Wagerup Alumina Refinery

Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 3A

Environmental Commissioning Plan

October 2021

Table of Contents

1. Introduction

This document describes the Environmental Commissioning Plan for the Wagerup VOC/Odour Emissions Reduction Project (The Project). The full scope and details of the Project can be found in Attachment 3B.

As outlined in the Department of Water and Environmental Regulation's (DWER) Guideline: Industry Regulation Guide to Licensing (June 2019), environmental commissioning is testing undertaken to validate actual environmental performance relative to predicted performance, as assessed by the Department under the works approval. This is a separate activity to commissioning that may occur for production or to check that contractors have completed construction works as agreed.

The document summarises the environmental commissioning and air quality verification sampling plan, to verify that the expected Volatile Organic Compound (VOC) and odour emission reductions are achieved with the implementation of the project.

The 2018 Wagerup Refinery Emission Inventory (Alcoa 2020) summarises the state of knowledge of refinery emissions to air and forms the basis of this Environmental Commissioning Plan with respect to defining baseline emissions. The 2018 Emission Inventory included an Improvement Program of work that was identified to further improve emissions estimates. This Improvement Program included testing of VOCs and odour in the Powerhouse stacks in 2019. For the purposes of this Commissioning Plan the additional 2019 Improvement Program data has also been considered.

1.1. Scope of the Environmental Commissioning Plan

Sources being modified by The Project that are predicted to have an odour or VOC emission change are listed in Table 1. Figure 1 provides a map of the point sources included in the Wagerup Refinery Emission Inventory, including those emission points identified in Table 1.

Table 1: Sources included in the Environmental Commissioning Plan

Area	Source	Map reference
Slurry Storage (Building 25A)	25A-2 Tank Vent	25
	25A-4 Tank Vent	26
Powerhouse Boilers (Building 110)	Boilers 2 and 3 Multiflue	18

This Environmental Commissioning Plan is applicable to the 25A-2 and 25A-4 Slurry Storage Tanks and Boilers 2 and 3, for which emissions will be altered as a result of the works detailed in Attachment 3B. Note that it is not considered necessary to test Boiler 1 emissions as part this Project, as no modifications will be made to this emission source.

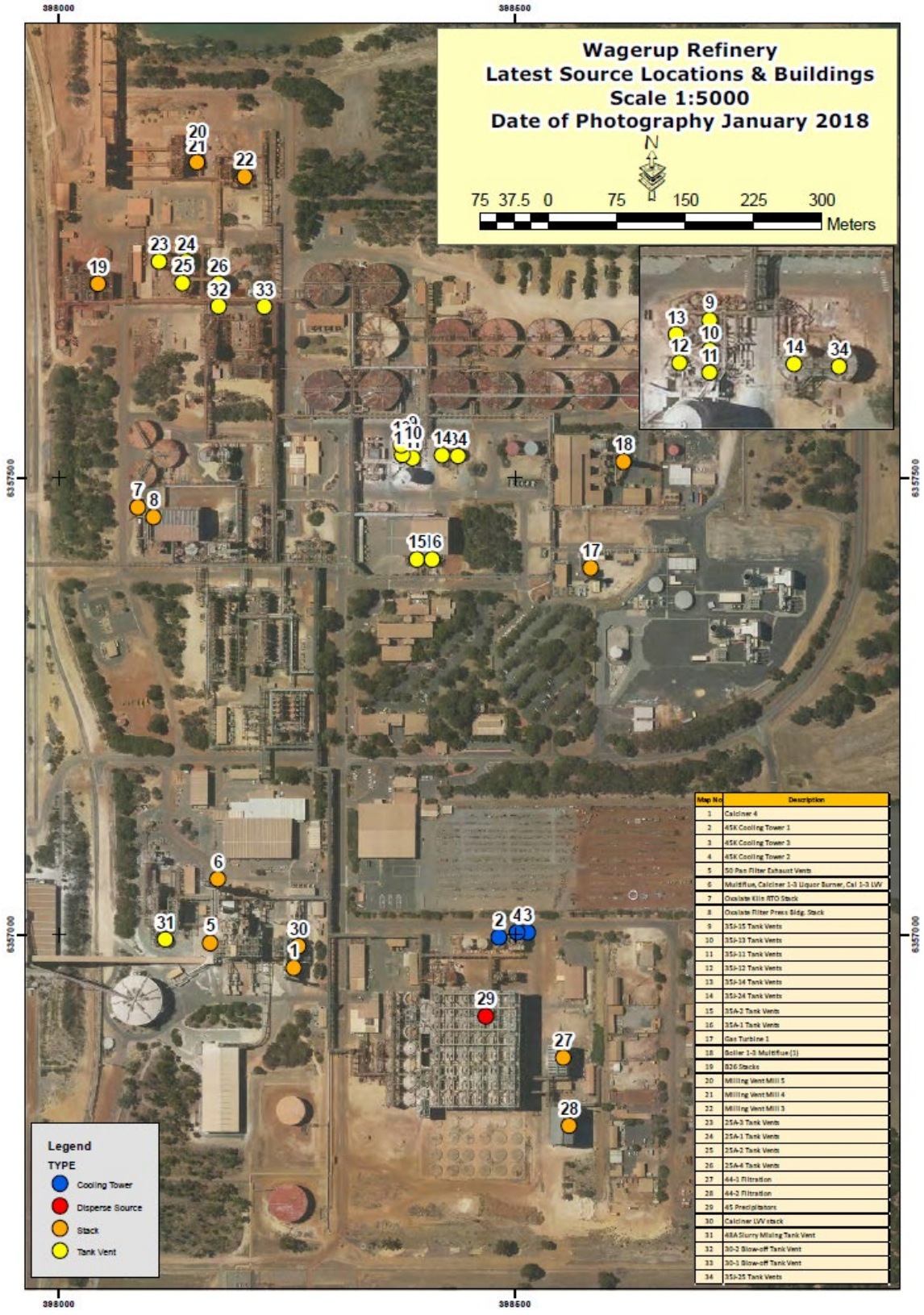


Figure 1: Wagerup Refinery emission source locations

2. Historical Non-condensable gas destruction system evaluation

Refer to Attachment 3B for a full description of the current 35N non-condensable gas destruction system. A comprehensive evaluation study of the non-condensable gas destruction project was completed in 2003. The verification program involved:

- Four bi-monthly campaigns testing VOC emissions from refinery non-condensable gas sources, prior to project installation
- Three VOC tests of the non-condensable gas supply to the boilers
- Five VOC tests in the boiler stacks prior to project implementation:
  - Two tests for Boiler 2
  - Two tests for Boiler 3
  - One test for Boiler 1 (for comparison)
- Fifteen Odour tests in the boiler stacks prior to project implementation:
  - Four tests for Boiler 2
  - Two tests for Boiler 3
  - Nine tests for Boiler 1 (for comparison)
- Five VOC tests in the boiler stacks after project implementation:
  - Three tests for Boiler 2
  - Two tests for Boiler 3
- 28 Odour tests in the boiler stacks after project implementation:
  - 12 tests for Boiler 2
  - 16 tests for Boiler 3

VOC testing was conducted using USEPA Method 18 (Tube), USEPA Method 18 (Bag) and USEPA Modified Method T05.

The analyses showed that emitted odour levels from the boiler stacks were comparable to measurements made prior to the process change. Similarly, there was no increase in the emission levels of VOC species as a result of the process change, suggesting that essentially complete VOC destruction occurred.

3. Commissioning Process

Commissioning will involve opening the valve to connect the two 25A tanks to the 35N non-condensable gas reticulation system, which will allow the system to extract the vapours from the tank vents.

Initially, when the two 25A tanks have been connected to the 35N network, there may be some intermittent local venting from some of the other emission sources on this network (i.e. digestion, evaporation, heat interchange, causticisation and the green liquor filtrate tank) as pressure stabilises. During the first week of commissioning the ambient air dilution valves on the network will be adjusted to ensure the network has the correct pressure profile for full extraction to occur at each location.

4. Target analytes

Emissions of interest for the verification are volatile organic compounds (VOCs) and odour, as the Project is aimed at reducing VOC and odour emissions from the Refinery. Other emissions such as combustion gases (NOx, CO and SO_2), particulates and metals are not considered in this Environmental Commissioning Plan.

VOCs included in the Wagerup Refinery Emission Inventory are:

- Acetone
- Acetaldehyde
- 2-Butanone
- Formaldehyde
- Benzene
- Toluene
- Xylenes
- Ethylbenzene
- Styrene
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene
- Naphthalene (as BaP equivalents)

These substances are measured as concentrations and emission rates are calculated from volumetric flow rates and concentrations.

Odour emission "concentrations" are measured as odour units (OU) or OU/m^3, which is a dilution to threshold ratio as described in AS/NZS4323.3:2001[1], with emission rates measured from the concentrations and volumetric flow rates.

Table 3 contains VOC and odour data extracted from the Wagerup Refinery 2018 Emission Inventory for the 25A-2 Slurry Storage Tank. Sampling was performed between 2002 and 2007 on a single vent from the 25A-2 tank. Some compounds were not measured at 25A-2, so data from the 25A-3 tank has been used. 25A-4 has similar operating conditions to 25A-2 and therefore emissions can be assumed to be similar to 25A-2.

Table 2: Emission Information for 25A-2 Slurry Storage Tank

Compound	Method	Unit	Source	Conc (ave)	Conc Range	No. Data points
Odour	AS4323.3	OU/wet/Nm^3	25A-2	14806	697-34360	18
Acetaldehyde	Modified USEPA MTO5	mg/m^3	25A-2	57	27-92	18
Acetone	Modified USEPA MTO5	mg/m^3	25A-2	480	195-644	18
Benzene	USEPA M18 (tube)	mg/m^3	25A-3	0.58	0.23-2.0	13
2-butanone	Modified USEPA MTO5	mg/m^3	25A-2	52	19-72	18
Formaldehyde	Modified USEPA MTO5	mg/m^3	25A-2	ND	-	31
Naphthalene	USEPA M18	mg/m^3	25A-3	ND	-	12
Ethylbenzene	USEPA M18/M0030 (VOST)	mg/m^3	25A-3	0.46	0.010-0.80	15
Styrene	USEPA M0030 (VOST)	mg/m^3	25A-3	0.050	0.010-0.10	3
Toluene	USEPA M18/M0030 (VOST)	mg/m^3	25A-3	5.5	0.47-19	14
1,2,4 Trimethylbenzene	USEPA M18/M0030 (VOST)	mg/m^3	25A-3	0.59	0.0-3.7	15
1,3,5 Trimethylbenzene	USEPA M18/M0030 (VOST)	mg/m^3	25A-3	0.82	0.22-1.5	15
Xylenes	USEPA M18/M0030 (VOST)	mg/m^3	25A-3	0.51	0.22-2.9	14

[1] The two units are equivalent in respect of odour concentrations. OU is a ratio, whereas OU/m^3 is akin to a concentration. Odour emission rates calculated from OU are reported as OU.m^3/s, whereas emission rates calculated from OU/m^3 are reported as OU/s.

The data in Table 3 show that the VOC content of 25A-2 vent emissions is primarily made up of acetone, acetaldehyde and 2-butanone. Of the VOCs listed in the emission inventory, these compounds make up 80%, 9.5% and 8.7% respectively of the total average VOC emissions from the 25A-2 tank. The remaining VOCs make up 1.4% of the total average VOC emissions from 25A-2.

The evaluation of the 2002 non-condensable gas destruction project also found that acetone and acetaldehyde were the only VOCs detected in boiler emissions after project implementation.

The Environmental Commissioning Plan for The Project will focus on these three VOCs (acetone, acetaldehyde and 2-butanone) that are expected to make up the majority of the VOC emissions from the Slurry Storage Tanks. Odour will also be measured as part of the verification program.

5. Air quality verification monitoring program

5.1. Assessment of Project Effectiveness

Assessment of the effectiveness of 25A vapour capture and thermal destruction requires measurement of VOC and odour concentrations in the 25A tank vent vapours and boiler stacks 2 and 3.

It is anticipated that the high destruction efficiency afforded by incineration of VOCs in the boilers would provide a minor change in boiler emissions from inclusion of 25A vapours in the air feed to the boilers.

While it is expected that VOCs will be thermally oxidised within the boilers, there is a small percentage of gases coming from the 35N system that bypass the boiler furnace via the rotary air heater (pre heater). This occurs in the current system. The percentage of gas flow that bypasses the boiler furnace has been conservatively assumed to be 15%. Due to this the Project may result in a small increase in emissions from Boilers 2 and 3. The verification testing program will enable estimation of the actual percentage bypassed via comparison of the boiler emissions for pre- and post-project implementation.

5.2. Source testing

Odour and VOC sampling for the 25A Slurry Storage Tanks has historically been carried out on a single vent from each of 25A-2 and 25A-3 tanks, with the concentrations measured from 25A-2 assumed to represent the emissions from 25A-1 and 25A-4.

The existing vent stacks on 25A-2 and 25A-4 will be replaced by new stacks in the same location. The new stacks will include stack sampling ports designed and installed as per the recommendations from Emissions Assessments Pty Ltd who are a NATA accredited stack sampling consulting company and who have based their recommendations on Australian Standard 4323.1 – 1995 Stationary Source Emissions - Selection of Sampling Positions.

The proposed vapour capture and reporting of vapours to the 35N system will significantly reduce the frequency and extent of vent emissions. Post-project verification testing is to involve isolation of the duct from each vent to the 35N system, to restore tank headspace flows to atmosphere from the vents. VOC and odour sampling can then proceed to characterise the 25A-2 and 25A-4 emissions.

Sampling is proposed from the boiler stacks with the 25A vents isolated from the 35N system to provide baseline without contribution from the 25A tank vapours. The vent flow to the 35N system will then be restored and sampling repeated from the boiler stacks to determine the impact of the increased loading of VOCs on that process.

Flow measurements will also be conducted in the 25A-2 and 25-4 vents to confirm the success of vapour extraction from the tanks.

Alcoa anticipates following the project implementation that there will be minimal to no flow from the 25A-2 and 24A-4 vents.

The proposed stack testing program is detailed in Table 5.

Table 3: Proposed post-expansion stack testing program – 25A Slurry Storage Tanks & Boilers

Parameter	**Method**	**Number of samples**					
		Vent flow from 25A to 35N isolated				Vent flow from 25A to 35N restored[2]	
		Boiler 2 stack	Boiler 3 stack	25A-2 vent	25A-4 vent	Boiler 2 stack	Boiler 3 stack
Odour	AS/NZS 4323.3:2001	4	4	4	4	4	4
A&K[1]	USEPA SW846 Method 0011	4	4	4	4	4	4
Velocity, temperature, CO_2 & O_2, moisture	USEPA methods 2, 3 and 4	4	4	4	4	4	4

Note:

1. A&K will include acetaldehyde, acetone and 2-butanone.
2. Flow measurements will also be conducted in the 25A-2 and 25-4 vents to confirm the success of vapour extraction from the tanks

5.3. Odour

Details of historic and planned odour testing for the 25A Slurry Storage Tanks and Boilers are included in the Odour Source Assessment (See Supporting Information – Detailed Odour Assessment).

Odour testing conducted as part of this Environmental Commissioning Plan will be carried out in accordance with AS/NZS 4323.3:2001. Sample times and pre-dilution requirements will be determined through consultation with an accredited emissions sampling consultant.

6. References

Alcoa of Australia Ltd, 2020. 2018 Wagerup Refinery Emission Inventory: Prepared for August 2019 Section 46 Review of Conditions.

Alcoa World Alumina, 2003. Wagerup Refinery Emissions Reduction Program: Project Evaluation Report Reduction of Odorous Non-Condensable Emissions from the Digestion Area By Thermal Oxidation in the Powerhouse Boilers.

Department of Water and Environment, 2019. Guideline: Odour Emissions.

Wagerup Alumina Refinery

Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 3B

Proposed Activities

October 2021

Contents

1. Overview

Alcoa of Australia Limited (Alcoa) operates the Wagerup Alumina Refinery (the Refinery) located approximately 120 kilometres south of Perth, Western Australia. The nearest townships to the Refinery are Hamel (located approximately 3 kilometres north of the Refinery) and Yarloop (located approximately 2.5 kilometres south of the Refinery). The nearest regional centre is Waroona, approximately 7 kilometres north of the Refinery. The Refinery is positioned close to the foot of the Darling Scarp and is separated from the Refinery Residue Storage Area (RSA) by the South West Highway and the Perth-Bunbury railway line.

Bauxite is supplied to the Refinery by overland conveyor from Alcoa's Willowdale bauxite mine located 15 kms to the east. Alumina produced at the Refinery is transported by rail to Alcoa's Bunbury shipping terminal and then exported to overseas markets or to Alcoa's smelters.

The Refinery produces alumina from bauxite using the Bayer process. The process involves four main steps: digestion, clarification, precipitation and calcination. In addition, two other important activities occur on site; the generation of power and steam for the Bayer process and the storage of bauxite residue (the material left over after alumina is extracted) in impoundment areas known as the Residue Storage Areas (RSAs).

- Digestion - Bauxite is milled to sand size particles and hot concentrated caustic soda solution is added to make bauxite slurry. The hot caustic dissolves the available alumina within the bauxite.
- Clarification – Sand and clay (red mud) are settled out leaving an alumina rich "green" liquor. The settled out sand and mud are washed and then pumped out to the residue area.
- Precipitation – The hot "green" liquor is cooled from approximately 100°C to 60-75°C and seed alumina hydrate crystals are added causing alumina hydrate to crystallise. The liquor and hydrate are separated. The hydrate crystals are sized, and crystals of a suitable size are removed. Undersized hydrate crystals are returned to the process as seed crystals.
- Calcination – Sized hydrate is washed and dried, then heated to 1000°C to drive off chemically bonded water leaving aluminium oxide (alumina).
- Power and Steam Generation – Power and steam requirements for the refinery are met by an onsite power station. The primary fuel supply for the power station boilers is natural gas.
- Residue and Waste – The material remaining after the alumina has been extracted from the bauxite ore is commonly termed "residue". Residue is produced at a rate of approximately two dry tonnes per tonne of alumina. This material is stored in RSAs adjacent to the refinery.

Successful developments and implementation of technology and processes have seen the existing two Wagerup production units demonstrate the capability to achieve production of 2.90Mtpa, which is the current annual production limit specified in Condition A1(a)(i) of Environmental Licence L6217/1983/15 (Licence). Incremental improvements mean that Wagerup is expected to have the capability to achieve production beyond 2.90Mtpa in the next 12-18 months.

This works approval application is intended to allow a Volatile Organic Compounds (VOCs) and Odour Emissions Reduction Project (Project) to be implemented. The proposed works will capture the tank vapours from two tanks within the Digestion process, the 25A-2 and 25A-4 Slurry Storage Tanks. Currently the vapour from these two tanks vent to atmosphere. The Project will redirect the tank vapours via the existing 35N non-condensable gas treatment

system for thermal destruction in the Powerhouse Boilers 2 and 3. Once implemented, Alcoa anticipates this Project will support a future Licence amendment application to increase production up to 3.045Mtpa via the offset of VOC and odour emissions, as permitted under Condition 8-5 of Ministerial Statement 1157.

2. Related Approvals

2.1. Ministerial Statements

Wagerup Alumina Refinery has prior ministerial approvals dating from 2006 to produce up to 4.7 Mtpa calcined alumina subject to the conditions and procedures contained in Ministerial Statement 728 (MS 728), as amended by Ministerial Statement 1069 (MS 1069). MS 728 approval was initially associated with a Third Production Unit which would be in addition to the existing two operating units to achieve a major production increase. MS 728 has since been amended by MS 1069 with conditions remaining based on a Refinery expansion occurring in one stage to 4.7 Mtpa through a Third Production Unit.

In August 2018 Alcoa initiated an application under Section 46 of the Environmental Protection Act 1986 (EP Act) to amend the conditions to permit the increase in production in two stages, initially to 3.3 Mtpa then to 4.7 Mtpa. In January 2021 the Minister for Environment approved Alcoa's Section 46 application for the Wagerup Refinery and a new Ministerial Statement (MS 1157) was issued. This enables the Refinery to undertake incremental increases in production over time, in accordance with new environmental conditions agreed via the Section 46 process, rather than solely through a single substantial increase via a third production unit.

Alcoa is undertaking this Project in accordance with Condition 8-5 of the MS 1157 and this Project is not intended to trigger Condition 8-1.

2.2. Historical Emissions Reductions Projects and Related Production Increases

Alcoa Wagerup has a long history of implementing emissions reduction projects to support production increases.

Most recently in 2015 Alcoa demonstrated successful abatement of VOC emissions which resulted in a licenced annual production limit increase from 2.65Mtpa to 2.85Mtpa. This was achieved by capture and destruction of VOCs previously released to atmosphere via the Calciner 1-3 Low Volume Stack. The magnitude of VOC abatement was determined with reference to the baseline of the Wagerup Alumina Refinery 2014 Emissions Inventory.

In November 2020, Alcoa again implemented an abatement program for VOC emissions which resulted in a licence amendment being approved and an annual production limit increase from 2.85Mtpa to 2.90Mtpa. This abatement included the removal from circuit of two 35J Lime Causticisation Tanks and the feed water for the Precipitation Cooling Towers to be switched to Upper Dam water for 1.6% of the time, equivalent to 141 hours per calendar year between the 1st May and 30th September.

3. Approval Request

The purpose of this works approval application is for the Project to proceed, which will seek to reduce total Refinery VOC emission levels by 6.2% and Odour levels by 0.98%, achieved primarily through thermal destruction in two of the powerhouse boilers.

This Works Approval application does not seek to propose a further production increase at this time, however, the intent is for this abatement program to allow for future production creep in line with the requirements of condition 8-5 of Ministerial Statement 1157 of no more than

5% increase on the assessed annual production capacity of the Licence (i.e. up to 3.045Mtpa). The production increase will be the subject of a future Licence amendment application.

3.1. Relevant Licence Conditions

Within the Licence, there are four conditions related to the proposed Project however it is not foreseen that these conditions will be impacted upon nor is Alcoa seeking amendment to these conditions. These Licence conditions are:

- Condition A5(b)
- Condition A22(a)
- Condition A22(b)
- Condition A27

3.2. Condition A5

Condition A5
The licence holder shall ensure that gases and vapour emitted from the digesters and flash tanks at the refinery are passed through a condenser (unless the condenser is under maintenance) and:

(i) condensate extracted by the condenser is directed to the lower dam at the refinery for oxidation and/or the condensate is directed to the Lakewater circuit at the refinery and/or used as process waters at the refinery; and

(ii) gases and vapour not extracted by the condenser are directed to the air feed of the boilers within the powerhouse at the refinery for incineration, unless maintenance is being undertaken on the air feed line to the boilers.

During the construction phase of this Project, the existing 35N VOC reticulation system, which directs gases and vapour to the air feed of the boilers, will require an estimated period of shutdown of between two and three weeks to allow the new infrastructure to be tied into the existing system. The interruption to the operation of this system will be planned to ensure that the system is offline for the minimal period possible and has been considered under Condition A5 (ii) of the Licence as a maintenance activity.

3.3. Conditions A22(a), A22(b) and A27

Condition A22(a)
The licence holder shall monitor the HRSG stack and boiler stack(s) for the parameters specified in Table 13 of Appendix A at the intervals specified in Table 13 of Appendix A, during normal operating conditions.

Condition A22(b)
The licence holder shall provide the CEO with a report of the results of the monitoring program specified under condition A22(a) comprising concentrations of the parameters specified in Table 13 of Appendix A and the calculated mass emissions of the parameters specified in Table 13 of Appendix A using measured flow rates at the time of sampling of the parameter, and include the operational range for each operational parameter.

Condition A27
Subject to condition A28, the licence holder shall not exceed any limit for an emission source as specified in Table 8.

Table 8: Licence Limits

Source(s)	Parameter	Licence Limit
Boilers when fired on gas (average over boilers 1, 2 and 3)	NOx	350 mg/ m^3 *

Table 13: Monitoring Program – HRSG and Boilers

Emissions testing	Parameters to be measured	Frequency	Units	Method
HRSG stacks; and Boilers (1, 2, & 3), whilst fired on natural gas	NO	3 – monthly	mg/m^3	USEPA Modified Method 7E
	NO_2		mg/m^3	USEPA Modified Method 7E
	NOx		mg/m^3	USEPA Modified Method 7E
	CO		mg/m^3	USEPA Modified Method 10
	fuel feed rate over the duration of the test		m3 /hr	N/A
	steam output over the duration of the test		tonnes/hr	N/A
	Stack velocity		m/sec	USEPA Method 2
	Stack flow rate		m^3/min	USEPA Method 2
	Confirm if noncondensables are flowing to boilers 2 or 3		n/a	Confirmation ID fan operating and log book entry
Boiler stacks 2 & 3, fired on diesel (when operating for one month or greater)	NO	The number of tests shall be adequate to define the relationship between- mass discharge rate for NO; and mass discharge rate for NO_2; and steam output over the range of ambient temperatures that may reasonably be expected to occur over the course of one year.	mg/m^3	USEPA Modified Method 7E
	NO_2		mg/m^3	USEPA Modified Method 7E
	NOx		mg/m^3	USEPA Modified Method 7E
	SO_2		mg/m^3	USEPA Modified Method 6C
	CO		mg/m^3	USEPA Modified Method 10

As outlined in Section 3.1 of this document, it is not foreseen that these Licence conditions will be impacted upon nor is Alcoa seeking amendment to these conditions. The required monitoring will continue to occur.

