Manager	M. Assal
Signed by	Refer to correspondence	Panel Operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: 'Determination of odour concentration by dynamic olfactometry (AS/NZS4323.3). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17} . This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at $22^\circ\text{C} \pm 3^\circ\text{C}$.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-001.
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS 4323.3. $r = 0.280$ (October 2019) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS 4323.3. $A = 0.076$ (October 2019) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou, which is 4 times the lowest dilution setting.
Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

Accredited for compliance with ISO/IEC 17025 - Testing.
This report shall not be reproduced, except in full.

Date: Thursday, 20 May 2021

Panel Roster Number: SYD20210510_048

A. Schulz
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20210510_048

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Dilution Equipment ID	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m ³ /m ² /s) ¹
Sample 1 – S-1 (1 of 2)	SC21341	10/05/2021 1000 hrs	10/05/2021 1325 hrs	4	8	--	--	--	69	69	0.0423
Sample 2 – S-1 (2 of 2)	SC21342	10/05/2021 1000 hrs	10/05/2021 1359 hrs	4	8	--	--	--	16	16	0.00981
Sample 3 – P-1 (1 of 2)	SC21343	10/05/2021 1055 hrs	10/05/2021 1423 hrs	4	8	--	--	--	140	140	0.0859
Sample 4 – P-1 (2 of 2)	SC21344	10/05/2021 1055 hrs	10/05/2021 1447 hrs	4	8	--	--	--	128	128	0.0785
Sample 7 – Stormwater pond (1 of 2)	SC21345	10/05/2021 1028 hrs	10/05/2021 1517 hrs	4	8	--	--	--	17	17	0.0103
Sample 8 – Stormwater pond (2 of 2)	SC21346	10/05/2021 1115 hrs	10/05/2021 1535 hrs	4	8	--	--	--	<16	<16	0.00965

Samples Received in Laboratory – From: TOU Date: 10/05/2021 Time: 1300 hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of samples by the methods of AS/NZS 4323.4 and the calculation of Specific Odour Emission Rate (**SOER**).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS 4323.3 (Yes / No)
n-butanol	SYD20210510_048	51,400	$20 \leq \chi \leq 80$	1,024	50	Yes

Comments Odour characters (non-NATA accredited) as determined by odour laboratory panel:

SC21341 musty
 SC21342 musty
 SC21343 dirty
 SC21344 dirty
 SC21345 musty water
 SC21346 dirty water

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
3. Any comments included in, or attachments to, this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.
4. This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd.

Report Status

Status	Version	Date	Prepared by	Checked by	Change	Reason
Draft	0.1	20.05.2021	A. Schulz	I. Farrugia	-	-
Final	1.0	20.05.2021	A. Schulz	M. Assal	-	-
Revised	-	-	-	-	-	-

END OF DOCUMENT

THE ODOUR UNIT PTY LTD



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Internet: www.odourunit.com.au
ABN: 53 091 163 061



Accreditation
Number: 14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Wollongong City Council	Telephone	+61 2 4227 8176
Contact	C. Hayne	Facsimile	--
Sampling Site	Whytes Gully Waste & Resource Recovery Park	Email	CHayne@wollongong.nsw.gov.au
Sampling Method	Isolation Flux Hood	Sampling Team	TOU

Order details:

Order requested by	C. Hayne	Order accepted by	M. Assal
Date of order	April 2021	TOU Project #	N2307L
Order number	PO1029912	Project Manager	M. Assal
Signed by	Refer to correspondence	Panel Operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: 'Determination of odour concentration by dynamic olfactometry (AS/NZS4323.3)'. The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17} . This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at $22^\circ\text{C} \pm 3^\circ\text{C}$.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-001.
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS 4323.3. $r = 0.280$ (October 2019) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS 4323.3. $A = 0.076$ (October 2019) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou, which is 4 times the lowest dilution setting.
Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

Accredited for compliance with ISO/IEC 17025 - Testing.
This report shall not be reproduced, except in full.

Date: Thursday, 20 May 2021

Panel Roster Number: SYD20210511_049

A. Schulz
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20210511_049

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Dilution Equipment ID	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m ³ /m ² /s) ¹
Sample 5 – B-1 (1 of 2)	SC21347	10/05/2021 1220 hrs	11/05/2021 0954 hrs	4	8	--	--	--	118	118	0.0704
Sample 6 – B-1 (2 of 2)	SC21348	10/05/2021 1258 hrs	11/05/2021 1022 hrs	4	8	--	--	--	108	108	0.0644
Sample 9 – Unlined, intermediate cover (150 mm) (1 of 2)	SC21349	10/05/2021 1232 hrs	11/05/2021 1054 hrs	4	8	--	--	--	32	32	0.0191
Sample 10 – Unlined, intermediate cover (150 mm) (2 of 2)	SC21350	10/05/2021 1232 hrs	11/05/2021 1123 hrs	4	8	--	--	--	35	35	0.0209
Sample 11 – Lined, intermediate cover (150 mm) (1 of 4)	SC21351	10/05/2021 1323 hrs	11/05/2021 1151 hrs	4	8	--	--	--	197	197	0.111

Samples Received in Laboratory – From: TOU Date: 10/05/2021 Time: 1800 hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of samples by the methods of AS/NZS 4323.4 and the calculation of Specific Odour Emission Rate (**SOER**).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Sample Measurement Results
Panel Roster Number: SYD20210511_049

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Dilution Equipment ID	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m ³ /m ² /s) ¹
Sample 12 – Lined, intermediate cover (150 mm) (2 of 4)	SC21352	10/05/2021 1415 hrs	11/05/2021 1317 hrs	4	8	--	--	--	38	38	0.0222
Sample 13 – Lined, intermediate cover (150 mm) (3 of 4)	SC21353	10/05/2021 1415 hrs	11/05/2021 1349 hrs	4	8	--	--	--	279	279	0.163
Sample 14 – Lined, intermediate cover (150 mm) (4 of 4)	SC21354	10/05/2021 1534 hrs	11/05/2021 1424 hrs	4	8	--	--	--	35	35	0.021
Sample 15 – ATF (1 of 2)	SC21355	10/05/2021 1529 hrs	11/05/2021 1501 hrs	4	8	--	--	--	4,100	4,100	2.45
Sample 16 – ATF (2 of 2)	SC21356	10/05/2021 1529 hrs	11/05/2021 1530 hrs	4	8	--	--	--	4,470	4,470	2.67

Samples Received in Laboratory – From: TOU Date: 10/05/2021 Time: 1800 hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

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Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS 4323.3 (Yes / No)
n-butanol	SYD20210511_049	51,400	$20 \leq \chi \leq 80$	1,218	42	Yes

Comments Odour characters (non-NATA accredited) as determined by odour laboratory panel:

SC21347	dirty	SC21353	sweet, fermented
SC21348	dirty	SC21354	musty
SC21349	musty	SC21355	garbage
SC21350	musty	SC21356	garbage
SC21351	sweet, dirty		
SC21352	sweet, dirty		

Disclaimers

- Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
- The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
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Revised	-	-	-	-	-	-

END OF DOCUMENT