4. Overview of Refinery VOC and Odour Emissions

Recognition of the importance of VOC and odour capture and destruction or reduction, from the overall Refinery in order to maintain existing Refinery emission levels (when compared to the 2018 Baseline in the Wagerup Emission Inventory) is anticipated to support increases in the annual production limit. As outlined in Section 3 this Works Approval application does not seek to propose a production increase at this time. However, the intent is for this abatement program to allow for future production creep. The production increase will be the subject of a future Licence amendment application.

There are no suitable or practical VOC abatement options available within the calcination area. Potential abatement of other VOC and odour emissions sources within Refinery areas outside calcination have been considered. Two of these (35J Caustisication and the 45K Cooling Towers) were the subject of a recent licence amendment (Refer to Licence Amendment Application for L6214/1983/15 Attachment 3B, August 2020, Version 2).

Alcoa is proposing to offset future increases in VOC and odour emissions by altering a further two areas of the operation, the first stage of Digestion (25A Bauxite Slurry Storage Tanks) and the Powerhouse Boilers (Building 110)/35N Reticulation System. This proposal was foreshadowed in the most recent Licence amendment application (Refer to Licence Amendment Application for L6214/1983/15 Attachment 3B, August 2020, Version 2).

This Project is targeting the 25A Bauxite Slurry Storage Tanks (Slurry Storage Tanks) which contribute to 20% of the total Refinery VOC emissions and 16% of the total Refinery odour emission at the current maximum annual production of 2.90Mtpa. Figure 1 shows the breakdown of VOC and odour emissions across Refinery sources at the current maximum annual production of 2.90Mtpa.

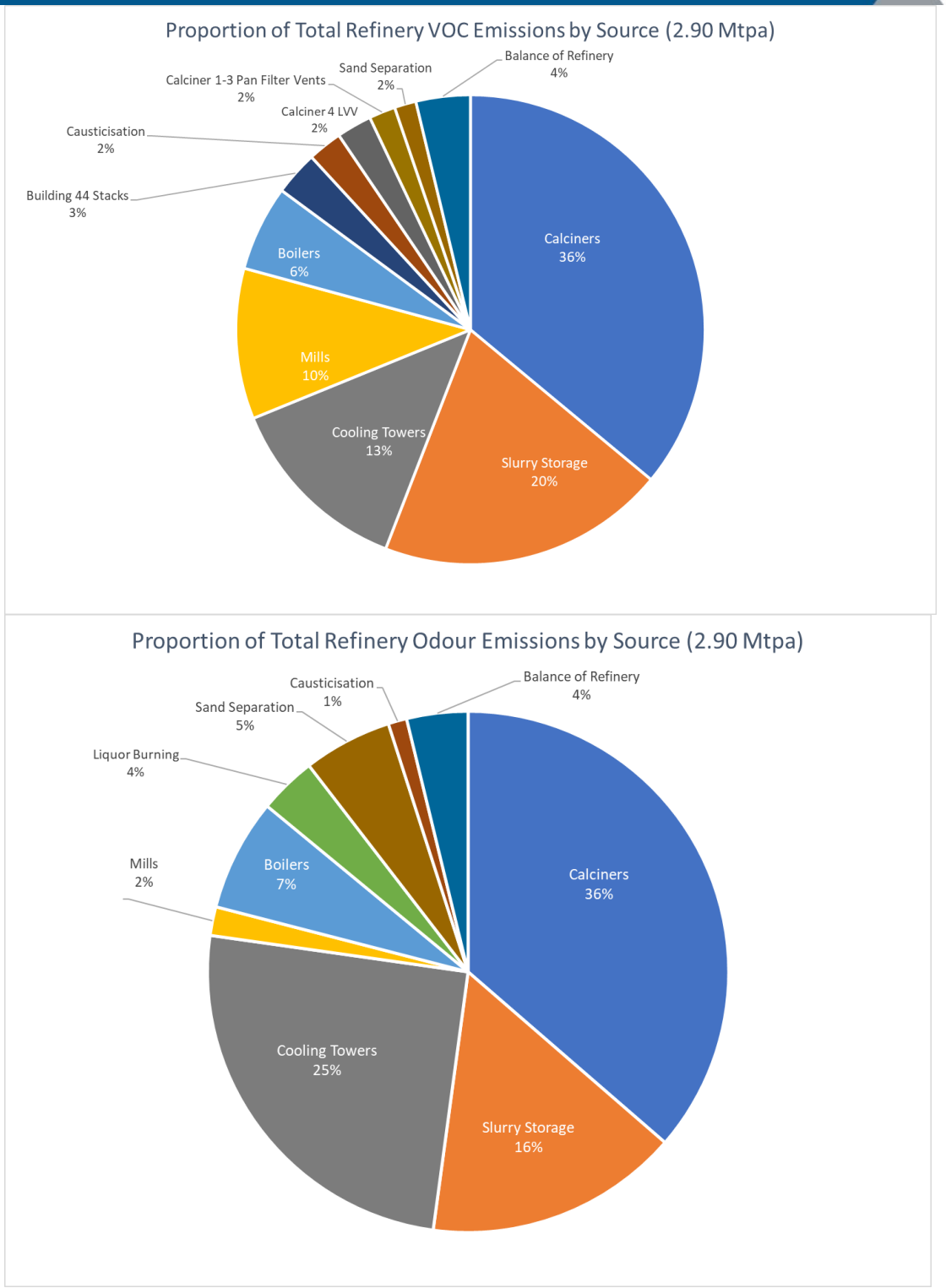


Figure 1 Proportion of Total Refinery Odour and VOC Emissions by Source (2.90Mtpa)

Figure 2and Figure 3 graphically represent current VOC and odour emission rates under various scenarios. Baseline refers to baseline emissions in the 2018 Wagerup Emission Inventory. The scenarios include:

- 2.85Mtpa (former licence annual maximum)
- 2.90Mtpa without abatement at 35J and 45K operations (subject of 2020 licence amendment)
- 2.90Mtpa with abatement (subject of 2020 licence amendment and current operational condition where abatement refers to 35J and 45K operations)
- 2.90Mtpa with this Emissions Reduction Project at 25A
- 2.90 Mtpa with this Emissions Reduction Project at 25A and 5% increased Refinery production to 3.045Mtpa

It is important to note that the increased Emissions Reduction Project and increased production scenarios are predicted forecasts. The actual numbers will depend on monitoring results measured in accordance with Attachment 3A Environmental Commissioning Plan. It is anticipated that this Project will achieve an additional 0.14g/s reduction in VOC emissions above what will be required to offset a future request for a 5% increase in production.

Refer to Attachment 6A for further discussion on emissions and discharges.

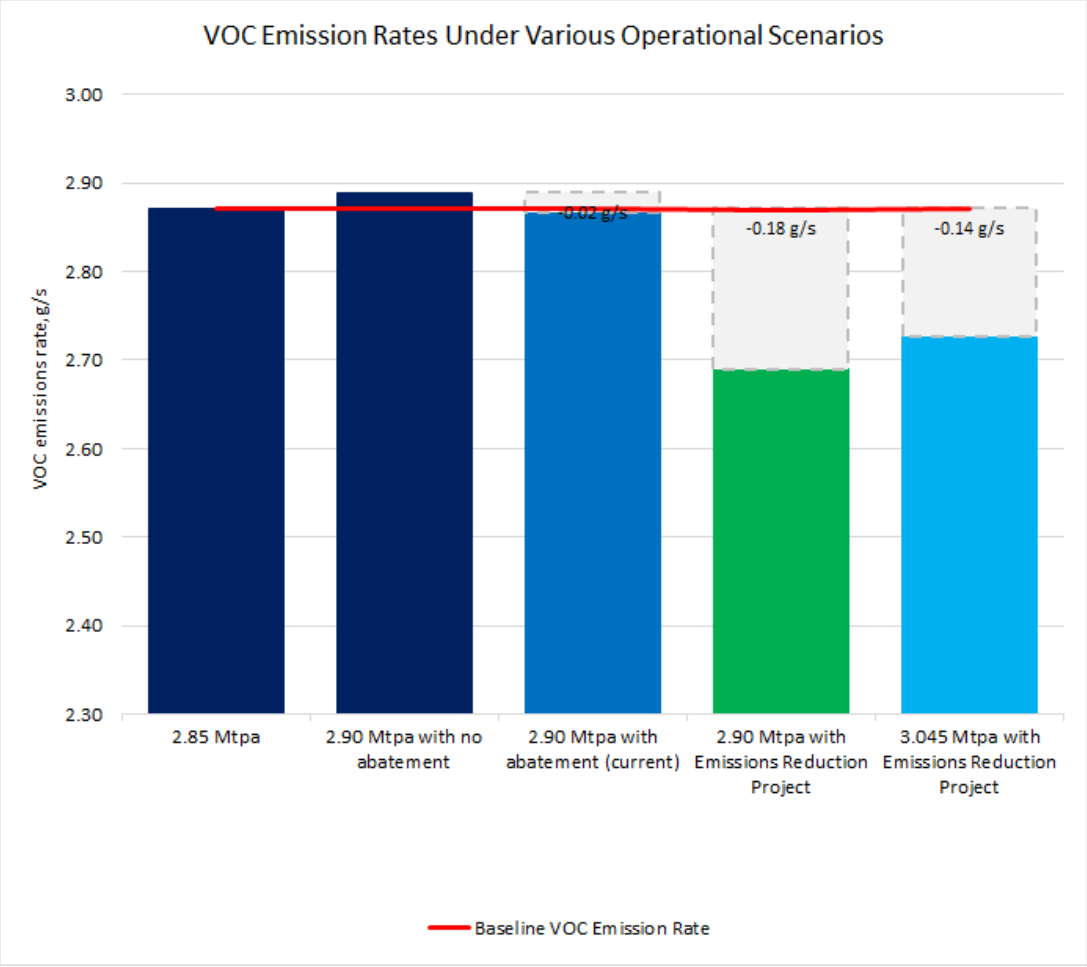


Figure 2 Total Refinery VOC Emission Rates under Various Scenarios

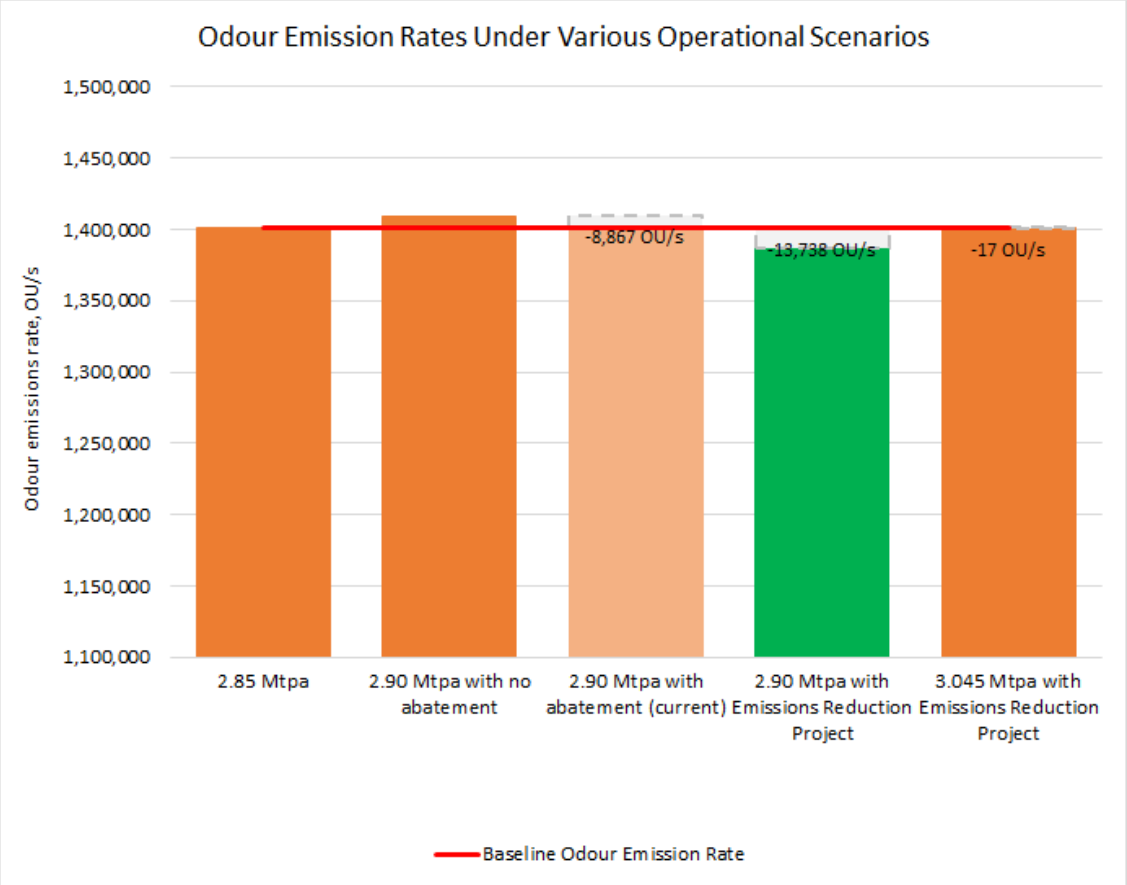


Figure 3 Total Refinery Odour Emission Rates under Various Scenarios

5. Description of Existing Powerhouse Boilers Vapour Destruction and 35N Reticulation System

The Wagerup Powerhouse Building 110 generates electricity and process steam (for process heating and generation of electricity) for the refining process by means of natural gas fired boilers and a Gas Turbine Heat Recovery Steam Generator. Currently, three boilers are in operation at Wagerup: Boilers 1, 2 and 3.

A project to reduce odorous emissions from digestion area sources by thermal oxidation of the non condensable gases was initiated in 2001. Ultimately a relatively simple design evolved which included a vacuum piping system to collect emissions from the multiple sources and direct them to the natural gas fired Boilers 2 and 3 where the odorous components were expected to be readily destroyed by thermal oxidation (Alcoa World Alumina 2003). The modifications were implemented in the first half of 2002 and commissioned in mid 2002. At that time approximately 20% to 40% of the Refinery VOCs commenced being captured and directed to the powerhouse boilers for thermal oxidisation. The system has been operational since June 2002 with an availability of greater than 99%.

The 35N system consists of a light weight stainless steel pipe network throughout the refinery coupled to an induced draught fan to direct the gases to the boilers. The Refinery side of the fan is maintained under vacuum to “draw” the odorous gases from each operating area and ensure any leaks will not add odour to other areas of the refinery. The system is designed to ensure that the concentration of combustible components is below the lower explosive limit. Figure 4 depicts the current configuration of the non-condensable gas destruction system.

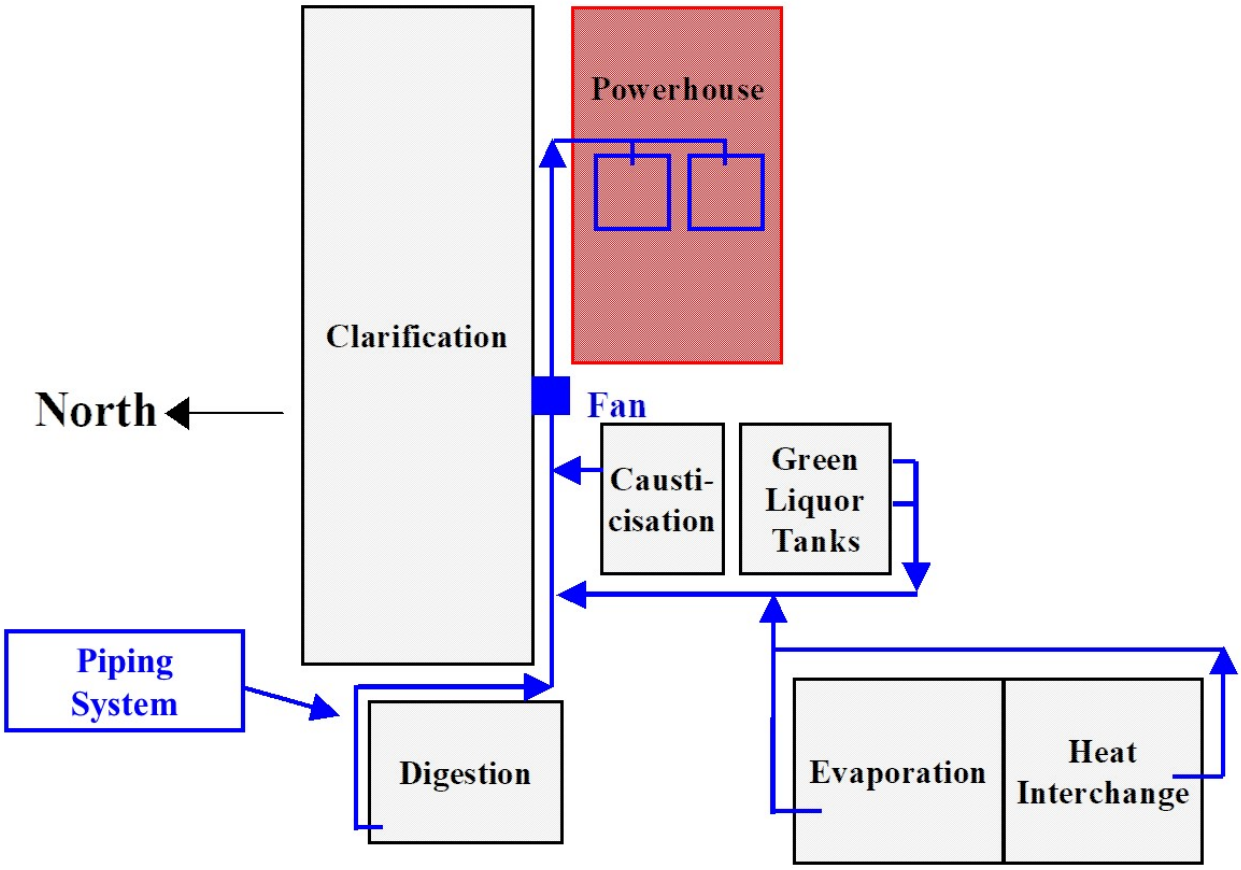


Figure 4: Simplified schematic of current configuration of the non-condensable gas destruction system

A comprehensive evaluation study of the non-condensable gas destruction project was completed in 2003. The analysis showed that there was no increase in the emitted concentrations of VOC and odour from the boiler stacks as a result of the addition of the non-condensable gases. Emitted odour levels from the boiler stacks were comparable to measurements made prior to project implementation. Similarly, there was no increase in the emission levels of VOC species as a result of the project, suggesting that essentially complete VOC destruction occurred. The system installed in 2002 thus resulted in a net reduction to total Refinery VOC and odour emissions. Further information on the 2003 emissions verification program can be found in Attachment 3A.

6. Description of 25A Bauxite Slurry Storage Tanks

The slurry storage tanks have several functions, the primary purpose being to raise the temperature of the slurry which enhances the desilication reaction. Additionally, the Bauxite Slurry Storage Tanks provide an interface for surge capacity between the mills and the digestion process. Figure 5 diagrammatically represents the current operation of the 25A Slurry Storage Tanks within the broader Digestion process.

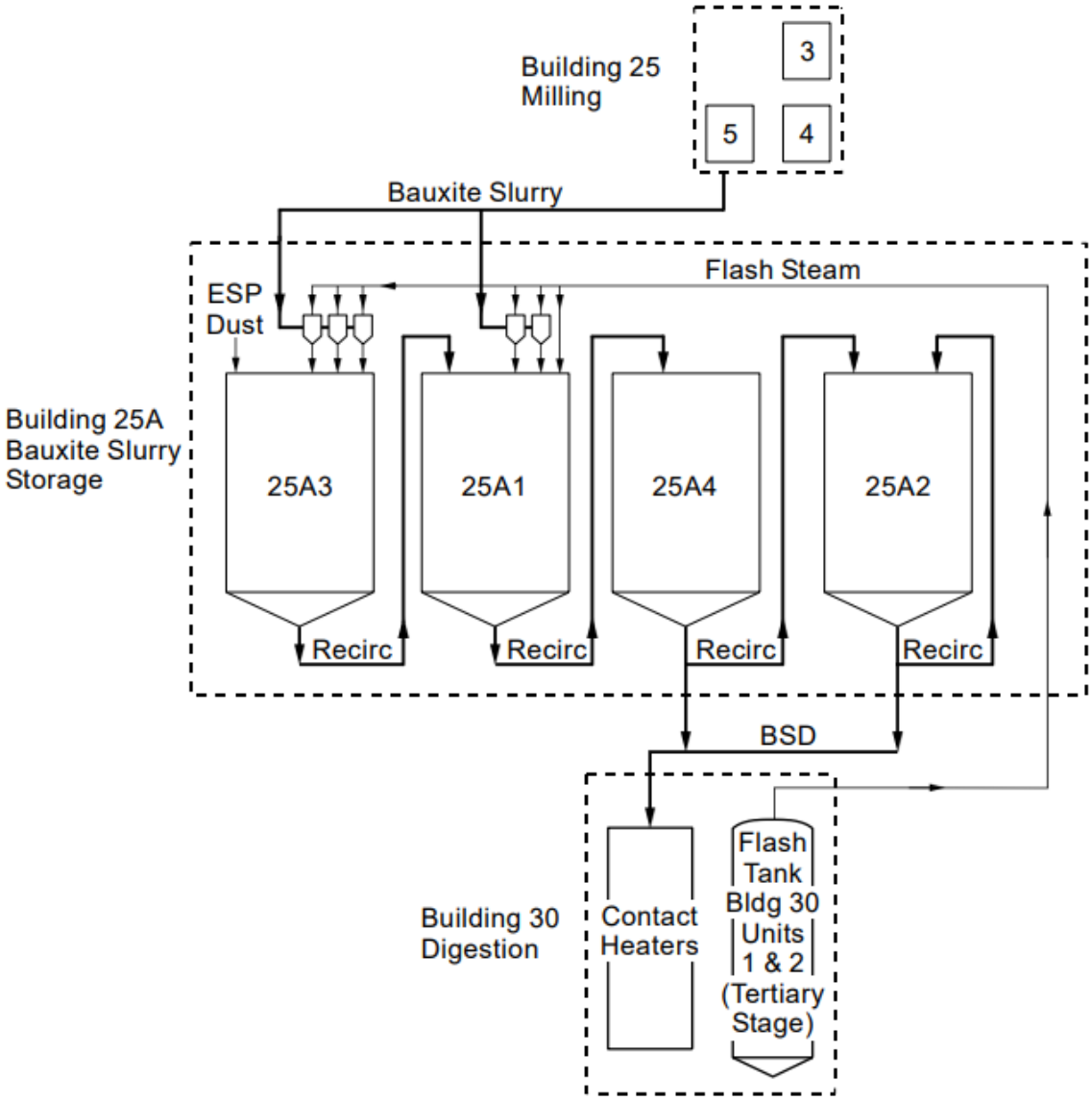


Figure 5: Simple representation of current "Normal" operation of 25A Tanks

Building 25A has four identically sized cylindrical slurry storage tanks with conical bottoms, each with a maximum capacity of 3.4 ML. Bauxite slurry from the mills in Building 25 enters the top of the first storage tank, 25A3. The tanks are run in series, with the flow going from 25A3 to 25A1 to 25A4 through to 25A2. The slurry leaves 25A2 for the digestion process in building 30.

The heating of the slurry, together with the long holding time in the 25A tanks, provide favourable reaction conditions for desilication. Desilication product (DSP) is an insoluble solid, which can form very hard scale in digester vessels, piping and heaters at elevated temperatures. By removing the DSP prior to digestion scaling in high temperature vessels downstream is minimised.

The 25A tanks are not pressure vessels and air emissions from these tanks are currently directed to atmosphere through single point stacks.

7. Proposed Modifications to the 25A Bauxite Slurry Storage Tanks

Alcoa plans to add to the existing 35N system to further reduce total Refinery VOC and odour emissions.

Reducing Refinery VOC and odour emissions can be achieved by redirecting air emissions from two of the four 25A tanks (25A2 and 25A4) and connecting them to the existing 35N Reticulation system. To connect the existing 25A 2 and 25A4 tank vents into the existing 35N system will require the installation of duct pipework, valving, replacement stacks, stack sampling points and a knockout pot. This is shown diagrammatically in Figure 6, with the additional equipment required drawn in red.

Alcoa considered several permutations of modified operation of the 25A Bauxite Slurry Storage Tanks. The proposed solution is considered optimal with respect to flow and existing capacity in the 35N system and control of moisture to the boilers.

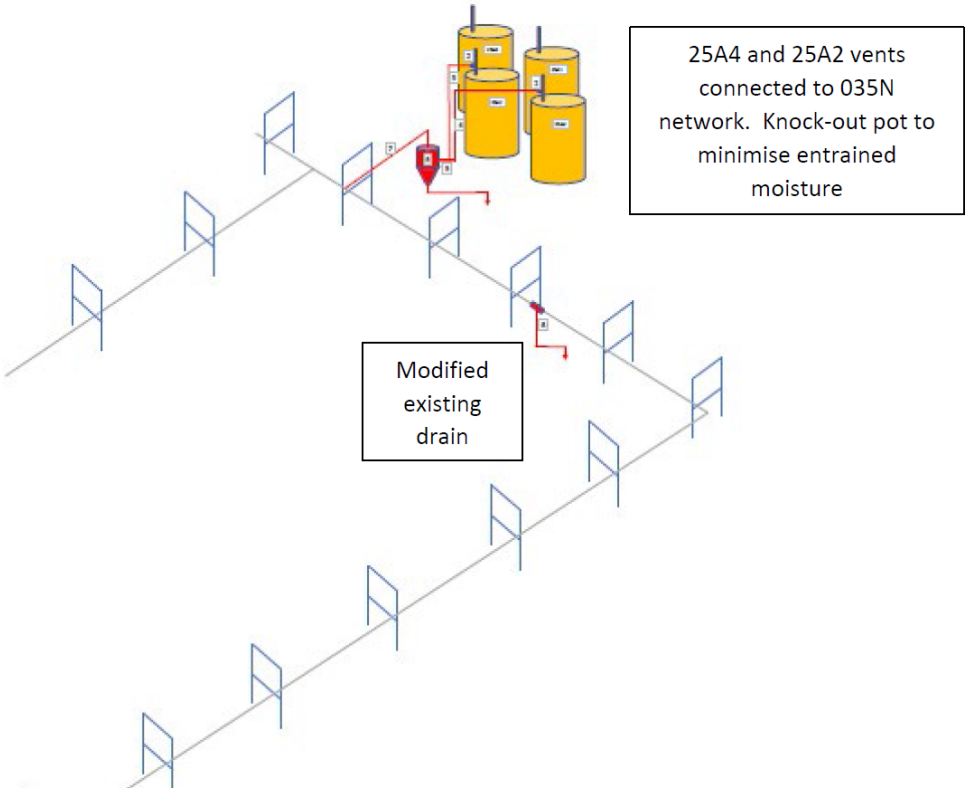


Figure 6: Simple Representation of Modified Operation of the Bauxite Slurry Storage Tank air emissions

The redirection of the emissions from these two tanks would result in a predicted emissions reduction from each of the 25A2 and 25A4 tanks by 96%. The emissions from the remaining two tanks will continue to vent to atmosphere and are not anticipated to change as a result of redirecting emissions from 25A2 and 25A4. Details of the specifics around the emissions profile changes can be found in Attachment 6A.

Figure 7shows the current vent stacks located on the 25A2 and 25A4 tanks and the images in green represent a mock up of the proposed modifications that will allow the emissions to be redirected to the 35N reticulation system. The existing vent stacks on 25A-2 and 25A-4 will be replaced by new stacks in the same location. The new stacks will include stack sampling ports designed and installed as per the recommendations from Emissions Assessments Pty

Ltd who are a NATA accredited stack sampling consulting company and who have based their recommendations on Australian Standard 4323.1 – 1995 Stationary Source Emissions - Selection of Sampling Positions.

Figure 7 also shows the installation of a knock out pot (image in pink) that will be required to remove excess moisture from the vapour prior to entering the 35N system. A mercury trap is included in the knockout pot design (Refer to Section 7.1). The tie in point to the existing 35N system is also shown in Figure 7.

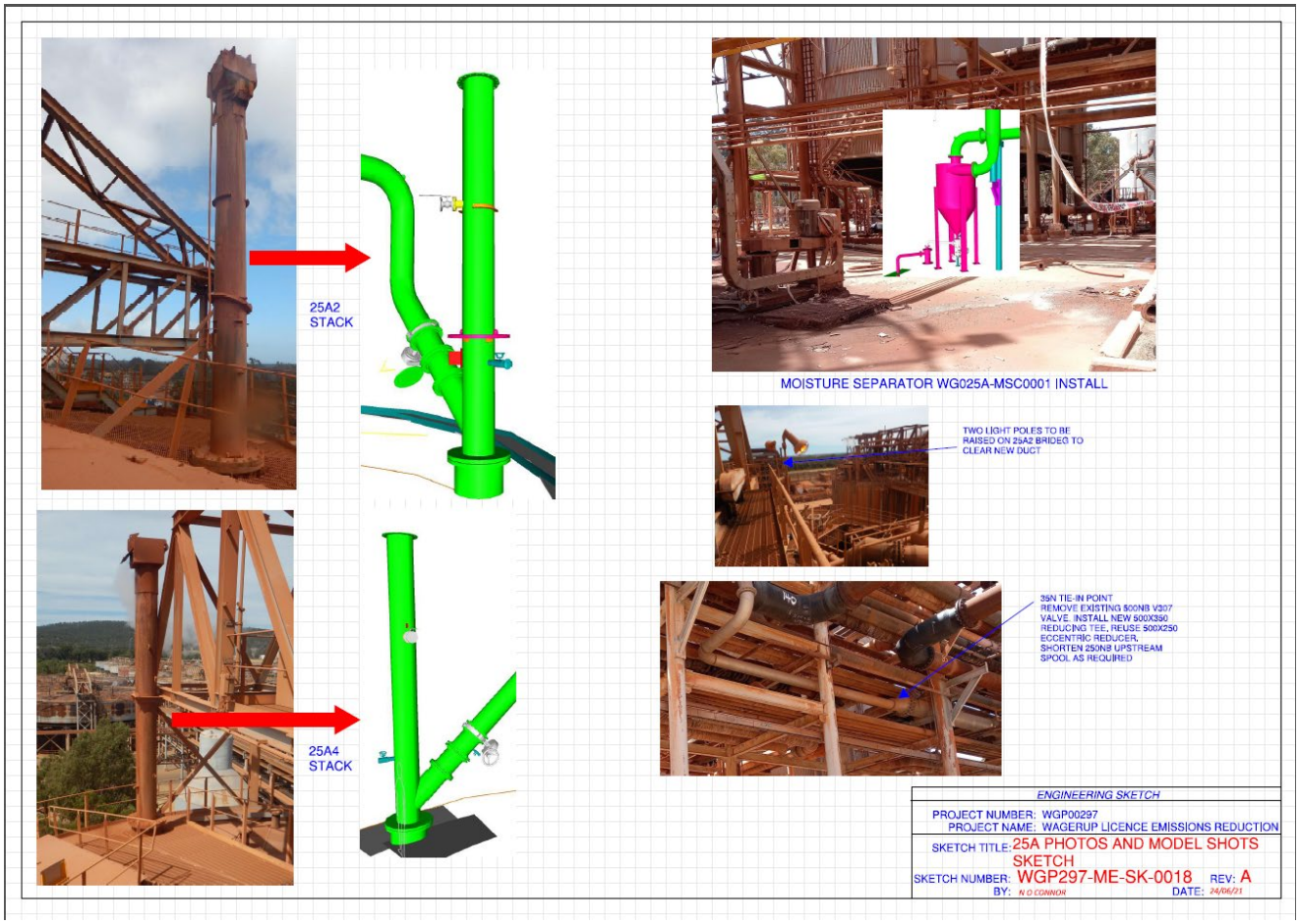


Figure 7: Current 25A2 and 25A4 stack emission points and proposed modifications

7.1. Mercury Trap

Mercury naturally occurs in the Bauxite feed in variable concentrations. During the initial digestion process occurring in the 25A tanks, some mercury has the potential to vaporise into the vapour stream directed to the 35N system. A small quantity of mercury is expected to condense as the vapour from the 25A tank vents naturally cools en route to the 25A knock-out pot. A mercury trap is proposed to be incorporated into the mud and moisture removal knockout pot at the 25A tanks. The knock-out pot design will incorporate a mercury collection point to facilitate the removal of the condensed mercury by a specialised controlled waste contractor. The mercury will be disposed of at an offsite licenced disposal facility in line with our current practices. The forecast quantity of condensed mercury is of the order of ~0.5kg/year which is less than 0.2% of the total mercury air emissions for the Refinery.

8. Proposed Modifications to the 35N Reticulation System

The modification to the existing 35N system will consist of the installation of stainless steel ducting and valves to allow the tie in from the 25A slurry storage tanks. Figure 8 shows the small extent of the 35N reticulation system modifications relative to the existing system.

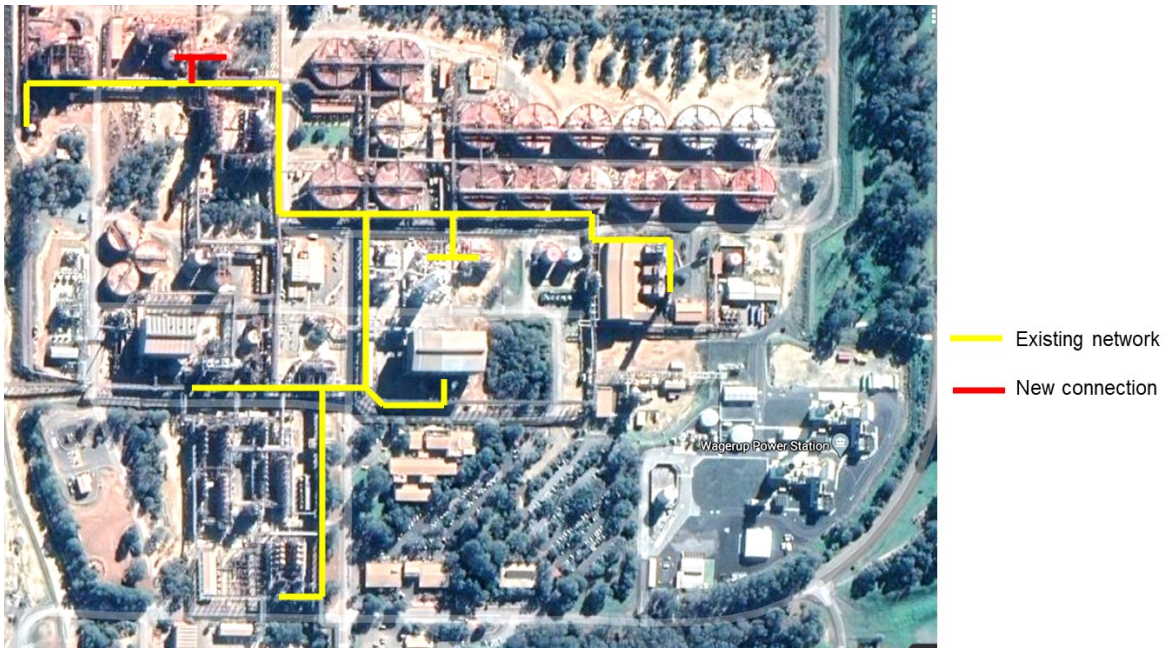


Figure 8: 35N VOC Destruction System – existing and proposed network

9. Proposed Modifications to the Powerhouse Boilers

No modifications are required to the Powerhouse Boilers as part of this Project.

Currently non-condensable gases from digestion, evaporation, heat exchange; and collected tank vapours from causticisation, liquor filtration, and the 984Y mercury removal system are diverted to Boilers 2 and 3 to destroy their organic/VOC content prior to atmospheric release. Depending on process requirements/conditions, the non-condensable gases can be sent either 100% to Boiler 2, 100% to Boiler 3, or a 50% allocation to each of Boiler 2 and 3. The boiler stack emissions are monitored quarterly under the environmental licence L6217/1983 (Refer to Section 3.3). The operation of the boilers will not change as part of this Project.

An assessment was performed to determine the impact upon the Powerhouse Boiler operation with the addition of the 25A2 and 25A4 vents into the 35N system. The vents will introduce a hot, humid gas stream which will contribute to additional moisture reporting to the boilers, with some of the vapour expected to condense within the 35N network and some at the boiler inlet plenum when mixed with cool, ambient air. As well as moisture a small quantity of mud has the potential to carry over from the 25A tanks into the 35N system.

To account for this, the new section of pipework that connects the 25A tank vents into the 35N system will be an inclined section of large bore pipe to assist in dis-entrainment of water droplets and mud carryover back into the 25A tanks. A knockout pot will be installed to provide additional removal of mud and moisture from the system. In addition, existing drain legs on the 35N system will be added to or modified to assist with moisture removal from the 35N system.

10. References

Alcoa of Australia, 2020. Licence Amendment Application for L6214/1983/15 Attachment 3B, August 2020, Version 2.

Alcoa World Alumina, 2003. Wagerup Refinery Emissions Reduction Program: Project Evaluation Report Reduction of Odorous Non-Condensable Emissions from the Digestion Area By Thermal Oxidation in the Powerhouse Boilers.

Wagerup Alumina Refinery

Works Approval Application for 6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 5

Consultation

October 2021

Contents

1. Approvals Consultation

Developing and maintaining strong, mutually beneficial relationships with our stakeholders, including in the communities where we operate, is fundamental to Alcoa's business model. We believe it is important to have transparent and regular dialogue with identified stakeholders to ensure a mutual understanding of issues, concerns and opportunities.

A Stakeholder Engagement Framework guides Alcoa locations globally in their engagement activities, including consultation for ongoing operations and projects. Wagerup Alumina Refinery (Wagerup refinery) undertakes stakeholder engagement via a range of different channels and forums including:

- Stakeholder briefings – with local, state and federal government representatives occurring on a regular basis. The meetings are an opportunity for Alcoa to update on business developments and for questions and concerns to be raised with the company.
- Wagerup Community Consultative Network (CCN) – this forum for two-way discussion with interested parties typically occurs every two months. The forum is open to any members of the local community and is regularly attended by neighbours and representatives from the Shires of Waroona and Harvey, and South West Development Commission. Summary notes of CCN meetings are published in the Harvey Waroona Reporter (HWR). These meetings routinely include updates on upcoming or in process changes to the Refinery's environmental approvals.
- Advertorials – published in the HWR on a bi-monthly basis provide regular information flow to the broader community about activities at the refinery and Alcoa more broadly.
- Employee and contractor communications – occur via a variety of different channels including townhall meetings, newsletter articles and briefings.

2. Regulator Consultation

A scoping meeting regarding the Alcoa Wagerup VOC/Odour Emissions Offset Works Approval was held on 26 February 2021. Attendees included representatives from the Department of Water and Environmental Regulation (DWER), Air Quality Services and the Process Industries Sector.

During this meeting Alcoa outlined the proposed project scope to reduce emissions from the 25A tanks to facilitate future production creep using a two-staged approach.

- An initial stand-alone works approval for the emissions reduction, followed by
- A subsequent Part V licence amendment application.

It was agreed that this was an appropriate method to follow.

In addition, the timing for the project approvals and the supporting documentation and assessment requirements were discussed.

3. Other Consultation

In relation to the VOC and Odour Offset Project, Alcoa has communicated its intent to lodge this Works Approval application with the CCN.

The matter was discussed at a regular CCN meeting on 26 February 2021. Alcoa discussed the proposed project with the CCN participants. There was no significant feedback received from the members of the CCN in relation to the proposed emissions offset project and associated works approval application.

Appendix A below represents the slide pack that was presented to the CCN during the meeting.

Once submitted, the Works Approval application link will be put on the Alcoa website and the following key stakeholders advised:

- Local Government including Shire of Waroona, Shire of Harvey and City of Bunbury
- CCN Participants
- Area A Landowners

4. Appendix A

Proposed Project Scope

Alcoa

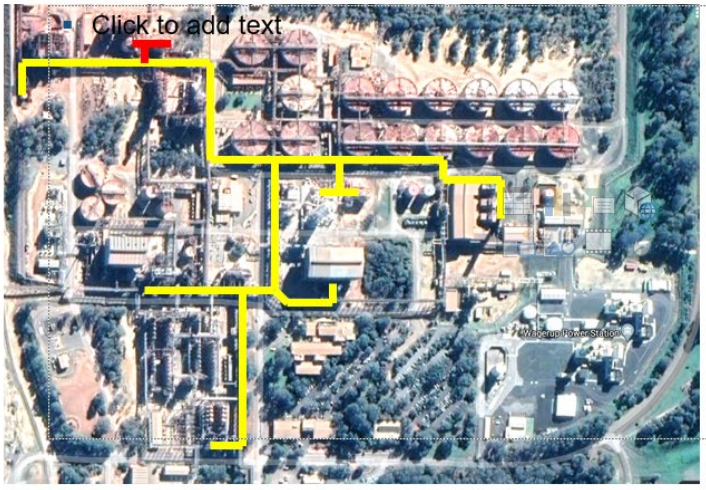
25A Tanks – Partial Treatment – 25A4 and 25A2

2

Proposed Project Scope

Alcoa

35N VOC Destruction System (to Powerhouse Boilers)

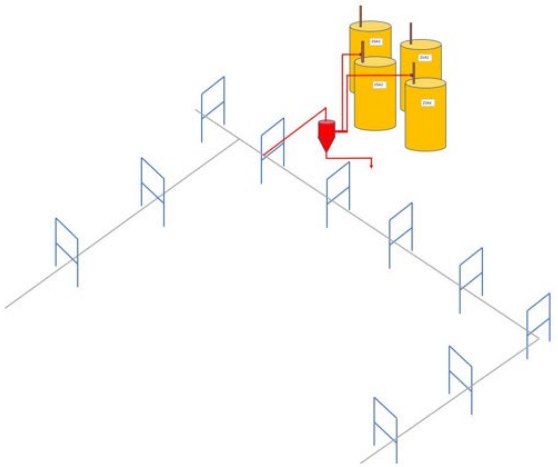


3

Proposed Project Scope

Alcoa

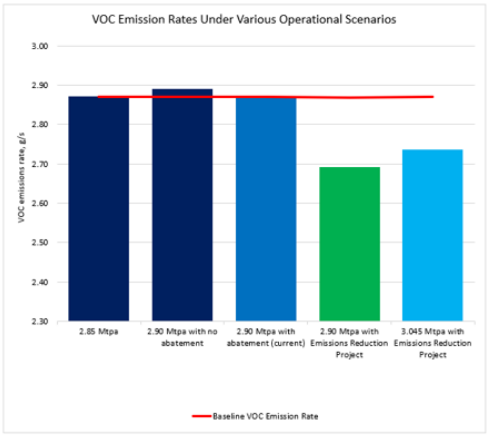
Simplified Schematic

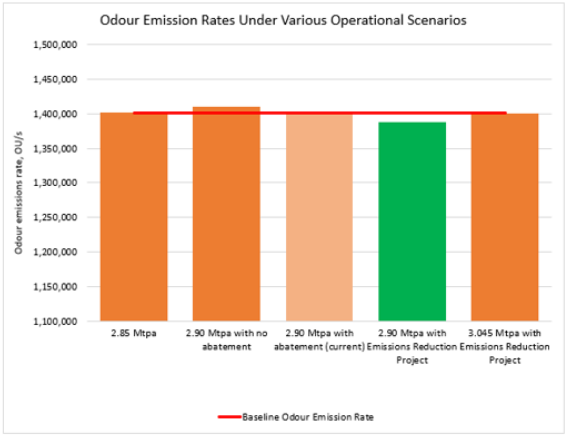


4

Impact on VOC and Odour Emissions

Alcoa





Wagerup Alumina Refinery

Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 6A
Emissions and Discharges

October 2021

This attachment is a complete assessment of potential changes to emissions and discharges associated with this works approval.

Contents

1. Air Emissions

1.1 Recent Development of Air Emissions Inventory, Model and Health Risk Assessment

The Wagerup Refinery Emission Inventory summarises the state of knowledge of Refinery emissions to air.

Point source emissions fall into two main categories, Bayer and non-Bayer process sources. Bayer process sources are all those associated with the Bayer process liquor used to digest the bauxite to produce alumina. These sources generate a variety of substances and emissions typical of the alumina refining process, as well as other substances that are more generic in industrial and mineral processing. It is these emissions that produce the characteristic odour associated with Bayer process refineries. Non-Bayer process emissions include products of combustion of natural gas fired boilers and gas turbines, and those related to constituents in the fuels consumed in the refinery.

Extensive investigations of refinery emissions have been conducted in and around the Wagerup Refinery over the last 18 years, with Alcoa having obtained a detailed knowledge of the range and concentration of chemical compounds present in emissions. Alcoa has continued to refine and improve its monitoring and emissions calculation techniques since the development of the refinery's first emissions inventory in 2002 that was built on and submitted with the Wagerup Refinery Unit 3 Environmental Review and Management Plan (ERMP) and associated submissions in 2005/2006. In the last few years Alcoa has made significant improvements in understanding the source inventory, dispersion of emissions and potential impacts. Specific and relevant studies include:

- 2018 Wagerup Refinery Emission Inventory, February 2020.
- Air Quality Modelling, Evaluation of TAPM with Wind Data Assimilation of Upper Winds (Phase 1 Modelling), May 2019.
- Wagerup Alumina Refinery Air Quality Modelling – Phase 2 Study. January 2020.
- Wagerup Alumina Refinery Air Quality Modelling – Phase 3. July 2020.
- Wagerup Alumina Refinery Expansion- Health Risk Assessment 2020, October 2020. This document includes the health risk assessment for both the base case at an alumina production rate of 2.85Mtpa and at an expansion case of 3.3Mtpa.

In 2019-2020 the Western Australian Environmental Protection Authority (EPA) endorsed the 2018 Emission Inventory (Alcoa of Australia 2020 and 2020b) and Air Quality model as fit for purpose as part of Alcoa's Section 46 application to amend Ministerial Statement conditions. The 2020 Health Risk Assessment (HRA) (Katestone 2020) was independently peer-reviewed by a consultant appointed by the Department of Water and Environmental Regulation (DWER). These documents form the basis for the emissions estimates for this Project.

The 2018 Emission Inventory was scaled to 2.90 Mtpa to support Alcoa's 2020 abatement program for VOC and odour emissions, which resulted in a licenced annual production limit increase from 2.85Mtpa to 2.90Mtpa (Licence L6217/1983/15). This abatement included the removal from circuit of two 35J Lime Causticisation Tanks and the feed water for the Precipitation Cooling Towers to be switched to Upper Dam water for 1.6% of the time, equivalent to 141 hours per calendar year between the 1st May and 30th September (Alcoa of Australia 2020c).

Alcoa has completed health risk assessments at 2.85Mtpa (previous Licence production limit) and 3.3Mtpa (with abatements). The results of the Health Risk Assessment, for both 2.85Mtpa and 3.3Mtpa scenarios indicate the acute risk, chronic risk and carcinogenic risk are all low (Katestone 2020).

Alcoa believes the 2.85Mtpa Health Risk Assessment is representative of the risks of the impact of emissions at 2.90Mtpa due to the layers of conservatism built into the process. Katestone states that "All health risk estimates made by the Wagerup 2020 HRA are based on inherently conservative assumptions". This is due to the methods used when developing the health risk assessment methodology, in particular the method for estimating peak emission rates. Due to the resultant compounding conservatism across the HRA stages, the quantitative risk indicators should be considered as over-estimates of potential health risks associated with emissions from Wagerup Refinery" (Katestone 2020, p.v).

1.2 Impact of Proposed Project to Emission Sources

The proposed works will capture the tank vapours from 25A-2 and 25A-4 Slurry Storage Tanks and redirect the emissions via the existing 35N non-condensable gas treatment system for thermal destruction in the Powerhouse Boilers 2 and 3, instead of venting to atmosphere (as occurs currently). Refer to Attachment 3B for specific details of the proposed Project. Predicted changes to refinery emission sources as a result of the proposed works are outlined in Table 1.

Table 1: Predicted Changed to Refinery Emission Sources with redirection of the 25A2 and 25A4 emissions to the powerhouse for thermal destruction.

Area	Emissions Change
50 Calcination	No emission change.
25A Slurry Storage	Emissions will decrease[1]
45K Precipitation Cooling Towers	No emission change.
25 Milling	No emission change
44 Seed Filtration	No emission change
26 Sand Separation	No emission change
45 Precipitation	No emission change
30 Digestion	No emission change
110 Powerhouse	Emissions will increase[2]
47 Oxalate Removal	No emission change
48 Liquor Burning	No emission change
35 Clarification, Causticisation, filtration	No emission change
259 Residue Disposal Area	No emission change
OVERAL REFINERY	Emissions will decrease

Mass emissions of VOCs from the 25A Slurry Storage Tanks are predicted to decrease as a consequence of this emissions offset, whilst the powerhouse VOC emissions will realise a slight increase. The net effect will be an overall reduction in emissions.

[1] A decrease in emissions will occur at the 25A Slurry Storage Tanks as a result of redirecting the emissions from the 25A2 and A4 tanks to the powerhouse for thermal destruction. Refer to discussion about modified operations in Attachment 3B.

[2] An increase in emissions is predicted to occur at the Powerhouse Boilers 2 and 3 as a result of redirecting the emissions from the 25A2 and A4 tanks to the powerhouse for thermal destruction. Refer to discussion about modified operations in Attachment 3B.

1.3 Point Source Emissions

The predicted impact on total refinery emissions as a result of the proposed works is detailed in Table 2. The redirection of the 25A-2 and 25A-4 Slurry Storage Tanks point source air emissions for combustion within the powerhouse Boilers 2 and 3 will result in a decrease in the total refinery emissions profile (predicted decreases of approximately 0.98% for Odour and 6.2% for VOCs).

Table 2: Predicted Impact on Key Types of Emissions

Type of Emission	Current Emissions (with modified operation of Causticisation & Cooling Towers)	Post-project Emissions (with 25A-2 and A-4 emissions directed to the powerhouse)	Post-project Emissions percentage change (with 25A-2 and A-4 emissions directed to the powerhouse)
Production (Mtpa)	2.90	2.90	0%
Odour (OU/s)	1,400,373	1,386,713	(- 0.98%)
Total VOCs (g/s)	2.87	2.69	(-6.2%)
Combustion gases (g/s)	55.24	55.24	(0%)
Particulates (g/s)	3.90	3.90	(0%)
Metals (g/s)	0.0282	0.0282	(0%)

1.3.1 Refinery VOC and Odour Emissions

The 25A Area comprises four tanks in series: 25A-3, 25A-1, 25A-4 and 25A-2. 25A-3, the first tank in the series (referred to as the 'head tank'), is the hottest because it receives flash vapour (steam) directly from the digestion process. The digestion flash vapour contains some organics, and some of these are released with excess steam. (Note: When 25A-3 is off-line, 25A-1 acts as the head tank). Emissions from the four tanks are via vents. VOCs can volatilise and become an emission at Bayer liquor temperatures in tank vents with vapour. The 25A-3 and 25A-1 tanks have two vents each, while the remaining tanks have one vent each. Given that 25A-3 is the head tank and receives flash vapour from digestion, it has a different emission concentration and flow rate to the remaining three downstream tanks under standard operating conditions.

Sampling for the slurry storage tanks was performed on a single vent from each of the 25A-3 and 25A-2 tanks. It has been assumed that the flow rates from the 25A-4 vent are the same as the flow rates from the 25A-2 vent under standard operating conditions. The 25A Slurry Storage Tanks contribute approximately 20% of total refinery average VOC emissions and 16% of total refinery average odour emissions. The redirection of the 25A2 and 25A4 Slurry Storage Tank (SST) point source air emissions for combustion within the powerhouse Boilers 2 and 3 is predicted to result in a 96% total reduction in emissions from each of the 25A-2 and 25A-4 tanks. The emissions from the remaining two tanks will continue to vent to atmosphere and are not anticipated to change as a result of redirecting the two tanks. The remaining 4% of emissions from the 25A-2 and 25A-4 tanks would occur as intermittent emissions from the

tanks under abnormal operating conditions. Total VOC[3] and odour emissions from the 25A Slurry Storage Tanks are predicted to decrease overall by 38% and 7% respectively.

Thermal oxidation is a commonly available technology for destruction of combustible compounds including gaseous volatile organic compounds (VOCs). The VOCs are destroyed by heating to above the auto ignition temperature, in the presence of oxygen, for sufficient time to enable complete combustion. The final combustion products are carbon dioxide and water. Commercially available thermal oxidisers for VOC destruction typically operate at temperatures between 850ºC and 950ºC. It is therefore expected that the VOCs present in the non-condensable refinery gas feed to the boilers should be rapidly thermally oxidised at the boiler operating temperature of greater than 1200ºC. Table 3 lists the VOCs present in the refinery non-condensable gases and their auto ignition temperatures. The auto-ignition temperatures of the VOCs are well below the 1200ºC boiler operating temperatures.

Table 3: Auto-Ignition Temperatures of possible VOCs in Non-Condensable Gas Supply to the Boilers[4]

Compound	Auto-Ignition temp (ºC)	Compound	Auto-Ignition temp (ºC)
Benzene	560	Acetone	538
Hexane	223	Acetaldehyde	175
3-Methyl Pentane	264	Formaldehyde	300
Toluene	530	2-Butanone	516
Methanol	385	Benzaldehyde	192
Ethanol	363	2-Methylpropenal	452

While it is expected that VOCs will be thermally oxidised within the boilers, there is a small percentage of gases coming from the 35N system that bypass the boiler furnace via the rotary air heater (pre heater). This occurs in the current system. The percentage of gas flow that bypasses the boiler furnace has been conservatively assumed to be 15%. Due to this, the Project may result in a small increase in emissions from Boilers 2 and 3. (~1% of total refinery VOC emissions). This will be confirmed with verification testing following project construction and commissioning, refer to Attachment 3A.

VOC and odour emission rates for pre- and post-project implementation are shown in Table 4 and Table 5. The Refinery has had a historical amenity issue related to Bayer process odour emissions. Odour emissions can be highly distinctive between sources of emission differing in both intensity and magnitude between production areas. Odour emissions from individual process areas also have a high variability based on dynamic olfactory testing results. Alcoa has completed a Detailed Odour Assessment in accordance with the DWER Odour Guideline, refer to Attachment 8Afor a more detailed discussion on odour sources and impacts

[3] Total VOCs is the sum of emission rates of all VOCs included in the Wagerup Emission Inventory: Acetaldehyde, Acetone, BaP equivalents, Benzene, 2-Butanon, Ethylbenzene, Formaldehyde, Styrene, Toluene, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene and Xylenes.

[4] Source: CRC Handbook of Chemistry and Physics (77th edition) & The Merck Index (12th edition)

Table 4: Odour and VOC average emission rates from Boilers and 25A Tank Vents at 2.90 Mtpa prior to Project implementation (scaled from 2018 Emission Inventory)

Source	Stack Height	Measured Odour	Ammonia	Acetald-ehyde	Acetone	BaP Equiva-lents	Benz-ene	2-Buta-none	Ethyl-benzene	Formal-dehyde	Styrene	Toluene	1,2,4 Trimethyl-benzene	1,3,5 Trimethyl-benzene	Xylenes
	m	OU/sec	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Boiler 1	65.0	41808	0.18	8.54E-03	3.13E-02	N/A	5.34E-03	8.54E-03	0.00E+00	8.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 2	65.0	34702	0.13	9.30E-03	2.64E-02	N/A	3.88E-03	6.20E-03	0.00E+00	6.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 3	65.0	20907	0.12	5.81E-03	3.34E-02	N/A	3.63E-03	5.81E-03	0.00E+00	5.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
25A-1 Tank Vents (Vent 1)	25.4	4285	0.23	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-1 Tank Vents (Vent 2)	25.4	4285	0.23	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-2 Tank Vents	25.4	8570	0.46	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
25A-3 Tank Vents (Vent 1)	25.4	97605	0.52	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-3 Tank Vents (Vent 2)	25.4	97605	0.52	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-4 Tank Vents	25.4	8570	0.46	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
Total (Boilers + 25A)		318,337	2.8	1.52E-01	4.85E-01	0.0	1.34E-02	5.98E-02	4.53E-04	2.06E-02	4.93E-05	5.46E-03	5.78E-04	8.08E-04	5.08E-04

Table 5: Predicted Odour and VOC average emission rates from Boilers and 25A Tank Vents at 2.90 Mtpa after Project implementation

Source	Stack Height	Measured Odour	Ammonia	Acetald-ehyde	Acetone	BaP Equiva-lents	Benzene	2-Buta-none	Ethyl-benzene	Formal-dehyde	Styrene	Toluene	1,2,4 Trimethyl-benzene	1,3,5 Trimethyl-benzene	Xylenes
	m	OU/sec	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Boiler 1	65.0	41808	0.18	8.54E-03	3.13E-02	0.00E+00	5.34E-03	8.54E-03	0.00E+00	8.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boiler 2	65.0	36101	0.20	1.11E-02	4.11E-02	0.00E+00	3.89E-03	7.79E-03	1.41E-05	6.20E-03	1.53E-06	1.70E-04	1.80E-05	2.51E-05	1.58E-05
Boiler 3	65.0	22306	0.20	7.56E-03	4.81E-02	0.00E+00	3.65E-03	7.40E-03	1.41E-05	5.81E-03	1.53E-06	1.70E-04	1.80E-05	2.51E-05	1.58E-05
25A-1 Tank Vents (Vent 1)	25.4	4285	0.23	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-1 Tank Vents (Vent 2)	25.4	4285	0.23	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-2 Tank Vents	25.4	341	0.018	4.28E-04	3.59E-03	0.00E+00	4.33E-06	3.87E-04	3.43E-06	0.00E+00	3.74E-07	4.13E-05	4.38E-06	6.13E-06	3.85E-06
25A-3 Tank Vents (Vent 1)	25.4	97605	0.52	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-3 Tank Vents (Vent 2)	25.4	97605	0.52	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-4 Tank Vents	25.4	341	0.018	4.28E-04	3.59E-03	0.00E+00	4.33E-06	3.87E-04	3.43E-06	0.00E+00	3.74E-07	4.13E-05	4.38E-06	6.13E-06	3.85E-06

Total (Boilers + 25A)		304,677	2.1	1.35E-01	3.41E-01	0.0	1.32E-02	4.44E-02	3.15E-04	2.06E-02	3.43E-05	3.80E-03	4.03E-04	5.63E-04	3.54E-04

1.3.2 Particulates

Particulates emitted from combustion point sources at the refinery are from the liquor burner stack, oxalate kiln and the four calciner stacks. The 25A Slurry Storage Tanks and the Powerhouse Boilers are not characterised sources of particulates emissions.

The proposed works will not result in any change to particulate emissions from the Refinery.

1.3.3 Combustion Gases

Combustion gases include nitrogen oxides and carbon monoxide which are released from the refinery vessels such as the powerhouse boilers, calciners, liquor burner and oxalate kiln. There is no change anticipated in combustion gas emissions as a result of the proposed works.

Under the current licence Alcoa is required to monitor the combustion gases from the liquor burner stack, oxalate kiln stack, boiler stacks and calciner stacks. This will not change. Alcoa will remain subject to a NOx limit of 350 ug/m3 from the calciner stacks, liquor burner stack and boiler stacks (when fired on gas and averaged over boilers 1, 2 and 3).

1.3.4 Metals

Target metals were initially developed as part of the Wagerup III expansion studies in 2005 (Environ 2005) and have been expanded on during recent studies. Alcoa considers target analytes to include arsenic, beryllium, boron, cadmium, chromium (VI), lead, manganese, mercury, nickel and selenium. Metals have been included in the recent air emissions modelling and health risk assessments. There will be no net change in total refinery metals emissions as a result of the proposed works. There will be a decrease in metals emissions from the 25A Slurry Storage Tanks, and an equivalent increase in metals emissions from Boilers 2 and 3.

As outlined in Section 1.1, Alcoa believes the HRA (Katestone 2020) to be representative of the impacts of emissions at 2.90Mtpa and therefore there is no anticipated change to the acute, chronic or carcinogenic risks at the receptors.

1.3.5 Diffuse Source Emissions

There is no anticipated impact to RSAs or water storage areas as a result of the proposed works. There is therefore no expected increase to diffuse source emissions including dust, VOCs and odour.

1.3.6 Emissions to Air during Commissioning

During the construction phase of this project the existing 35N VOC reticulation system will require a period of shutdown to allow the new infrastructure to be tied into the existing system. The interruption to the operation of this system will be planned to ensure that the system is offline for a minimal period and has been considered under Condition A5 (ii) of the L6217/1983/15 environmental licence as a maintenance activity. Further information relating to this condition can be found in Attachment 3B Proposed Activities. Initially, when the two 25A tanks have been connected to the 35N network, there may be some intermittent local venting from some of the other emission sources on this network (i.e. digestion, evaporation, heat interchange, causticisation and the green liquor filtrate tank). During the first week of commissioning the ambient air dilution valves on the network will be adjusted to ensure the network has the correct pressure profile for full extraction to occur at each location.

2. Noise

Alcoa has a noise approval issued under Regulation 17 of the Environmental Protection (Noise) Regulation 1997. The Environmental Protection (Wagerup Alumina Refinery Noise Emissions) Amendment Approval 2013 varies the assigned levels for Wagerup Refinery. Alcoa has submitted reports associated with the approval, which are currently being assessed by the DWER as part of the re-application for a further Regulation 17 approval.

The proposed VOC and Odour Emissions Reduction Project is not associated with the installation of any major infrastructure. A desktop noise assessment has been undertaken by a third party acoustic consultant and the results of this study concluded that "*levels are insignificant and would have no impact on compliance with occupational or environmental noise limits" (Wood 2021), refer Attachment 8B.* Alcoa are still required to comply with the existing approvals.

3. Residue and Waste

The material remaining after the alumina has been extracted from the bauxite ore is commonly termed "residue". Residue is produced at a rate of approximately two dry tonnes per tonne of alumina. This material is stored in RSAs adjacent to the refinery.

As described in the Long Term Residue Management Strategy – Wagerup 2017 (Alcoa of Australia 2020d) the residue consists of a coarse sand fraction (often termed "red sand") and a fine silt fraction (often termed "red mud"). Approximately 37% of the residue stream is sand and 63% is mud. The mud density is increased at the residue area by thickening prior to its final discharge into RSAs. The sand is stockpiled and subsequently used for internal construction activities at the residue storage area.

Oxalate, another process by-product, is also stored in approved areas on site. Included within the residue complex are a number of other facilities that support the refining operations. These include ponds designed to cool the plant process waters (cooling ponds) and to store rainfall run-off water from the refinery site and residue area (run-off water storage (ROWS) ponds).

This proposal is for a VOC and Odour emissions reduction therefore there is no anticipated impact to residue storage areas or production of waste, including oxalate.

3.1 Mercury

A small quantity of mercury is expected to condense as the vapour from the 25A tank vents naturally cools en route to the 25A knock-out pot. The knock-out pot design will incorporate a mercury collection point to facilitate the removal of the condensed mercury by a specialised controlled waste contractor. The mercury will be disposed of at an offsite licenced disposal facility in line with our current practices. Refer to Attachment 3B for further information on knock out pot and mercury trap design.

The quantity of mercury predicted to enter the trap has been calculated using the 25A-4 and 25A-2 mercury mass rate emission from the 2018 Emissions Inventory and mercury vapour pressure data.

The forecast quantity of condensed mercury is approximately 0.5 kg/year. There is expected to be an equivalent reduction in mercury emissions to air (note that this has not been factored into the calculated metals emissions in Section 1.3.4).

4. Point source emissions to surface water

The Refinery does not have any point source emissions to surface water and therefore the risk of point source emissions to surface water is low. This works approval application does not change the risk profile for emissions to surface water.

5. Point source emissions to groundwater

The Refinery does not have any point source emissions to ground water and therefore the risk of point source emissions to ground water is low. This works approval application does not change the risk profile for emissions to ground water.

6. Emissions to Land

Alcoa has considered the inclusion of a Spillway on the Runoff Water Storage Pond in a recent licence amendment (26 July 2019). This proposal is for a VOC and Odour emissions reduction; therefore it is not associated with any change to water storage and there is no change of risk in relation to the potential use of the spillway and associated Licence conditions.

7. References

Alcoa of Australia Ltd, 2020. 2018 Wagerup Refinery Emission Inventory: Prepared for August 2019 Section 46 Review of Conditions.

Alcoa of Australia, 2020b. Wagerup 2018 Emissions Inventory – Appendices and Methodology. February 2020.

Alcoa of Australia, 2020c. Licence Amendment Application for L6214/1983/15 Attachment 3B, August 2020, Version 2.

Alcoa of Australia, 2020d. Long Term Residue Management Strategy Wagerup 2017, April 2020. Available at: https://www.alcoa.com/australia/en/pdf/2017-wagerup-refinery-ltrms.pdf.

Environ, 2005. Compound Selection Procedure: Wagerup Refinery Unit Three Expansion. for Alcoa World Alumina Australia, 2005. Environ Australia Pty Ltd Available at: https://www.alcoa.com/australia/en/sustainability/wagerup-unit-three-project-ermp.

Katestone, 2020. Wagerup Alumina Refinery Expansion – Health Risk Assessment 2020. July 2020.

Wood, 2021. Wagerup Emissions Reduction Project Noise Study. May 2021

Wagerup Alumina Refinery

Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 8A
Detailed Odour Assessment

October 2021

Table of Contents

1. Introduction

This Detailed Odour Assessment is to support a works approval application intended to allow a Volatile Organic Compounds (VOCs) and Odour Emissions Reduction Project to proceed which once implemented will support future production capacity increases and associated Part V licence amendment applications.

The proposed works will capture the tank vapours from 25A-2 and 25A-4 Slurry Storage Tanks and redirect the emissions via the existing 35N non-condensable gas treatment system for thermal destruction in the Powerhouse Boilers 2 and 3, instead of venting to atmosphere (as occurs currently). Refer to Attachment 3B.

2. Screening Analysis Outcome

Screening analysis deliverables detailed in the Department of Water and Environmental Regulation (DWER) guideline: Odour emissions (DWER, 2019) include a statement of the screening analysis outcome to be submitted with the report. This statement summarises the Screening analysis outcome prepared for the Wagerup Refinery VOC/Odour Emissions Reduction Project.

The screening analysis for existing premises questionnaire was completed. Step 2 of this questionnaire asks whether odour impacts have occurred as a result of the current operational configuration. The Wagerup Refinery has historically received odour related complaints and odour impacts have potentially occurred as a result of the current operational configuration. The answer to this question therefore was Yes and the questionnaire then directs the applicant to the flowchart.

Q2. Identification of current odour impacts	
Have odour impacts occurred as a result of the current operational configuration and / or practices? Please tick all applicable boxes: ☒ Complaints ☐ Odour diaries ☒ Field odour assessments ☒ Community feedback ☐ Other. _____	☒ **YES** or **Can't determine:** Go to flowchart. ☐ **NO:** Go to Question 3.

The flowchart in Step 2 confirmed that, because the answer was Yes at Question 2, the application will require the submission of a detailed analysis which has been prepared for submission with this application.

The full screening analysis report is included as **Appendix A**.

3. Summary of Detailed Analysis Tools

Alcoa has reviewed the available tools to assess odour and has included the tools identified in this table suitable for use as part of this odour assessment.

Detailed analysis tools	Tick if used	Comments
Emission source		
Operational odour analysis (OOA) (priority tool)	☒	
Odour source assessment (OSA)	☒	
Pathway and receptor		
Location review ("highly recommended")	☒	
Odour field assessment (OFA)	☒	
Complaints data analysis	☒	
Community surveys	☐	
Comparative dispersion modelling	☐	
Comparison with similar operations	☐	

4. Location Review

The location review examines environmental factors such as topography and local meteorology that influence the dispersion of odour. The location review also outlines the location and nature of sensitive receptors.

4.1 Local Topography and Meteorology

The Wagerup Refinery is located in the Swan Coastal Plain, 25 km from the Indian Ocean and to the immediate west of the Darling escarpment (scarp), approximately 130 km due south of Perth. The climate of the area is Mediterranean with hot dry summers and cool wet winters.

The winds in the region are controlled by the synoptic weather patterns and local features such as the topography, and sea and land breezes. In the summer the passage of high-pressure systems to the south generates synoptic easterlies over the region, whilst in the winter months the passage of cold fronts and low-pressure systems results in more frequent westerly synoptic flows between periods of lighter winds (Air Assessments, 2005). For the Wagerup Refinery, at the base of the Darling escarpment (scarp), topographical features are critically important in modifying these larger scale winds. Figure 1 shows the topography of the local area.

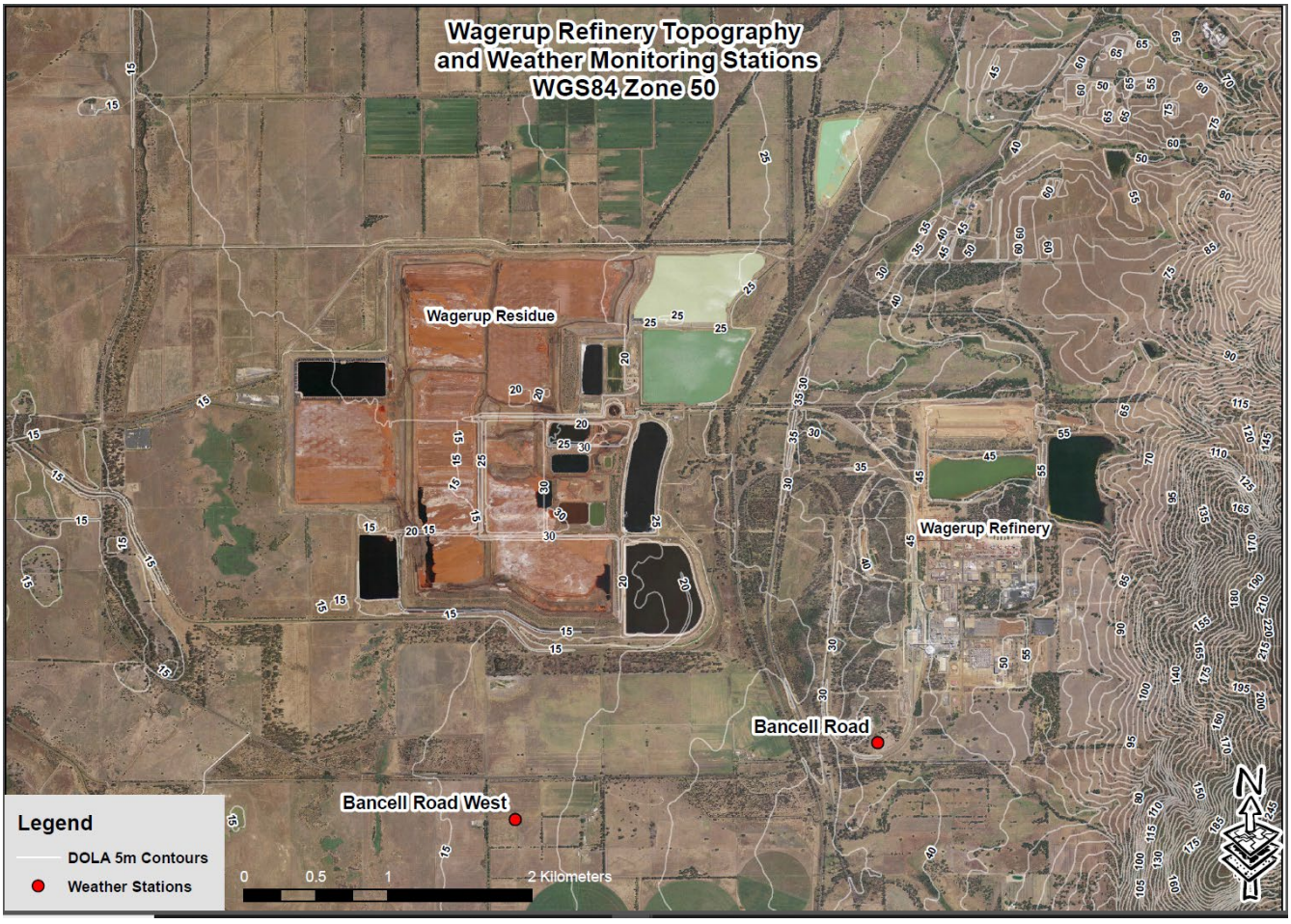


Figure 1: Topographical map displaying 5m contours and weather stations

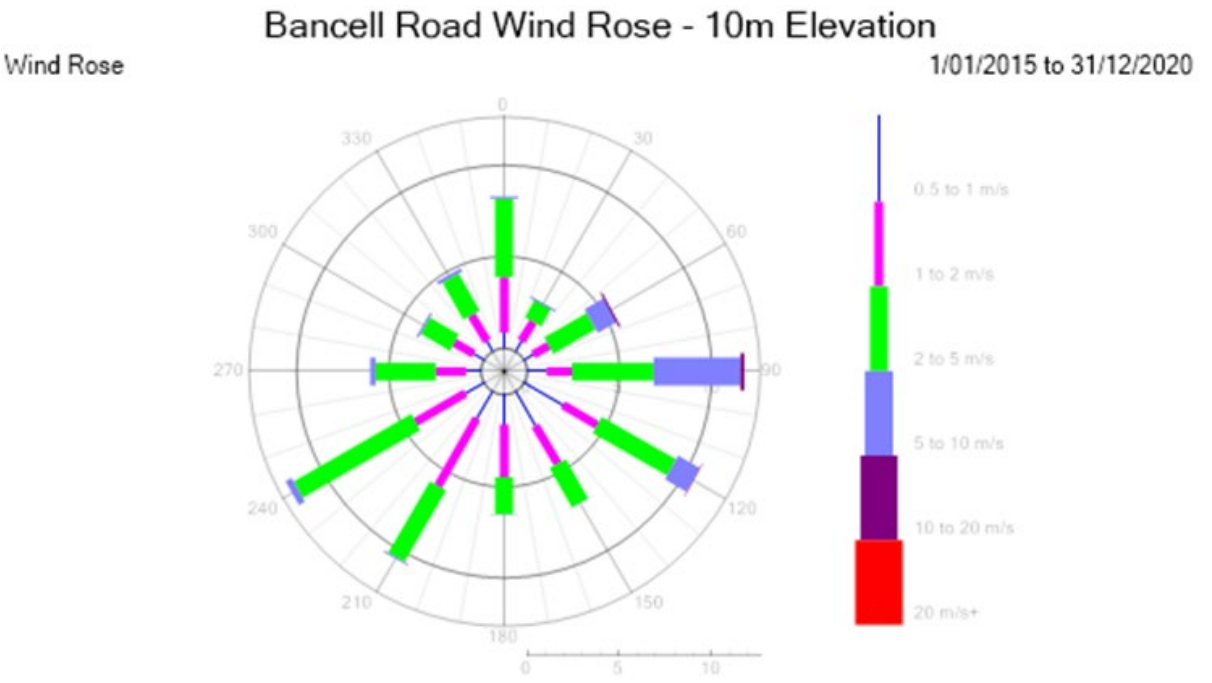
These topographic features tend to:

1. Generate local strong winds during summer, principally at night and in the early morning which are known as “gully winds” or “foothill winds”;
2. Create rotors or wind reversals near the foothills under easterly winds;
3. Channel or deflect westerly winds near the base of the scarp; and
4. Create light drainage (katabatic flows) down the scarp.

The most pronounced effect of the scarp is the generation of very strong easterly winds from early evening to early/mid-morning, occurring predominantly in the summer months. These winds extend from the top of the scarp to the west at distances from several to 10 kms from its face. Wind speeds in this zone are typically a factor of two or higher than elsewhere on the coastal plain. Hourly averaged wind speeds of 15 m/s (30 knots) are commonly recorded in the foothills during the summer months.

North-westerly winds near the scarp can often be more northerly by up to 20 degrees than winds further west, away from the scarp. This is likely due to north/south channelling of the winds by the scarp.

Figure 2 indicates 6-minute average wind rose meteorological data for the period 2015 – 2020. This data is sourced from the two Alcoa owned meteorological stations located at Bancell Road and Bancell Road West (depicted in Figure 1). These weather stations have been installed and are maintained to comply with AS 3580.14-2011. A third-party NATA accredited contractor manages the operation and maintenance of these weather monitoring stations, including monthly data validation.



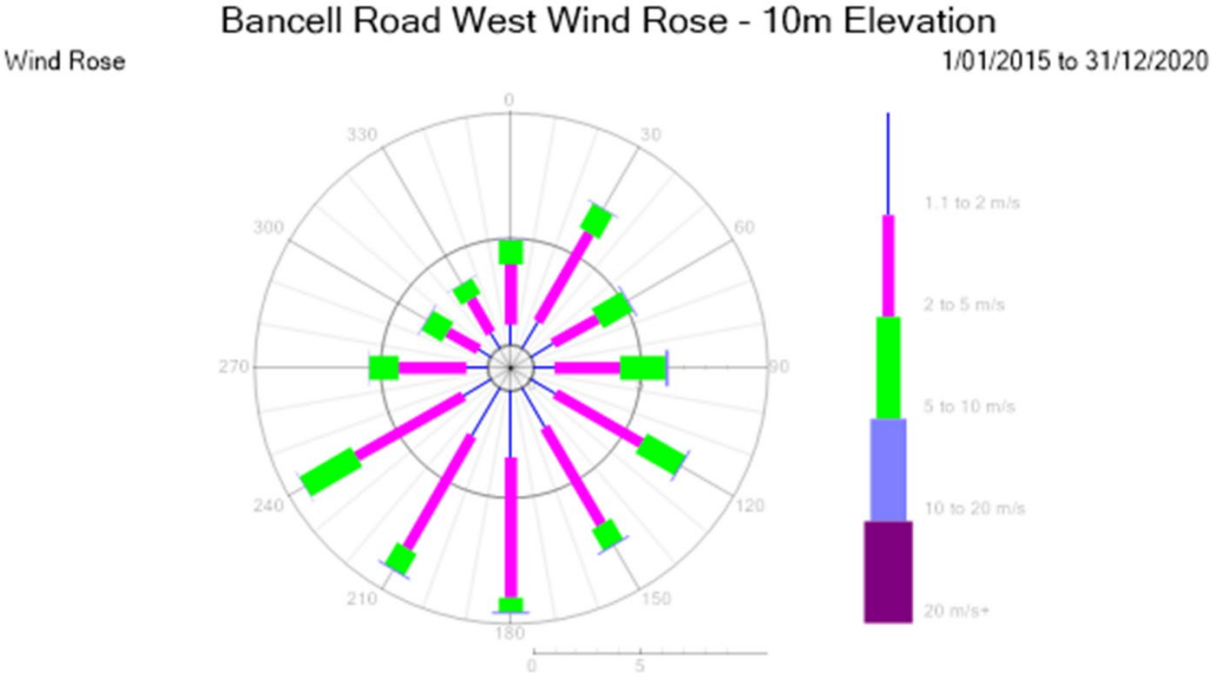


Figure 2: Wind roses of meteorological data for the period 2015- 2020 for the Bancell Road and Bancell Road West Meteorological stations.

4.2 Previous studies relating to odour complaints and meteorological influences

In 2004 Alcoa commissioned CSIRO Atmospheric Research to undertake an independent Air Quality Review at Wagerup. The review documented the air quality knowledge and information concerning Wagerup and the surrounding region at that time and assessed the various scientific studies undertaken. In the review, CSIRO recognised that the work undertaken at the refinery represented "a substantial advance in knowledge about emissions to the atmosphere from alumina refineries".

As part of the review, CSIRO made several recommendations aimed at deepening understanding about air quality around the refinery. Alcoa Wagerup committed to implementing these recommendations and developed an 'Air Quality Management Plan' to progress the items and a Technical Advisory Panel (TAP) was formed to review the outcome of the studies to complete the recommendations.

Two recommendations were itemised to address concerns on odour complaints and meteorological influences (Recommendation 10), and meteorology and dispersion processes (Recommendation 16).

Recommendation 10 revolved around Complaints Data Analysis and stated "Other meteorological influences such as stability in the lower atmosphere and wind speed may also cause year to year variations in the number of odour complaints. Their influence on odour complaints should be quantified." Previous investigations have demonstrated that wind speed is not correlated with complaints (Riley, Dec 2000).

To address the remainder of the intent of Recommendation 10, a review of the findings of the 2004 and 2005 odour complaint statistical analysis was conducted to determine:

1. If there is a variability from year to year in atmospheric stability at the Wagerup Refinery; and
2. If associations between atmospheric stability and odour and health complaints exist.

The report concluded, on the basis of statistical analysis of annual complaints data that "meteorological factors such as stability in the lower atmosphere and wind speed are not a primary cause of significant year to year variations in the number of odour complaints". The recommendation was marked as completed and closed.

Recommendation 16, Meteorology and Dispersion Processes, was 'An investigation of the key meteorological factors and dispersion processes that govern the frequency and intensity of pollution events in the areas surrounding Wagerup is needed". The program of work implemented to address the requirements of Recommendation 16 involved meteorological monitoring, analysis of meteorological data, meteorological modelling and atmospheric dispersion modelling. The aim of the investigations was to identify specific meteorological factors and dispersion processes that contribute to observed refinery air quality events. Due to these different facets of the recommendation, the report addressed it as three aspects:

1. Key meteorological factors;
2. Key dispersion processes; and
3. How the key factors and processes interact to influence the nature and occurrence of pollution events.

A number of key factors and resulting influences on air quality events in the vicinity of the refinery have emerged from the studies and investigations conducted. Firstly, in winter, the dominant conditions leading to likely odour events were characterised by CSIRO as Type 1 and/or Type 2, being:

- Type 1: Morning inversion break-up fumigation and shallow convective mixing. 77% of model events (when combined with Type 2); and

- Type 2: Neutral stability, strong winds and/or cloudy conditions. 77% of model events (when combined with Type 1).

An intensive winter meteorological data collection program was carried out in 2006, and a thorough review of all data collected was undertaken by Air Assessment (Air Assessments, 2007). The 2006 Winter Study, as well as more detailed and refined modelling conducted since the original ERMP modelling, have continued to highlight the importance of these two event types to the majority of events observed, analysed, or recorded by Alcoa, DWER, CSIRO, other consultants and stakeholders including community.

The findings and conclusions from these studies, relating to meteorological factors and dispersion processes were:

1. The majority of air quality events associated with the refinery that have been described in the reference studies, occurred for CSIRO Types 1 and 2, which collectively account for 77% of modelled emission events at Yarloop. These event types are characterised by light northerly winds and inversions, and moderate to stronger winds with neutral atmospheric stability respectively.

2. Other less frequently observed event types are characterised by light nocturnal drainage flows from the escarpment with westerly flows aloft (Type 3) or shallow westerly flows at the surface with synoptic easterly winds aloft (Type 4).

3. More complex processes were occasionally observed, involving light surface winds with a stable boundary layer causing dispersion of plume emissions from low level refinery sources during night and early morning (Type 5); and foothill winds with low level (<300 m) jet flows near the scarp, that may sometimes be accompanied by the formation of rotors in reverse flows beneath synoptic easterly winds (Type 6).

4. Further and even more complex conditions may exist as one vent type transitions into another, as the 'Type 5/1' event type defined in CSIRO's investigations. It is generally accepted that these types of complex dispersion process and patterns are very difficult to predict in advance or to simulate in current dispersion models.

4.3 Screening Distances

According to the Odour Emissions Guideline, metal refining of 1000 tonnes or more per year has a screening distance on a case by case basis.

4.3.1 Historical Land Management Strategies

Alcoa first commenced land acquisitions at Wagerup in the 1970s when the site was identified as being suitable for the construction of an alumina refinery.

Refinery operations commenced in 1984 and land acquisitions continued on an ad-hoc basis until 2001 when Alcoa conducted community consultation on a draft Land Management Proposal, designed to allow people that lived within a defined area around the refinery and residue area the opportunity to move away, should they wish to do so. The northern and southern boundaries of this area (now known as Area A) were based primarily on the 35 dB(A) modelled refinery noise contour. People residing in Area A may experience noise levels greater than the assigned levels allowed under the Regulations. The proposal defined a land acquisition process that would facilitate equitable outcomes, transparency and consistency.

Following community feedback, Alcoa revised its Land Management Proposal and in 2002 implemented the Land Management Plan which contained two key elements:

1. People who own property within Area A would have for the life of the refinery the option to voluntarily decide if they want to sell their property to Alcoa. Properties purchased would be retained by Alcoa.

2. People who own property in the townships of Yarloop or Hamel, outside Area A, would have at least five years to decide if they wish to sell to Alcoa. During that time, Alcoa would conduct a benchmark survey of property values in the area and if values decline due to the refinery's presence, Alcoa's commitment to purchase properties would be extended for a further five years. Properties purchased by Alcoa in Area B would be on-sold.

In 2006, as a condition of approval for the proposed Wagerup Unit Three expansion project, the State Government announced the Supplementary Property Purchase Program (SPPP).

This program was administered by an independent State Government appointed Administrator and provided residents outside the boundary of the Wagerup Land Management Plan but within the localities of Wagerup, Hamel, Yarloop and Cookernup with the option to sell their property to Alcoa. Under this program 152 properties were acquired by Alcoa. Of those properties purchased, 106 have been sold, and 46 remain to be sold. The SPPP closed in 2007.

From the commencement of the Wagerup Land Management Plan in January 2002 it has been a priority that the approach adopted for purchasing properties be consistent, transparent and equitable. The basic process that Alcoa has used and will continue to use during the period of the Approval is outlined below.

1. Alcoa's Land Administrator(s) co-ordinate all aspects of the Land Management Plan.

2. The Land Administrator maintains contact with Alcoa neighbours by letter, email, telephone or face-to-face meetings. Contact can be initiated by either the Land Administrator or the neighbour.

The method of contact and the frequency of any Alcoa initiated contact varies from neighbour to neighbour. This is primarily dependent on the wishes of each neighbour, based on their feedback during the previous contact. In some cases, contact may be circumstantial, for example if the Land Administrator meets a neighbour while in the area.

For those willing to participate in discussions, frank and open communication is undertaken with the landholders, which includes consideration of the individual neighbour's issues and requests, while maintaining consistency to the Land Management Plan.

Where the landholder has made it clear they do not wish to participate in discussions, then Alcoa respects this decision.

For most neighbours, brief records of contact are maintained by the Land Administrator to ensure that Alcoa has current information about their wishes and to ensure that periodic contact is maintained at a frequency that meets the neighbour's expectations. These are informal notes that aim to record key discussion points and the date of contact.

Periodically (roughly every two years) Alcoa will write to all remaining Area A neighbours reminding them of the Land Management Plan and Alcoa's wish to purchase their property.

4.3.2 Current Land Management Strategy

The current Wagerup Land Management Plan comprises two areas:

Area A

The area immediately surrounding the refinery, delineated to the north and south by the refinery 35 dB(A) modelled noise contour and to the west by the future expansion of the residue storage area. Consideration was given to existing cadastral boundaries.

Area B

The residential town sites of Hamel and Yarloop.

The Wagerup Land Management Plan was implemented by Alcoa and has no formal status in Statutory Planning Schemes. Area A is depicted by the yellow boundary and Area B by the blue boundaries in Figure 3.

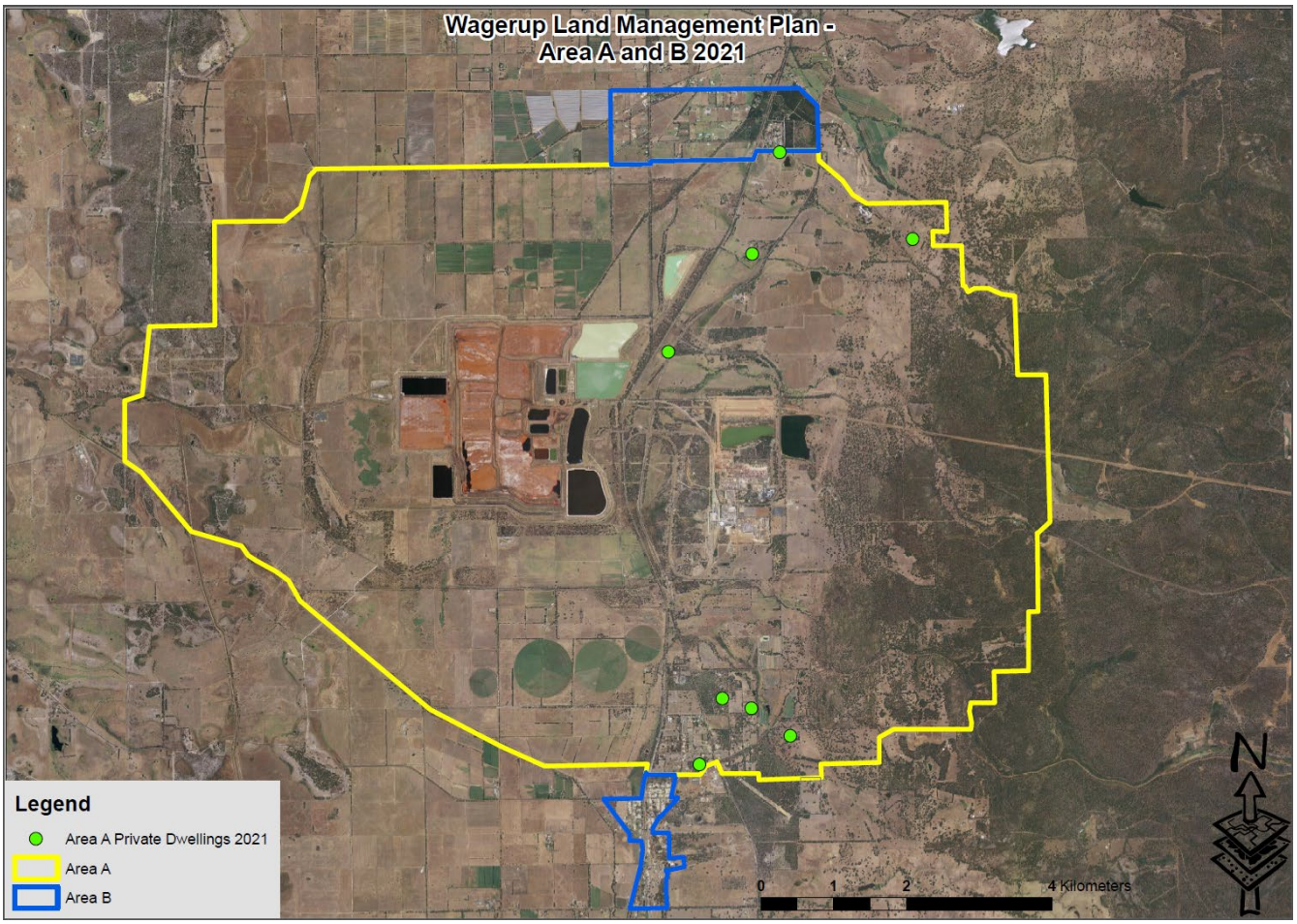


Figure 3: Wagerup Land Management Plan – Area A and Area B

Area A covers a geographical area of 8,442 hectares, comprising 337 properties.

Area B is 358 hectares and comprises properties in the townships of Yarloop and Hamel.

Alcoa personnel continue to undertake communication with landholders in an effort to ensure understanding and awareness of Alcoa's willingness to purchase properties in Area A (under the terms of the Wagerup Land Management Plan), and where appropriate, progress sales. This includes phone,

face-to-face and email discussions with at least five individuals regarding potential property purchases in 2020/2021.

Between 2002 and 2021 Alcoa purchased 185properties in Area A, increasing its ownership in Area A to a total of 277 properties. During that same period Alcoa also purchased 184 properties in Area B and on-sold 174 of these as per the intent of the Wagerup Land Management Plan.

Over 90% of the eligible land within Area A has been purchased by Alcoa and will be held by the company for the life of its operations at Wagerup. Similarly, 84% of the properties eligible for purchase within Area B have been bought with 95% of the purchased properties then sold back into the community. Table 1 summarises the properties purchased since 2009 and includes offers to purchase that have been declined.

Table 1: Summary of Offers Made and Assets Acquired in Area A by Alcoa

Year	Number of written offers to purchase	Number of offers accepted	Number of written offers declined	Assets acquired
2009	5	5	0	59ha & 4 homes
2010	7	7	0	206ha & 2 homes
2011	14	14	0	371ha & 1 home
2012	2	0	2	0
2013	2	1	1	1.9ha & 1 home
2014	3	1	0	74ha & 1 home
2015	1	0	0	0
2016	8	8	0	231ha & 3 homes
2017	0	0	0	0
2018	2	2	0	4.42ha
2019	2	2	0	24.17ha
2020	2	2	0	126.17ha
2021	1	1	0	16.29ha

As demonstrated in Table 2, Alcoa now owns the majority of properties in Area A, including over 90% of the eligible land. This is a direct result of the implementation of the Wagerup Land Management Plan.

In 2016 a bushfire destroyed a number of dwellings located in Area A. The fire destroyed four privately owned homes in Area A and Alcoa has since purchased two of these properties. Alcoa lost 41 houses in Area A as a result of the fire.

Table 2: Summary of Property Ownership within Area A

Landowner	Alcoa	Private	Other (Private & Government)[1]
Properties[2]	**277**	**22**	**33**
Dwellings (noise affected premises)[3]	494	8	N/A
Dwellings destroyed in 2016 bushfire	41	4	
Total Area (ha)	7164	544	733

[1] Properties not eligible to be purchased by Alcoa.

[2] Figures current as at last Annual Land Management Report (September 2020)

[3] Existing dwellings. A number of dwellings have been demolished following purchase by Alcoa as they were derelict and attracting anti-social behaviour.

Alcoa currently owns 277 properties in Area A. There remain eight dwellings eligible to be purchased by Alcoa in Area A, including one that was rebuilt after it was destroyed in the 2016 fire. There remains 22 properties within Area A that are eligible for purchase by Alcoa (including the eight properties with dwellings).

4.4 Sensitive Receptors

The local communities in the proximity of the refinery include Yarloop, Hamel and Waroona (Refer to Figure 4). Yarloop is located approximately 3 km south of the refinery, and Hamel and Waroona are located north of the refinery approximately 5 km and 8 km respectively. The discrete receptor locations used in the location review are listed in Table 3, and are shown in Figure 4. These discrete receptors are consistent with the previous modelling assessments and Health Risk Assessments and are receptors for total air emissions from the Wagerup Refinery and are not specifically selected as Odour receptors[5]. The discrete receptor locations listed are historical locations however some of these locations no longer contain residential dwellings on the property as a result of the 2016 Yarloop bushfire and/or property acquisition and demolition. Measurement Method 2 as outlined in the DWER Odour Guidelines has been used to identify the closest receptor locations. Receptor Location 16 is the closest privately owned and occupied residential dwelling and is located less than a kilometre to the North West of the Refinery Boundary. Only eight dwellings remain within Area A. Figure 3 shows the location of the 8 dwellings.

Since the designation of these receptors, some no longer have sensitive receptors (dwellings). Receptor 12 was removed some time ago for this reason. Alcoa would propose to no longer consider Receptors 2, 3 and 15.

[5] Receptor 12 is not included as it ceased being a residence in the mid-2000s

Table 3: Details of sensitive receptors in the vicinity of Wagerup Refinery

ID[6]	Rd Name	House No.	Survey	Type | Current Status[7]	Easting (m)[8]	Northing (m)	Separation Distance (m)
1	Boundary Rd	32	P090430 65	Individual residence | Alcoa owned	398,091	6,354,834	1805
2	Boundary Rd,	Lot 2606	P249779 2606	No residence | Alcoa owned Land	398393	6,355,006	n/a
3	Teesdale St, Yarloop	19	P002620 33	No residence Privately Owned Land | Area B	396,830	6,352949	n/a
4	Kaus Rd, Yarloop	46	D018220 2	Individual residence | Alcoa owned	397,138	6,354,827	2200
5	Clifton Rd, Yarloop	232	P232779 107	Individual residence | Alcoa owned	395,721	6,352,503	4700
6	Hoffman Rd, Yarloop	254	D066357	Individual residence | Alcoa owned	399,650	6,354,240	2540
7	Bremner Rd, Wagerup	152	D087877 9	Individual residence | Alcoa owned	390,775	6,358,733	7130
8	Somers Rd, Waroona	769	P020529 202	Individual residence | Alcoa owned	392,360	6,362,131	6561
9	McClure Rd, Hamel	94	D062510 7	Individual residence | Area B	396,099	6,362,024	3750
10	Burney, Rd Hamel	94	P222558 46	Individual residence | Area B	398,460	6,362,000	3249
11	Sth West HWay, Wagerup	8838	P228592 158	Individual residence | Area A	398,207	6,360,331	1608
13	Lyons Rd, Waroona	12	P052802 700	Residential population	400,520	6,364,215	5694
14	Waterous Rd, Waroona	161	D085596 102	Individual residence | Area A	400,727	6,360,830	2856
15	Bancell Rd	Lot 489	P254420 489	No residence | Alcoa owned Land	400,726	6,356,435	n/a
16	Sth West HWay, Wagerup	9032	P202652 14	Individual residence | Area A	397,365	6,359,285	894

[6] Receptor 12 is not included as it ceased being a residence in the mid-2000s.
[7] Area A is the area immediately surrounding the Refinery; Area B is the residential townships of Hamel and Yarloop.
[8] Location coordinates given in AGD84 Zone 50H

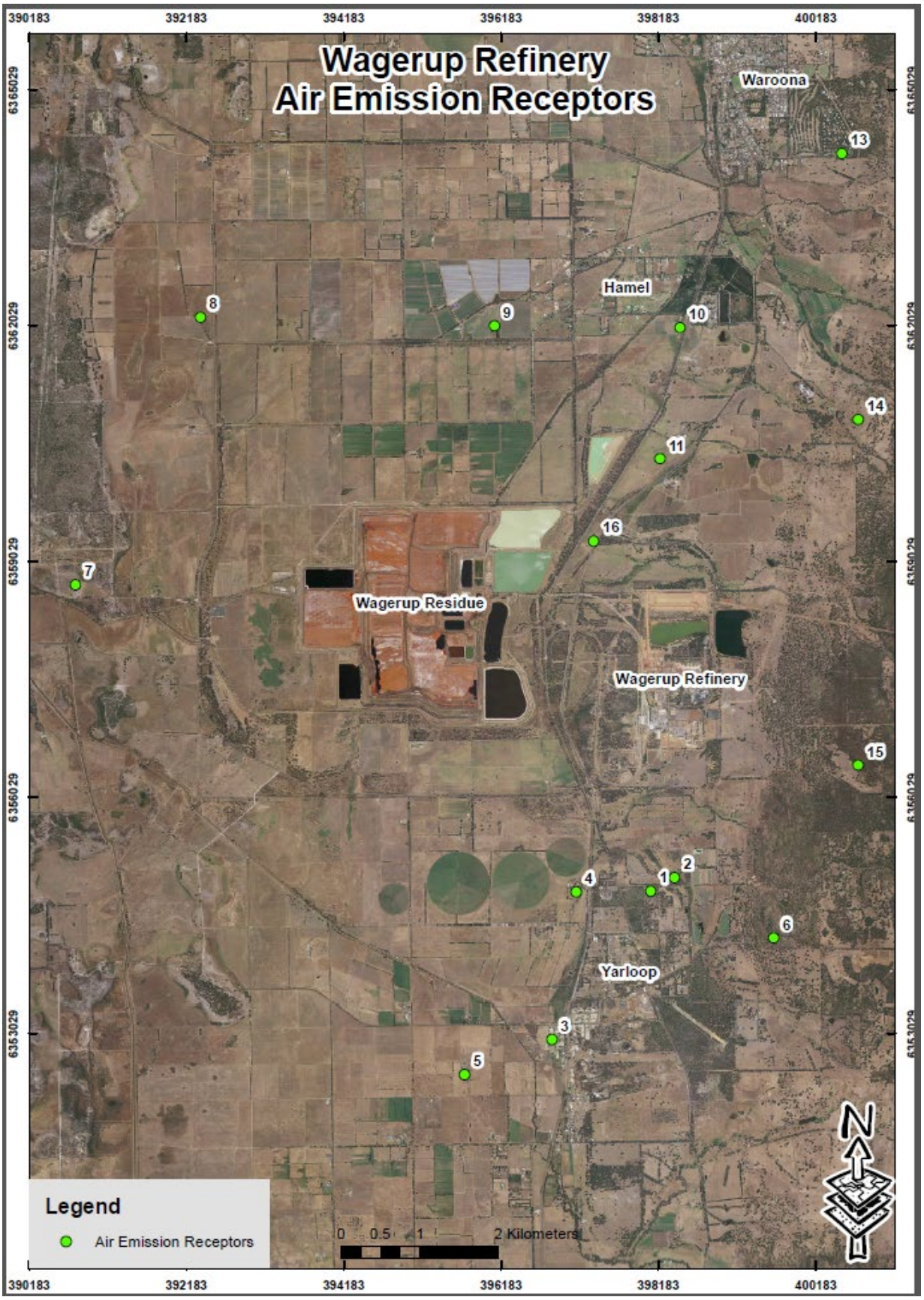


Figure 4: Location of historical sensitive receptors in the vicinity of Wagerup Refinery

5. Complaints Data Analysis

Air quality in populated areas near the Wagerup refinery has been an issue of importance since the mid-1990s with some members of the local community reporting odour, dust and health concerns as a result of refinery emissions. These concerns reached a peak in 2001 and 2002 with high numbers of complaints lodged with Alcoa, particularly for odour. Since this time the number of environment related complaints has fallen steadily in response to further emission control works and Alcoa's Land Management Strategy.

A review of odour complaints lodged for the period from January 2015 to August 2021 has been conducted for all odour complaints lodged with Alcoa; the Department of Water and Environmental Regulation (DWER); the Shire of Waroona; and the Shire of Harvey. Table 4 shows the total odour complaints received from all sources for the period 1 January 2015 through to 31 August 2021. Figure 5 provides graphical representation of these complaints and Figure 6 shows a monthly distribution of complaints over the 7 years. The locations of odour complaints are show in Figure 7. Appendix B includes further details with regards to individual complainants.

Table 4: Odour Complaint Summary for the Period January 2015 to August 2021[9]

	2015	2016	2017	2018	2019	2020	2021[10]
Total no. odour complaints	**16**	**14**	**4**	**11**	**2**	**4**	**13**
Direct to Alcoa	13	9	4	1	0	4	**13**
To DWER	3	5	0	10	2	0	**0**
To Shire of Harvey	0	0	0	0	0	0	**0**
To Shire of Waroona	0	0	0	0	0	0	**0**
No. of properties lodging single complaint to Alcoa	0	2	1	2	0	1	**1**
No. of properties lodging more than one complaint to Alcoa	2	2	1	2	1	1	**1**
No. new[11] instances where properties lodged more than one complaint to Alcoa	0	0	0	0	0	1	**0**

[9] Total number of odour complaints includes complaints made directly to Alcoa and complaints made to DWER. In some cases, complainants will lodge complaints for the same event to both Alcoa and DWER.

[10] Data for 2021 as at 31/08/2021.

[11] New indicates a complaint where historical complaints have not been received in previous years from that property or individual

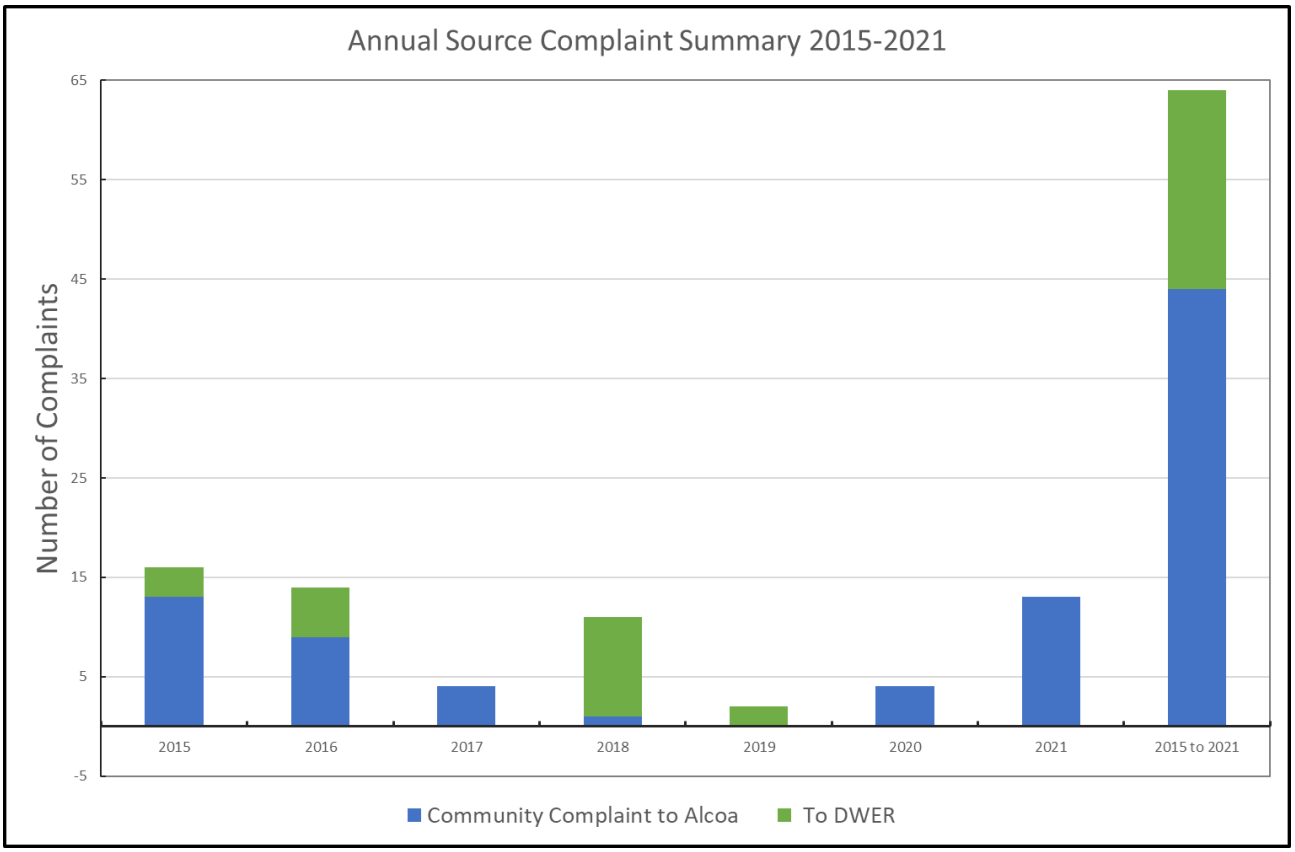


Figure 5: Annual Odour Complaint Summary to DWER and Alcoa for the Period: Jan 2015 to Aug 2021

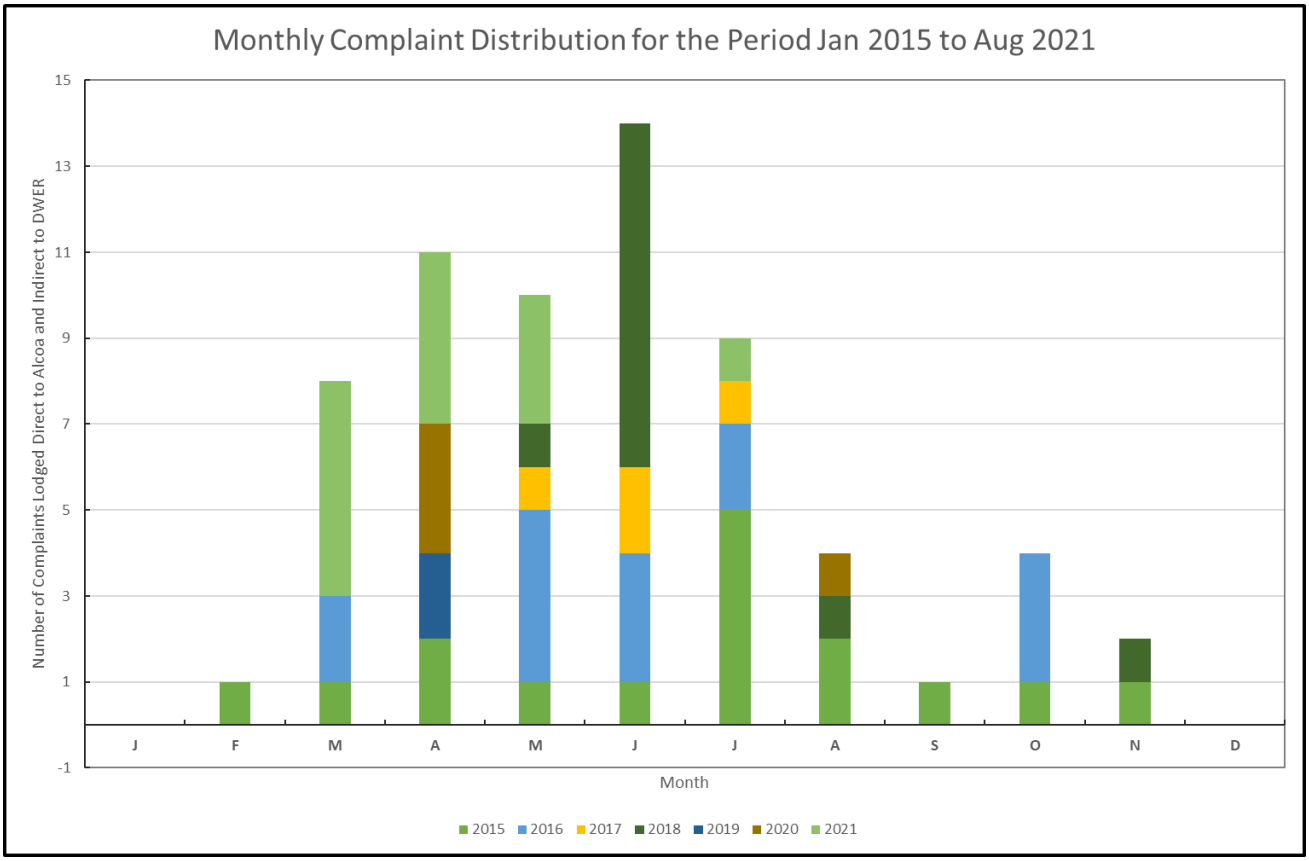


Figure 6: Monthly Odour Complaint Distribution for the Period Jan 2015 to Aug 2021

Review of the data indicates the following key points:

1. 64 odour related complaints have been received in total from all sources for the 7 year period from 2015 to 2021;
2. 44 of those complaints were received directly by Alcoa;
3. The remaining 20 complaints were received by the DWER and communicated by DWER to Alcoa;
4. The highest number of complaints was received in 2015 with 16;
5. The lowest number of complaints was received in 2019 with 2;
6. Odour complaints have decreased in recent years however a single complainant has made 12 complaints to date during 2021; and
7. Total number of properties contributing to the 64 odour complaints is believed to be 14[12]

[12] Indirect complaints to the DWER do not contain the actual address of the complainant when provided to Alcoa, however the street name is provided. Therefore, this figure is based on historical interactions between Alcoa and known complainants located on the designated street name.

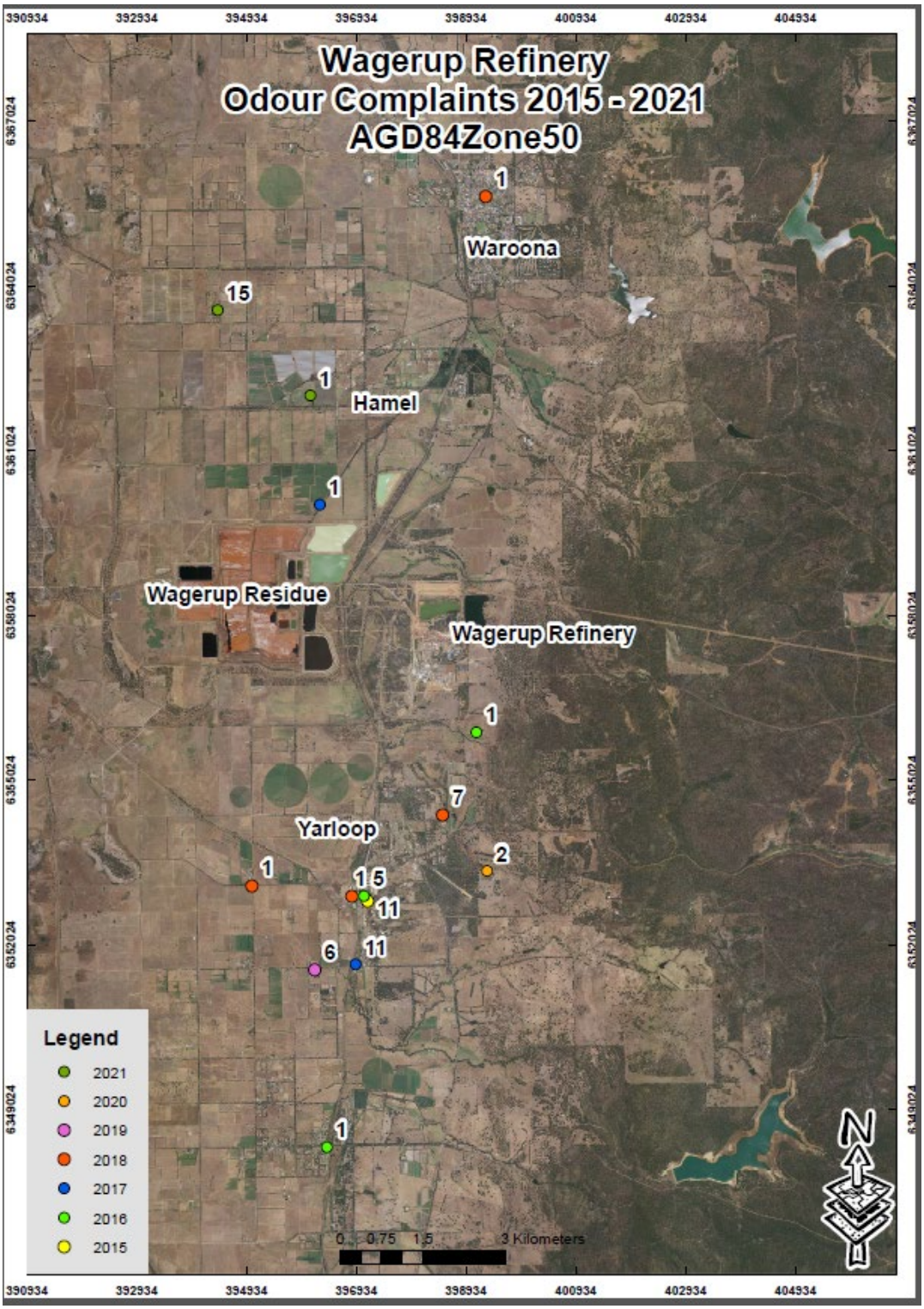


Figure 7: Locations of Odour Complaints 2015 to 2021[13]. The numbers indicate the number of complaints over the 7 year period whilst the colour represents the last year a complaint was received from this location.

[13] Complaints made directly to the DWER are provided to Alcoa without the complainant's address details. The road name is provided and therefore some locations on Figure 8 are only an approximate location.

5.1 Odour Characteristics

The 2020 Odour Field Assessment completed at the Wagerup Refinery (Section 7) described the odour characteristics that represent odours originating from the refinery and elsewhere (Table 5).

Table 5: Odour Characteristics

Code	Descriptor
A	Wet Cement
B	Digestion
C	Condensate
D	Residue
E	Liquor
F	Agriculture
G	Other

These odour descriptors were created following a site familiarisation of known odour sources (refer Table 5 within the refinery and residue areas using a team of external odour assessors that met the DWER definition “A person or group of people who have been tested and are qualified to undertake odour measurements in an odour laboratory or in the field in compliance with AS 4323.3:2001 and EN 16841-2 and VDI 3940-3 standards respectively.”(DWER, 2019)

Historically, odour complainants have described odours that are characteristic of the refinery operations as described above with the use of the term “wet cement” being prevalent in a number of complaint descriptions. The number of odour sources within the refinery and residue area does not allow for accurate identification of an individual odour source that may be detected by a complainant at some distance from the refinery (Refer to Attachment 3B and 6A for a discussion on various odour sources and how sources and overall odour emissions will be impacted by this Project).

Process conditions are reviewed at the time of the complaint when the complaint is received directly by Alcoa, however the source of the odour relating to the complaint may not be identified.

6. Operational Odour Analysis

Refer to Attachment 3B for an overview of the proposed Project. Wagerup Refinery maintains an Emission Inventory that contains details of all significant odour sources in the Refinery. Odour sources are deemed 'significant' if they emit odour at levels greater than 1% of the total refinery odour emissions. The sources listed in Table 6 are excluded from this OOA as they are known emission sources but are not being altered as part of The Project. The focus of this OOA in on Powerhouse Boilers 2 and 3 and the 25A Slurry Storage Tanks.

Table 6: Sources excluded from this OOA

Operation / odour source	Impact potential
Milling (Building 25)	No emission change
Blow-off Tanks (Building 30)	No emission change
Sand Separation (Building 26)	No emission change
Causticisation (Building 35J)	No emission change
Filtration (Building 35A)	No emission change
Seed Filtration (Building 44)	No emission change
Precipitation (Building 45)	No emission change
Precipitation Cooling Towers (Building 45K)	No emission change
Oxalate Removal (Building 47)	No emission change
Liquor Burning (Building 48)	No emission change
Calcination (Building 50)	No emission change
Gas Turbine/Heat Recovery Steam Generator (Building 110)	No emission change
Residue Storage Area	No emission change

6.1 Powerhouse Boilers 2 and 3 (Building 110) – Current Condition

Boilers: Odour emission operations review	Operational Condition(s)
The Wagerup powerhouse generates electricity and process steam (for process heating and generation of electricity) for the refining process by means of natural gas fired boilers and a Gas Turbine Heat Recovery Steam Generator. Currently, three boilers are in operation at Wagerup: Boilers 1, 2 and 3. Non-condensable gases[14] from digestion, evaporation, heat exchange; and collected tank vapours from causticisation, liquor filtration, and the 984Y mercury removal system are diverted to Powerhouse Boilers 2 and 3 to destroy their organic/VOC content prior to atmospheric release. Depending on process requirements/conditions, the non-condensable gases can be sent either 100% to Boiler 2, 100% to Boiler 3, or a 50% allocation to each of Boiler 2 and 3. The reticulation system and fan that transports the gases to the Boilers have operational controls to open or close either/or both of 2 block valves on the inlet air supply to Boiler 2 and 3. The system is simply either on or off. The boiler stack emissions are monitored quarterly under the environmental licence L6217/1983.	Normal; Start-up & Shut-down; Low throughput; Boiler Trip

[14] Non-condensable gases are gases that will not condense to a liquid at ambient temperatures (including VOCs)

<table>
<tr><td>Odour sources and emissions</td><td>
<u>Boilers Point Source Emissions</u>
• Continuously vented via a multiflue.
• Small contributor to overall refinery odour (Boilers 2 and 3 contribute 4% of total refinery odour).
<table>
<tr><th>Stack</th><th>Average emission rate (OU/s)</th><th>Peak emission rate (OU/s)</th></tr>
<tr><td>Boiler 2</td><td>34702</td><td>144060</td></tr>
<tr><td>Boiler 3</td><td>20907</td><td>53474</td></tr>
</table>
<u>Boilers Fugitive Emissions</u>
• Generated from open buildings.
• Emissions have not been measured.
• Low level release points so unlikely to impact private residents.
</td></tr>
<tr><td>Process controls</td><td>
<u>Boilers Point Source Emissions</u>
• Continuous odorous emissions from Boiler stacks when Boilers are operational.
• The block valve is not opened until the Boiler is at operating temperature.
• Normal operation is natural gas fuel feed rate;
Boiler 2 – 5000-20000 m^3/hr, Boiler 3 – 5000-20000 m^3/hr.
• Start up and shut down not expected to increase odour from Boilers 2 and 3 as non-condensable gases can be directed to either Boiler 2 and/or 3. Non-condensable gases are not introduced until a boiler is online and operating normally/stable
• Low throughput (feed rate <5000m^3/hr) is not expected to change odour emissions for Boilers 2 and 3 compared to normal operation as the temperature for combustion of the VOCs remains adequate.
• If an online gas detector in Boiler 2 or 3 detects an off normal combustion the block valve will close whilst troubleshooting is undertaken. If this occurs when one boiler is already offline, then the risk is that the 35N system trips.
<u>Boilers Fugitive Emissions</u>
• Minor leakage is unlikely to contribute to offsite odour emissions.
</td></tr>
<tr><td>Triggers and corrective actions</td><td>
<u>Boilers Point Source Emissions</u>
• Boiler taken offline would require block valve to be closed and emissions redirected 100% to the other online boiler out of Boiler 2 or 3.
<u>Boilers Fugitive Emissions</u>
• Minor leakage is unlikely to contribute to offsite odour emissions.
</td></tr>
<tr><td>Corrective action evaluation</td><td>
<u>Boilers Point Source Emissions</u>
• No corrective actions implemented.
<u>Boilers Fugitive Emissions</u>
• No corrective actions implemented.
</td></tr>
</table>

Contingency actions	Boilers Point Source Emissions • No contingency actions identified. Boilers Fugitive Emissions • No contingency actions identified.

Residual odour impact potential[15]			
Operation / odour source	**Consequence**	**Likelihood**	**Impact potential**
Boilers			
Normal Operation	Slight	Possible	Low
Single Boiler Start up/Shut down	Slight	Possible	Low
Low Throughput	Slight	Possible	Low
Single Boiler Trip	Slight	Possible	Low
Both Boilers Trip[16]	Minor	Unlikely	Medium
Gas Analyser Calibration when one of boiler 2 or 3 is offline.	Minor	Unlikely	Medium
Boilers Fugitive Emissions			
Normal Operation	Slight	Possible	Low
Single Boiler Startup/ Shut down	Slight	Possible	Low
Low Throughput	Slight	Possible	Low
Single Boiler Trip	Slight	Possible	Low
Both Boilers Trip[17]	Minor	Unlikely	Medium
Gas Analyser Calibration when one of boiler 2 or 3 is offline.	Minor	Unlikely	Medium

6.2 Slurry Storage Tanks 25A2 and 25A4 – Current Condition

25A Slurry Storage: Odour emission operations review	Operational Condition(s)
The slurry storage tanks have several functions, the primary purpose being to raise the temperature of the slurry which enhances the desilication reaction. Additionally, the Bauxite Slurry Storage Tanks provide an interface for surge capacity between the mills and the digestion process.	Normal; Filling & Emptying; Low tank level;

[15] Risk Ratings have been based on the DWER 2017 Risk Assessment Guideline

[16] A boiler trip involving both Boilers 2 and 3 will result in a decrease in odour emissions at the Powerhouse however emissions normally directed to the boilers will emit to atmosphere from their source locations within the refinery. A 2 boiler trip will result in loss of power supply to the refinery and odour emitting throughputs will be taken offline as a result.

[17] A boiler trip involving both Boilers 2 and 3 will result in a decrease in odour emissions at the Powerhouse however emissions normally directed to the boilers will emit to atmosphere from their source locations within the refinery. A 2 boiler trip will result in loss of power supply to the refinery and odour emitting throughputs will be taken offline as a result.

<table>
<tr><td colspan="2">Building 25A has four identically sized cylindrical slurry storage tanks with conical bottoms, each with a maximum capacity of 3.4 ML. Bauxite slurry from the mills in Building 25 enters the top of the first storage tank, 25A3. The tanks are run in series, with the flow going from 25A3 to 25A1 to 25A4 through to 25A2. The slurry leaves 25A2 for the digestion process in building 30.

The heating of the slurry, together with the long holding time in the 25A tanks, provide favourable reaction conditions for desilication. Desilication product (DSP) is an insoluble solid, which can form very hard scale in digester vessels, piping and heaters at elevated temperatures. By removing the DSP prior to digestion scaling in high temperature vessels downstream is minimised.

Only tanks 25A2 and A4 will be modified by the proposed Project and are considered further.</td><td>Bauxite Feed Off</td></tr>
<tr><td>Odour sources and emissions</td><td colspan="2"><u>25A Slurry Storage Emissions</u>

• Vented via single flues for tanks 25A-2 and 25A-4.
• Moderate contributor to overall refinery odour (1% of total refinery odour for 25A2 and 25A4 combined) as temperature is high and organics are being digested.

<table><tr><th>Stack</th><th>Average emission rate (OU/sec)</th><th>Peak emission rate</th></tr><tr><td>25A-2</td><td>8570</td><td>23638</td></tr><tr><td>25A-4</td><td>8570</td><td>23638</td></tr></table>
<u>25A Slurry Storage Fugitive Emissions</u>

• These tanks are not airtight vessels so minor emissions generated from tank openings (other than flued vents).
• Emissions have not been quantified but are considered to be insignificant.
• Low level release points are unlikely to contribute to offsite odour emissions.</td></tr>
<tr><td>Process controls</td><td colspan="2"><u>25A Slurry Storage Point Source Emissions</u>

• Continuous odorous emissions from tank vents when tanks are operational.
• The 25A tanks are not pressure vessels and air emissions from these tanks are currently directed to atmosphere through single point stacks.
• Tank levels are maintained between 50% and 90% capacity during normal operation.
• No changes to emission rates are expected during tank filling and emptying.
• Expected decrease in odour when bauxite feed is off.
• Operational target temperature for slurry in the 25A3 header is >95°C.
• No discernible decrease in odour is expected when tank level is low (<50% capacity) compared to normal operation

<u>25A Slurry Storage Fugitive Emissions</u>

• No controls.</td></tr>
</table>

Triggers and corrective actions	25A Slurry Storage Emissions • No triggers and corrective actions. 25A Slurry Storage Fugitive Emissions • No triggers and corrective actions.
Corrective action evaluation	25A Slurry Storage Emissions • No corrective actions implemented. 25A Slurry Storage Fugitive Emissions • No corrective actions implemented.
Contingency actions	25A Slurry Storage Emissions • No contingency actions identified. 25A Slurry Storage Fugitive Emissions • No contingency actions identified.

Residual odour impact potential			
Operation / odour source	**Consequence**	**Likelihood**	**Impact potential**
25A Slurry Storage			
Normal Operation	Moderate	Possible	Medium
Tank Filling	Moderate	Possible	Medium
Tank Emptying	Moderate	Possible	Medium
Low Tank Level	Moderate	Possible	Medium
Bauxite Feed Off	Minor	Possible	Medium
25A Slurry Storage Fugitive Emissions			
Normal Operation	Minor	Possible	Medium
Tank Filling	Minor	Possible	Medium
Tank Emptying	Minor	Possible	Medium
Low Tank Level	Minor	Possible	Medium
Bauxite Feed Off	Minor	Possible	Medium

6.3 Powerhouse Boilers 2 and 3 (Building 110) – Proposed Condition

<table>
<tr><th colspan="2">Powerhouse: Odour emission operations review</th><th>Operational Condition(s)</th></tr>
<tr><td colspan="2">As per 5.1, with the additional non-condensable gases from 25A2 and 25A4. Refer to Attachment 3B for details of the proposed Project.</td><td>Normal;
Start-up & Shut-down;
Low throughput;
Boiler Trip</td></tr>
<tr><td>Odour sources and emissions</td><td colspan="2">Boilers Point Source Emissions
• Continuously vented via a multiflue.
• Small contributor to overall refinery odour (Boilers 2 and 3 contribute 4% of total refinery odour).
<table><tr><th>Stack</th><th>Average emission rate (OU/s)</th><th>Peak emission rate (OU/s)</th></tr><tr><td>Boiler 2</td><td>36101</td><td>144060</td></tr><tr><td>Boiler 3</td><td>22306</td><td>53474</td></tr></table>
Boilers Fugitive Emissions
• Generated from open buildings
• Emissions have not been measured.
• Low level release points so unlikely to impact private residents.
• Proposed Project predicted to reduce fugitive emissions from the existing system due to addition of seal pot with level monitoring and control room alarms, however, this will be unable to be quantified.</td></tr>
<tr><td>Process controls</td><td colspan="2">Boilers Point Source Emissions
• Continuous odorous emissions from Boiler stacks when Boilers are operational.
• The block valve is not opened until the Boiler is at operating temperature.
• Normal operation is natural gas fuel feed rate;
Boiler 2 – 5000-20000 m^3/hr, Boiler 3 – 5000-20000 m^3/hr.
• Start up and shut down not expected to increase odour from Boilers 2 and 3 as non-condensable gases can be directed to either Boiler 2 and/or 3. Non-condensable gases are not introduced until a boiler is online and operating normally/stable
• Low throughput (feed rate <5000m^3/hr) not expected to change odour emissions for Boilers 2 and 3 compared to normal operation as the temperature for combustion of the VOCs remains adequate.

Boilers Fugitive Emissions
• Drain legs being installed will reduce fugitive emissions but is not able to be quantified.</td></tr>
</table>

Triggers and corrective actions	Boilers Point Source Emissions Boiler taken offline would require block valve to be closed and emissions redirected 100% to the other online boiler out of Boiler 2 or 3. Boilers Fugitive Emissions • The proposed seal pot at the powerhouse will include online level monitoring and alarms. If the level triggers an alarm the operators will be required to investigate/troubleshoot to minimise the risk of fugitive emissions.
Corrective action evaluation	Boilers Point Source Emissions • No corrective actions implemented. Boilers Fugitive Emissions • No corrective actions implemented.
Contingency actions	Boilers Point Source Emissions • No contingency actions identified. Boilers Fugitive Emissions • No contingency actions identified.

Residual odour impact potential			
Operation / odour source	**Consequence**	**Likelihood**	**Impact potential**
Boilers			
Normal Operation	Slight	Possible	Low
Single Boiler Start up/Shut down	Slight	Possible	Low
Low Throughput	Slight	Possible	Low
Single Boiler Trip	Slight	Possible	Low
Both Boilers Trip[18]	Minor	Unlikely	Medium
Boilers Fugitive Emissions			
Normal Operation	Slight	Possible	Low
Single Boiler Startup/ Shut down	Slight	Possible	Low
Low Throughput	Slight	Possible	Low
Single Boiler Trip	Slight	Possible	Low
Both Boilers Trip	Slight	Unlikely	Low

[18] A boiler trip involving both Boilers 2 and 3 will result in a decrease in odour emissions at the Powerhouse however emissions normally directed to the boilers will emit to atmosphere from their source locations within the refinery. A 2 boiler trip will result in loss of power supply to the refinery and odour emitting throughputs will be taken offline as a result.

6.4 Slurry Storage Tanks 25A2 and 25A4 – Proposed Condition

<table>
<tr><th colspan="2">25A Slurry Storage: Odour emission operations review</th><th>Operational Condition(s)</th></tr>
<tr><td colspan="2">As per 5.2, with the non-condensable gases from 25A2 and 25A4 re-routed to the 35N system. Refer to Attachment 3B for details of the proposed Project.</td><td>Normal;
Filling & Emptying;
Low tank level;
Bauxite Feed Off;
Boiler 2 &3 Failure</td></tr>
<tr><td>Odour sources and emissions</td><td colspan="2">25A Slurry Storage Emissions
• Emissions from 25A-2 and 25A-4 are diverted to Boiler 2 and/or Boiler 3 for thermal destruction.
• Moderate contributor to overall refinery odour (0.05% of total refinery odour for 25A-2 and 25A-4 combined).
<table><tr><th>Stack</th><th>Average emission rate (OU/sec)</th><th>Peak emission rate</th></tr><tr><td>25A-2</td><td>341</td><td>23638</td></tr><tr><td>25A-4</td><td>341</td><td>23638</td></tr></table>
25A Slurry Storage Fugitive Emissions
• Generated from tank openings.
• Emissions have not been measured.
• Low level release points so unlikely to impact private residents.</td></tr>
<tr><td>Process controls</td><td colspan="2">25A Slurry Storage Point Source Emissions
• Continuous odorous emissions from 25A-2 and 25A-4 tanks directed to 35N ventilation system for combustion in Powerhouse Boiler 2 and 3 while tanks are operational.
• Tank levels are maintained between 50% and 90% capacity during normal operation.
• Minor changes to emission rates are expected during tank filling and emptying.
• Expected decrease in odour when bauxite feed is off.
• No decrease in odour is expected when tank level is low (<50% capacity) compared to normal operation.
•
25A Slurry Storage Fugitive Emissions
• The proposal is expected to reduce fugitive emissions as the suction from the 35N fan will create a slight negative pressure in the tank.</td></tr>
</table>

Triggers and corrective actions	25A Slurry Storage Emissions • No triggers and corrective actions. 25A Slurry Storage Fugitive Emissions • No triggers and corrective actions.
Corrective action evaluation	25A Slurry Storage Emissions • No corrective actions implemented. 25A Slurry Storage Fugitive Emissions • No corrective actions implemented.
Contingency actions	25A Slurry Storage Emissions • In the unlikely event of simultaneous failure of Powerhouse Boilers 2 and 3, 25A-2 and 25A-4 tank emissions will be directed to atmosphere via the tank vents. 25A Slurry Storage Fugitive Emissions • No contingency actions identified.

Residual odour impact potential			
Operation / odour source	**Consequence**	**Likelihood**	**Impact potential**
25A Slurry Storage			
Normal Operation	Slight	Unlikely	Low
Tank Filling	Slight	Unlikely	Low
Tank Emptying	Slight	Unlikely	Low
Low Tank Level	Slight	Unlikely	Low
Bauxite Feed Off	Minor	Possible	Medium
35N System Offline[19]	Moderate	Possible	Medium
25A Slurry Storage Fugitive Emissions			
Normal Operation	Slight	Unlikely	Low
Tank Filling	Slight	Unlikely	Low
Tank Emptying	Slight	Unlikely	Low
Low Tank Level	Slight	Unlikely	Low
Bauxite Feed Off	Slight	Unlikely	Low
35N System Offline[20]	Moderate	Possible	Medium

[19] Planned or unplanned maintenance.
[20] Planned or unplanned maintenance.

7. Odour Source Assessment

Attachment 6A provides an overview of emissions and discharges in relation to the proposed Project and Attachment 3B outlines an Environmental Commissioning Plan which includes an air quality verification program. Section 6 of this document is designed to be read in conjunction with Attachments 6A and 3B.

The odour emission profile of Wagerup Refinery is expected to change as a result of the proposed Project. The objectives of this OSA are to:

- Document baseline information, including odour emission rates, for those odour sources that will be modified as a result of the Project; and
- Provide information about predicted odour emissions after the Project is complete.

Attachment 3B outlines the expected impact of this Project on overall Refinery odour emissions.

7.1 Odour Sources

Odour sources are identified in the 2018 Wagerup Refinery Emission Inventory data. It includes 55 point sources and 12 fugitive sources. Figure 8 provides a map of the point sources within the refinery. Sources being modified by The Project that are predicted to have an odour emission change are listed in Table 7.

Table 7: Sources included in the Odour Source Assessment

Area	Source	Map reference
Slurry Storage (Building 25A)	25A-2 Tank Vent	25
	25A-4 Tank Vent	26
Powerhouse Boilers (Building 110)	Boiler 2 and 3 Multiflue	18

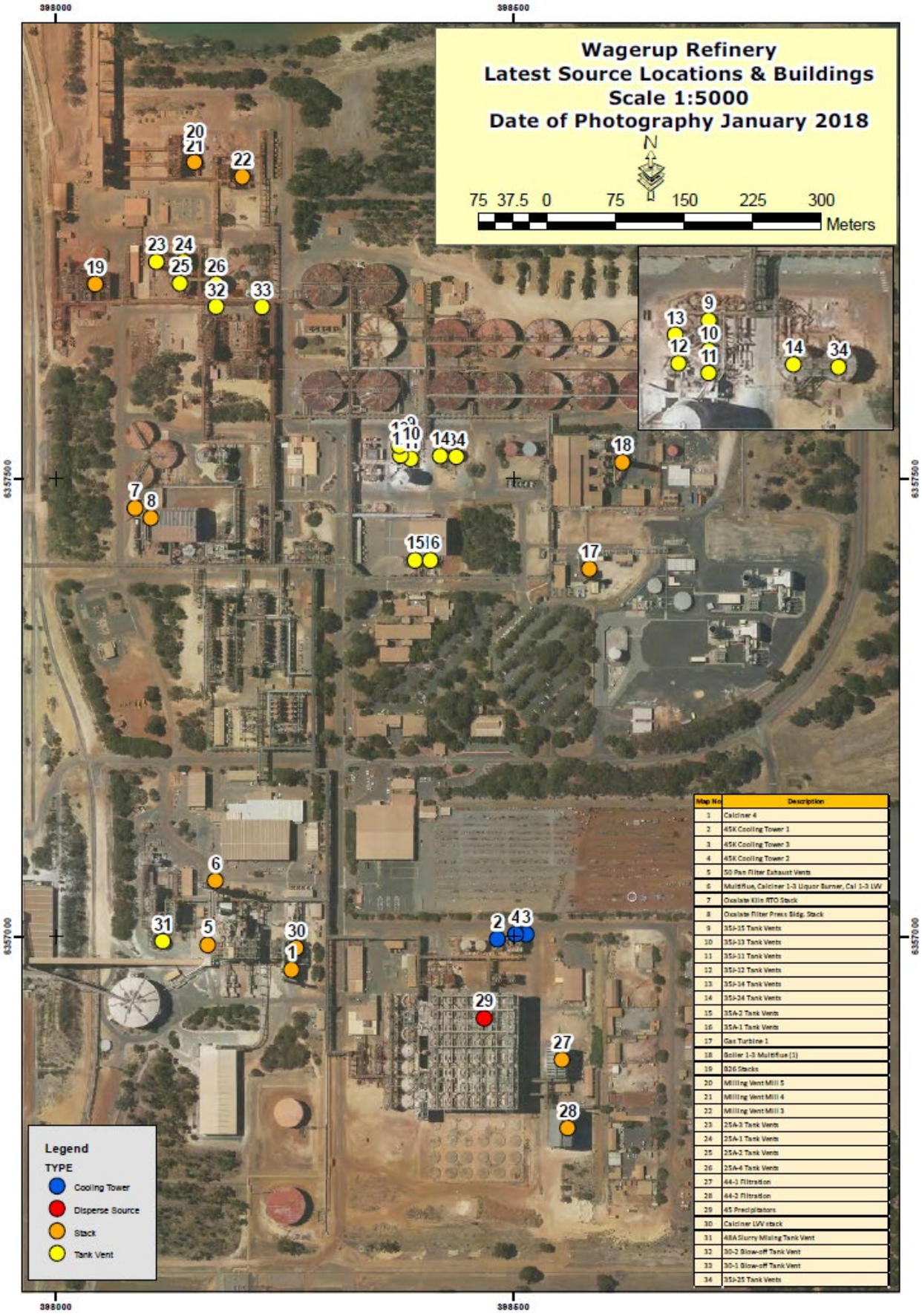


Figure 8: Wagerup Refinery emission source locations

7.2 Odour source information summary

7.2.1 Slurry Storage Tanks (25A tanks)

The slurry storage tanks have several functions, the primary purpose being to raise the temperature of the slurry which enhances the desilication reaction. Additionally, the Bauxite Slurry Storage Tanks provide an interface for surge capacity between the mills and the digestion process. The proposed Project will modify emissions from 2 of the 4 tanks, namely 25A2 and 25A4, which currently have one vent each. Refer to Attachment 3B for further information.

Source information for the 25A-2 and 25A-4 Slurry Storage Tanks is provided in Table 8. A summary of historic odour measurements is provided in Table 9. Note that some information is not available due to the age of the data.

Odour measurements have not been conducted for 25A-4. 25A-4 has similar operating conditions to 25A-2, and therefore odour emissions can be assumed to be similar to 25A-2.

Table 8: 25A Slurry Storage Tanks – Odour Source Information Summary

Description of the source/ reference/location	Slurry Storage Tanks 25A-2, 25A-4	**Map Reference**	
		25, 26	
Type of source	Point Source		
Dimensions	0.5 m (stack tip diameter)		
Elevation	25.4 m		
Planned operating conditions during sampling	Continuous, steady-state		
Sample location (Easting & Northing)	25A-2 Vent 25A-4 Vent	398280.132 398317.134	6357863.138 6357863.142
Planned sampling equipment	In accordance with AS/NZS 4323.3:2001		
Number of historic samples completed	18		
Planned number of samples for Environmental Commissioning	4 (25A-2 Vent), 4 (25A-4 Vent) (refer to Attachment 3A)		
Planned sampling times	Sample times will be determined in consultation with an accredited emissions sampling consultant. Sampling will be carried out in accordance with AS/NZS 4323.3:2001.		
Planned pre-dilution factor at the sampling stage	Predilution requirements will be determined in consultation with an accredited emissions sampling consultant. Sampling will be carried out in accordance with AS/NZS 4323.3:2001.		

Table 9: Historic Odour Information for 25A-2 Slurry Storage Tank Vent

Sampling Period	Method	Unit	Concentration (average)	Concentration (peak)	Concentration Range	No. Data points	Standard Deviation
2007	AS4323.3	OU/wet/Nm^3	14806	34360	697-34360	18	11372

7.2.2 Powerhouse Boilers 2 and 3 (Building 110)

The Wagerup powerhouse generates electricity and process steam (for process heating and generation of electricity) for the refining process by means of natural gas fired boilers and a Gas Turbine Heat Recovery Steam Generator. Currently, three boilers are in operation at Wagerup: Boilers 1, 2 and 3. The proposed Project will impact Boilers 2 and 3 (Refer to Attachment 3B for further information).

The 2018 Emission inventory included a program of work that was identified to further improve emissions estimates. This Improvement Program included testing of odour in the Powerhouse stacks in 2019.

Source information for Boilers 2 and 3 is provided in Table 10. A summary of historic odour measurements is provided in Table 11 and Table 12. Note that some information is not available due to the age of the data.

Table 10: Boilers 2 and 3 – Odour Source Information Summary

Odour source information summary			
Description of the source/ reference/location	Powerhouse Boilers 2 and 3.	**Map Reference**	
		18	
Type of source	Point Source (Multiflue)		
Dimensions	2.0m (stack tip diameter)		
Elevation	65 m		
Planned operating conditions during sampling	Continuous, steady state		
Sample location (Easting & Northing)	Boiler 2 Stack Boiler 3 Stack	398760.939 398760.939	6357660.418 6357660.418
Planned sampling equipment	In accordance with AS/NZS 4323.3:2001		
Number of historic samples completed	16 (Boiler 2), 12 (Boiler 3)		
Planned number of samples for Environmental Commissioning	8 (Boiler 2), 8 (Boiler 3)		
Planned sampling times	Sample times will be determined in consultation with an accredited emissions sampling consultant. Sampling will be carried out in accordance with AS/NZS 4323.3:2001.		
Planned pre-dilution factor at the sampling stage	Predilution requirements will be determined in consultation with an accredited emissions sampling consultant. Sampling will be carried out in accordance with AS/NZS 4323.3:2001.		

Table 11: Historic Odour Information for Boiler 2

Sampling Period	Method	Unit	Concentration (average)	Concentration (peak)	Concentration Range	No. Data points	Standard Deviation
2002-2019	AS4323.3	OU/wet/Nm^3	1033	3142	376-3142	16	695

Table 12: Historic Odour Information for Boiler 3

Sampling Period	Method	Unit	Concentration (average)	Concentration (peak)	Concentration Range	No. Data points	Standard Deviation
2002-2004	AS4323.3	OU/wet/Nm^3	727	1880	209-1880	14	454

8. Odour Field Assessment

Alcoa engaged Strategen-JBS&G to design and implement an odour field assessment program in July 2020. A report containing the details and results of the field assessment program is included as Appendix C to this document.

9. References

Air Assessments, 2005. Air Dispersion Modelling of Fugitive Emissions. Wagerup Refinery. Appendix D in Appendix G of Environment (2005). Wagerup Refinery Unit Three Expansion, Environmental Review and Management Program, May 2005.

Air Assessments, 2007. Wagerup Meteorological Measurements, June to October 2006. Report to Alcoa World Alumina, November 2007.

Air Assessments, 2015. Wagerup Alumina Refinery 2014 Air Quality Modelling. Prepared for Alcoa of Australia Limited. Final, December 2015.

Alcoa, December 2007. Wagerup Air Quality Technical Advisory Panel. Wagerup Air Quality Action Plan Sign-Off Report. Item 10 - Complaints Data Analysis.

Alcoa, August 2014. Alcoa Wagerup Air Quality Action Plan Sign Off Report prepared for the CSIRO Resolution Committee: Recommendation 16 – Meteorology and dispersion Processes.

Alcoa of Australia Ltd, 2020. 2018 Wagerup Refinery Emission Inventory, Prepared for August 2019 Section 46 Review of Conditions.

Department of Water and Environment, 2019. Guideline: Odour Emissions.

Riley, Geoff, December 2000, Review of Wagerup Odour Complaint Data, Alcoa Technology Delivery Group.

Appendix A : Screening Analysis Report

Screening analysis

Instructionsapplication
Applicants undertake a screening analysis to assess whether further detailed analysis of odour emissions and impacts is required. The analysis primarily involves comparison of the **screening distance** (*Appendix 2*), with the **sensitive receptor distance** (*Appendix 3*), together with consideration of other information. Screening distances are not provided for some activities. In these instances, applicants are generally required to undertake a detailed analysis. Applicants are required to provide sufficient information with their application to enable the Department to substantiate the screening analysis. Separate screening procedures are provided for applications for new or existing premises. The Screening analysis comprises three steps: **Step 1:** Complete the questionnaire relevant to the application (for new or existing premises) **Step 2**: Use the flowchart and questionnaire responses to determine whether a Detailed analysis is required **Step 3**: Compile information to support the Screening analysis. This can include maps of sources and receptors, topographical maps, specifications for proposed emissions controls and details of **screening distance** calculations. If an industry category is not listed in Appendix 2 and the odour risk is considered to be low by the applicant, an exemption from the requirement for Detailed analysis may be granted by the Department. In these cases, the Department can be contacted before commencing preparation of an application. Questionnaires and flowcharts for new or existing premises are shown below. An electronic version of the questionnaire for new or existing premises is available on the Department website.

Screening analysis for existing premises

Step 1: Questionnaire

Q1. Description of odour emissions Use the table below to provide brief information about activities and sources that emit odour.	
Activity / odour source	**Description, including proposed controls** **New source? (Yes or No)**
Alumina Refining (Bayer Process)	Alumina Refining – Bayer Process Emission Reduction Project. Redirection of point source odour emission to the Power House Boilers for destruction.

Q2. Identification of current odour impacts	
Have odour impacts occurred as a result of the current operational configuration and / or practices? Please tick all applicable boxes: ☒ Complaints ☐ Odour diaries ☒ Field odour assessments ☒ Community feedback ☐ Other._____	☒ **YES** or **Can't determine:** Go to flowchart. ☐ **NO:** Go to Question 3.

Q3. Changes to emissions	
Are there proposed changes to the existing premises that are likely to increase the odour emissions, or change the configuration of any source in the facility?	☐ **YES** or **Can't determine:** Go to Question 4. ☐ **NO:** Go to flowchart.

Q4. Screening distances	
Screening distances for categories of odour-generating activities are identified in Appendix 2. Select the appropriate option from the list below.	
Option 1: The **screening distance** is listed in *Appendix 2* for this industry category and throughput level. ***Screening distance*** (**A**) = _____m ***Sensitive receptor distance*** (**B**) = _____m **OR** **Option 2**: The **screening distance** for this industry category and throughput level is specified as 'case-by-case' in Appendix 2. **OR** **Option 3**: There is no entry for this industry category in Appendix 2.	☐ **B < A**: Go to flowchart. ☐ **B ≥ A**: Go to Question 5. ☐ **Case-by-case**: Go to flowchart. ☐ **Industry category not listed**: Go to flowchart.
Q5. Special case factors	

Are there special case factors that might increase odour impacts beyond the **screening distance** shown in Question 4? Please tick all applicable special case factors: ☐ Odour impacts from other nearby sources ☐ Presence of an existing elevated odour background ☐ Complex terrain (*Glossary*) ☐ Unusually large and/or complex facility when compared with other Australian operations ☐ Unusual configuration of odour sources compared with other Australian operations ☐ The premises is located in a Strategic Industrial Area (SIA) ☐ Multiple industry categories which emit odour are present on the same site	☐ **YES** or **Can't determine**: Go to flowchart. **OR** ☐ **NO**: Go to flowchart. Justification should be provided to support a 'No' response.

Special case factors – justification for 'NO' response.
Additional Comments.

Step 2: Flowchart - existing premises

The Screening analysis result is determined using the flowchart below and responses to the questionnaire overleaf.

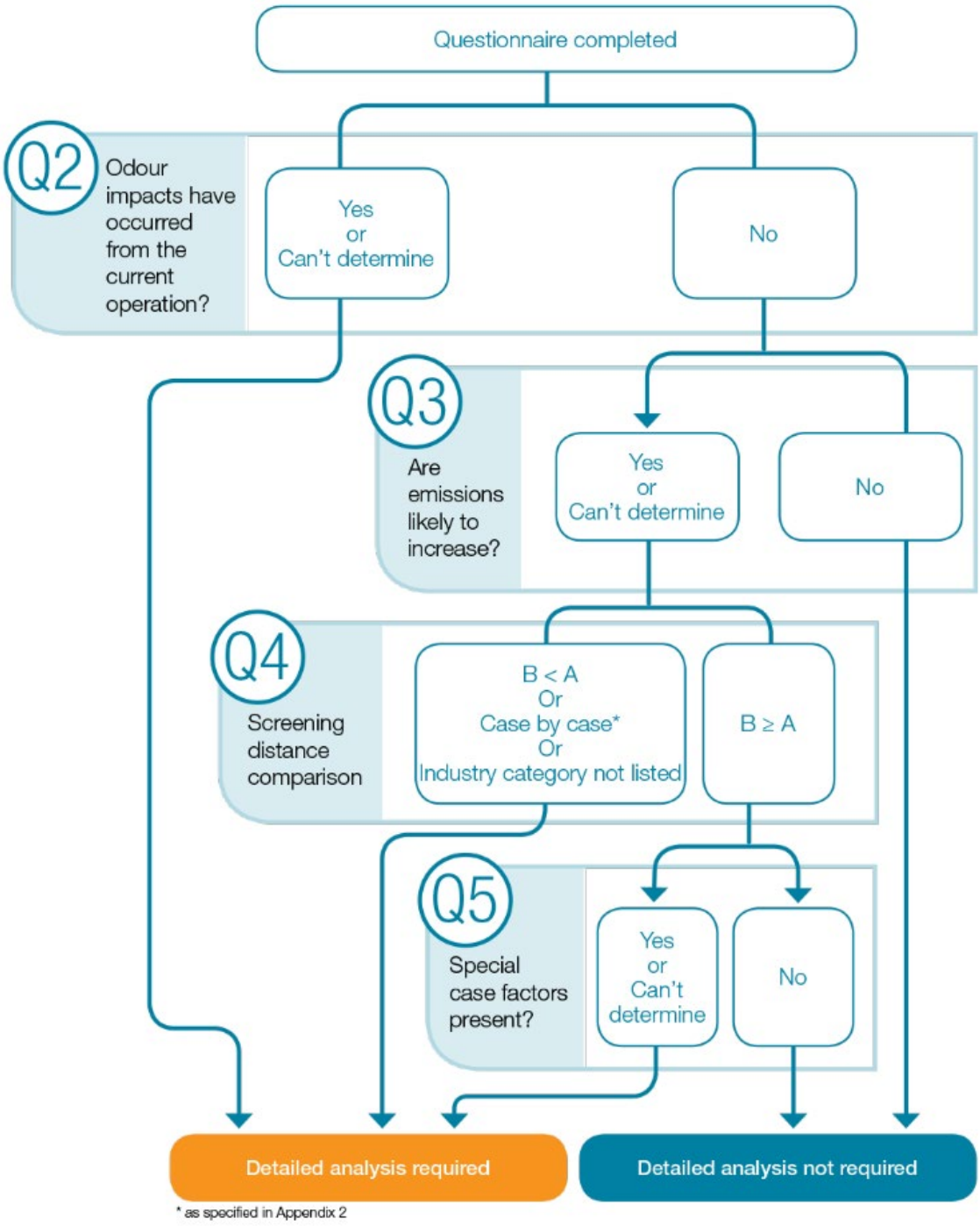


Figure A1: Screening analysis for existing premises

Appendix B: Complaints Data

Table B1: Detailed Complaints Data from January 2015 to December 2020

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
19/02/2015 0:35	18/02/2015	19:00 - 21:00	Neighbour could smell a refinery-based odour that lingered between 7-9pm.	Wind direction 226° Wind Speed: 2.4 m/sec Temperature: 24.5 degrees Humidity: 62% Barometer: 1007.7 hPa Generally clear conditions	Direct
4/03/2015 18:10	04/03/2015	18:00	Neighbour could smell a strong refinery-based smell. Neighbour described the odour as "smelling like a pole cat". Neighbour advised that the odour hung about for approximately 10-25 minutes before dissipating.	Wind Direction: 87° Wind Speed: 4.3 m/sec Temperature: 30.2 Humidity: 27% Barometer: 1012.2 hPa	Direct
29/04/2015 0:15	29/04/2015	11:15 - 12:15	Neighbour could smell a strong, heavy duty wet cement smell. A shifting breeze was moving about.	Wind direction:19.5° Wind speed: 4.4 m/sec Temperature: 22.1°C Humidity 37% Barometer:1012.5 hPa Conditions: Relatively clear.	Direct
30/04/2015 15:42	29/04/2015	11:45	DWER received complaint stating, 'complainant described strong 'wet cement' odour that caused a headache'.	Wind Direction: 18° Wind Speed: 4.4m/s Ambient Temperature: 22.1°C Humidity: 37% Barometer: 1012.5 hPa	Indirect (DWER)
22/05/2015 13:40	22/05/2015	13:30	Neighbour could smell strong pungent odour that smelt incredibly strong for 20 minutes. Advised the odour 'Stinks like a pole cat'.	Wind Direction: 77° Wind Speed: 3.4 m/sec Temperature: 18.8°C Humidity: 48% Barometer: 1011.6 hPa Generally clear conditions.	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
11/06/2015 21:30	11/06/2015	21:15	Neighbour could smell a wet cement cell with a sickly, sweet odour.	Wind direction 96° Wind speed: 2.1m/sec Temperature: 18.1°C Humidity: 79% Barometer: 1012.6 hPa	Direct
3/07/2015 0:33	03/07/2015	12:15 - 13:15	Neighbour could smell a strong refinery odour smell. Advised it was a bit stronger than usual and slightly overwhelming. Odour dissipated by 13:00.	Wind Direction: 301° Wind Speed: 2.2m/sec Temperature:18.8°C Humidity: 70.5% Barometer: 1016.6 hPa	Direct
23/07/2015 8:53	03/07/2015	09:30	DWER received complaint regarding strong 'wet cement' odour and visible smoke coming from the Alcoa Wagerup stacks. Complainant reported a burning nose, stinging eyes, blistered skin, itchiness and breathing difficulties.	Wind Direction: 341° Wind Speed: 2.5m/sec Temperature: 16.9°C Humidity: 92% Barometer: 1018hPa	Indirect (DWER)
7/07/2015 0:41	07/07/2015	00:35	Neighbour could smell a strong refinery odour. Advised there were low clouds overhead and a light breeze mostly from the north, conditions the neighbour felt might contribute to trapping odour.	Wind Direction: 293° Wind Speed: 2.0m/sec Temperature: 14.5°C Humidity: 99% Barometer: 1016hPa	Direct
8/07/2015 19:13	08/07/2015	19:08	Neighbour could smell a strong refinery style odour that could be smelt inside the home. Seemed to be a sudden change in air odour.	Wind Direction: 140° Wind Direction: 2.7m/sec Temperature: 9.4°C Humidity: 85% Barometer: 1024.4 hPa	Direct
28/07/2015 11:21	24/07/2015	10:00	DWER received complaint regarding a strong 'wet cement' odour with health impacts of burning throat, stinging eyes, chest pain and asthma.	Wind Direction: 330° Wind Speed: 1.3m/sec Temperature: 12.3 Humidity: 74% Barometer: 1024.7 hPa	Indirect (DWER)

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
22/08/2015 16:45	22/08/2015	16:45	Neighbour could smell odour inside home. Advised odour 'passed on' after 30 mins or so.	Wind Direction: 154° Wind Speed: 3m/sec Temperature: 15.3°C Humidity: 63.5% Barometer: 1014.7 hPa	Direct
26/08/2015 14:00	23/08/2015	13:00	Neighbour advised that odour came through Yarloop for about 20-30 minutes at about 1300. It wasn't as strong as previous night but was detectable. It had that wet cement smell to it.	Wind Direction: 102° Wind Speed: 4.7m/sec Temperature: 14.5°C Humidity: 61% Barometer: 1022.9 hPa	Direct
7/09/2015 20:30	07/09/2015	20:30	Neighbour could smell a strong wet cement smell that lingered for about 20-30 minutes.	Wind Direction: 123° Wind Speed: 3.2m/sec Temperature: 14.9°C Humidity: 86% Barometer:1022.7 hPa	Direct
20/10/2015 13:03	20/10/2015	13:03	Neighbour could smell an odour that lingered for about 10 minutes at 13.00. It was a general refinery smell.	Wind Direction:199° Wind Speed: 3.3m/sec Temperature: 23.9 Humidity: 33% Barometer: 1012.6 hPa	Direct
7/11/2015 18:48	07/11/2015	18:14	Neighbour could smell an odour believed to be similar to odour smelt on previous two evenings. Quickly dispersed the previous night, but on this occasion lingered for more than 10 minutes.	Wind Direction:166.7° Wind Speed: 3.2m/sec Temperature: 20.8°C Humidity: 55.3% Barometer: 1008.9 hPa	Direct
11/03/2016 8:55	07/03/2016	09:00	DWER received complaint reporting an 8/10 intensity wet cement odour that started at 9.00am. Was still strong at 4:35pm. At 6:12pm windows could be opened. Reported health impacts were dizziness, sickness and inability to lift their head.	Wind Direction:87° Wind Speed: 10.9m/sec Temperature: 22.1°C Humidity: 56% Barometer:1013.9 hPa	Indirect (DWER)
30/03/2016 8:11	30/03/2016	07:50	Neighbour could smell a wet cement smell just before 8am when walking outside home in Yarloop. The odour hung around for about 15 minutes. Neighbour advised there was only the barest wind movement from the north. Neighbour considered the odour to be present around the time of day when the air temperature was starting to increase from a cool night.	Wind Direction:336° Wind Speed: 2.4m/sec Temperature: 18.5°C Humidity: 68.7% Barometer: 1019.0 hPa	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
4/05/2016 8:50	04/05/2016	08:30	Neighbour went outside to walk dog and could smell a strong industrial smell of sulphur. Advised they had never smelt anything that strong in town before.	Wind Direction:348.2° Wind Speed: 2.1m/sec Temperature: 16.1°C Humidity: 88.5% Barometer: 1013.5 hPa	Direct
10/05/2016 10:38	10/05/2016	09:30	Neighbour could smell a sulphur acrid type odour in the town when outside. Did not believe it related to any other activities happening in town (bushfire clean up) and felt it was coming from the refinery.	Wind Direction:359.5° Wind Speed: 3.3m/sec Temperature: 16.8°C Humidity: 97.1% Barometer: 1023.78 hPa	Direct
11/05/2016 9:50	10/05/2016	10:00	DWER received complaint about a very strong unpleasant acrid burning sulphur type odour in Yarloop.	Wind Direction:352.5° Wind Speed: 2.8m/sec Temperature: 18°C Humidity: 69.8% Barometer: 1023.0 hPa	Indirect (DWER)
20/05/2016 10:08	20/05/2016	09:15	Neighbour could smell a sulphur bleachy type odour when walking the family dog in the main part of Yarloop townsite.	Wind Direction:276.1° Wind Speed: 1.8m/sec Temperature: Unavailable. Humidity: 83.2% Barometer: 1008.1 hPa	Direct
11/06/2016 19:55	11/06/2016	19:40	Neighbour could smell a strong plastic like hydrate type odour.	Wind Direction:22.5° Wind Speed: 5.8m/sec Temperature: 16.9°C Humidity: 55.3% Barometer: 1017.7 hPa	Direct
27/06/2016 8:20	19/06/2016	11:15	DWER received complaint about a strong wet cement odour. The complainant advised that at the time the wind was from the north. The complainant developed a sore throat, stinging eyes and asthma like symptoms. Ventolin was required to restore normal lung function.	Wind Direction: 347.2° Wind Speed: 5.0m/sec Temperature: 15.6°C Humidity: 73.1 Barometer: 1005 hPa	Indirect (DWER)
21/06/2016 10:02	21/06/2016	09:50	Neighbour could smell an industrial odour in Yarloop near her home. Neighbour advised it reminded them of an odour from when they lived near Beacham Pharmaceuticals in England.	Wind Direction:246° Wind Speed: 0.2m/sec Temperature: 11.3°C Humidity: 95.3	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
				Barometer: 1013.1 hPa	
21/07/2016 10:25	15/07/2016	17:00	DWER received complaint about a strong wet cement odour. Complainant developed a sore throat, stinging eyes and asthma like symptoms and needed to use Ventolin. Complainant advised they took video footage showing calciner 4 emissions at ground level.	Wind Direction:348.3° Wind Speed: 4.5m/sec Temperature: 17.5°C Humidity: 69.8% Barometer:1009.5 hPa	Indirect (DWER)
19/07/2016 0:00	19/07/2016	10:30	Neighbour could smell a wet cement smell at family home.	Wind Direction:291.9° Wind Speed: 1.0m/sec Temperature: 11.4°C Humidity: 86.2% Barometer: 1020.2 hPa	Direct
21/10/2016 14:37	05/10/2016	16:10	Neighbour could smell a very strong wet cement type odour for about 2 hours.	Wind Direction:304.8° Wind Speed: 6.6m/sec Temperature: 18.4°C Humidity: 61.2% Barometer: 1002.5 hPa	Direct
21/10/2016 11:52	07/10/2016	16:00	Neighbour could smell a very strong odour that caused irritation to the nose, eyes and a headache.	Wind Direction:309.5° Wind Speed: 5.3m/sec Temperature: 2035°C Humidity: 59.8% Barometer: 1002.5 hPa	Direct
27/10/2016 9:24	25/10/2016	08:00	DWER received a complaint about a strong wet cement odour. Complainant reported severe health impacts consisting of asthma, sore throat and sore eyes requiring multiple does of Ventolin.	Wind Direction:7.1° Wind Speed: 2.8m/sec Temperature: 12.4°C Humidity: 71.6% Barometer: 1012.4 hPa	Indirect (DWER)
31/05/2017 7:59	31/05/2017	07:50	Refinery worker could smell strong refinery odour at the Farmlands offices.	Wind Direction:212.8° Wind Speed: 2.8m/sec Temperature: 11.0°C Humidity: 84.1% Barometer: 1017.8 hPa	Direct
12/06/2017 13:04	12/06/2017	09:30	Neighbour could smell a strong wet cement odour intermittently throughout the morning. It was irritating to the throat, caused some coughing and dryness in the throat. Remained until approximately 13:00.	Wind Direction:18.8° Wind Speed: 6.8m/sec Temperature: 16.4°C Humidity: 29.2%	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
				Barometer: 1016.1 hPa	
15/06/2017 10:05	14/06/2017	10:30	Neighbour could smell a strong odour during the morning from after 9 am until nearly midday. It wasn't as strong as other times but was present and irritating.	Wind Direction:153.5° Wind Speed: 2.3m/sec Temperature: 15.4°C Humidity: 70.9% Barometer: 1016.5 hPa	Direct
6/07/2017 10:26	06/07/2017	09:30	Neighbour could smell an odour between 9-10 am that was starting to clear away as the day warmed up and the sun came out. Described the odour as a strong wet cement type of smell.	Wind Direction:325.4° Wind Speed: 1.5m/sec Temperature: 6.2°C Humidity: 98.9% Barometer: 1022 hPa	Direct
5/06/2018 7:53	31/05/2018	08:15	DWER received complaint about strong caustic smell between 08:15 to 09:30 on 31 May 2018. Presence of odour was associated with stinging eyes, burning throat and nose.	Wind Direction:357.9° Wind Speed: 5.0m/sec Temperature: 13.8°C Humidity: 77.2% Barometer: 1006.9 hPa	Indirect (DWER)
12/06/2018 17:22	04/06/2018	11:00 - 15:00	DWER received complaint about a strong caustic smell from direction of refinery, associated with burning throat and runny nose between 11:00 to 15:00.	Wind Direction:16.6° Wind Speed: 0.9m/sec Temperature: 15.3°C Humidity: 79.5% Barometer: 1008.8 hPa	Indirect (DWER)
12/06/2018 17:04	08/06/2018	13:30	DWER received complaint about strong caustic smell from direction of mud lakes and refinery, associated with stinging eyes, burning throat and skin irrigation. Odour present from 13:30 to 13:56.	Wind Direction:342.9° Wind Speed: 4.2m/sec Temperature: 13.0°C Humidity: 61.8% Barometer: 1011.8 hPa	Indirect (DWER)
12/06/2018 17:15	08/06/2018	13:30	DWER received complaint about a strong caustic odour from direction of refinery, associated with burning nose and throat. Odour present at 13:30.	Wind Direction:342.9° Wind Speed: 4.2m/sec Temperature: 13.0°C Humidity: 61.8% Barometer: 1011.8 hPa	Indirect (DWER)
12/06/2018 17:17	09/06/2018	05:45	DWER received complaint about a strong caustic smell from direction of mud lakes and refinery, associated with stinging eyes, burning throat/nose and asthma. Odour present from 05:45 to 15:00.	Wind Direction:355° Wind Speed: 7.5m/sec Temperature: 11.3°C Humidity: 79.9%	Indirect (DWER)

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
				Barometer: 1010.0 hPa	
12/06/2018 17:19	09/06/2018	05:45	DWER received complaint about a strong caustic smell from direction of refinery, associated with burning throat and nose. Odour present from 05:45 to 15:00.	Wind Direction:355° Wind Speed: 7.5m/sec Temperature: 11.3°C Humidity: 79.9% Barometer: 1010.0 hPa	Indirect (DWER)
29/06/2018 11:25	17/06/2018	09:55	DWER received complaint about odour.	Wind Direction:14.9° Wind Speed: 5.7m/sec Temperature: 16.1°C Humidity: 37.8% Barometer: 1012.7 hPa	Indirect (DWER)
29/06/2018 11:28	17/06/2018	14:00	DWER received complaint about odour.	Wind Direction:346.2° Wind Speed: 5.3m/sec Temperature: 20.1°C Humidity: 31.7% Barometer: 1007.5 hPa	Indirect (DWER)
29/06/2018 11:30	19/06/2018	10:30	DWER received complaint about odour.	Wind Direction:2.8° Wind Speed: 4.3m/sec Temperature: 11.9°C Humidity: 100% Barometer: 1021.6 hPa	Indirect (DWER)
8/10/2018 8:51	11/08/2018	09:00	DWER received complaint about odour.	Wind Direction:297.6° Wind Speed: 0.9m/sec Temperature: 7.4°C Humidity: 100% Barometer: 1028.6 hPa	Indirect (DWER)
27/11/2018 0:31	27/11/2018	00:30	Neighbour could smell a chemical type odour at residence. It made her mouth taste a bit funny and had been about for 10-20 minutes prior to the call.	Wind Direction:97.7° Wind Speed: 5.7m/sec Temperature: 11.4°C Humidity: 58.4% Barometer: 1014.4 hPa	Direct
30/04/2019 10:55	22/04/2019	08:50	DWER received complaint about strong caustic (wet cement) odour causing sore throat and stinging eyes.	Wind Direction:8.7° Wind Speed: 3.4m/sec Temperature: 17.5°C Humidity: 38.5	Indirect (DWER)

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
				Barometer: 1019.8 hPa	
30/04/2019 10:57	22/04/2019	10:10	DWER received complaint about strong caustic (Wet cement) odour. Odour caused asthma attack requiring Ventolin.	Wind Direction:351.2° Wind Speed: 4.0m/sec Temperature: 19.7°C Humidity: 34.3% Barometer: 1018.4 hPa	Indirect (DWER)
02/04/2020 07:45	02/04/2020	07:00	Neighbour reported caustic odour from the residue lakes from approximately 7am.	Wind Direction:169.2° Wind Speed: 2.1m/sec Temperature: 14.1°C Humidity: 89% Barometer: 1008 hPa	Direct
10/04/2020 18:17	10/04/2020	18:17	Neighbour reported smelling a strong caustic odour at their home on Buller Rd. This neighbour had recently complained as they believed the removal of a group trees previously planted on a property south of his farm helped stop the odour reaching their property. They believed the odour comes from the caustic lakes not the refinery.	Wind Direction:166.1° Wind Speed: 2.4m/sec Temperature: 27.7°C Humidity: 46.3% Barometer: 1008.9 hPa	Direct
14/04/2020 08:17	14/04/2020	07:30	Neighbour texted through to register that they could detect a strong caustic smell at their residence. They are concerned that the removal of a tree belt south of their property outside of Area A has contributed to odour reaching the property and compromised the visual amenity of residue in relation to their property. Has stated they would like Area A changed and their property purchased at their price.	Wind Direction: 133.1° Wind Speed: 1.6m/sec Temperature: 12.5°C Humidity: 94.3% Barometer: 1014.6 hPa	Direct
13/08/2020 09:11	13/08/2020	08:40	Neighbour reported a wet cement type smell that had stayed around since 8:40 am. Said that she only occasionally gets an odour smell then it's gone. Sometimes this is just before a storm front hits. This smell lingered and had her wondering if we had something wrong at the plant	Wind Direction: 271.8° Wind Speed: 0.5m/sec Temperature: 7.1°C Humidity: 90.7% Barometer: 1016.2 hPa	Direct
20/03/2021 18:59	20/03/2021	18:59	Neighbour sent a text to the Community Relations Manager regarding a strong odour he believed had a calciner type smell about it.	Wind Direction: 186° Wind Speed: 3.1m/sec Temperature: 25.2°C Humidity: 33.4% Barometer: 1005.3 hPa	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
24/03/2021	23/03/2021	18:45	Neighbour texted through on March 24th to say, "caustic odour smell my way as of late mainly evening nights very strong yesterday evening at 18:45."	Wind Direction: 193° Wind Speed: 2.7m/sec Temperature: 16.8°C Humidity: 62.7% Barometer: 1008.5 hPa	Direct
26/03/2021 19:34	26/03/2021	19:34	Neighbour texted through concern of a strong caustic odour at his home.	Wind Direction: 176° Wind Speed: 2.7m/sec Temperature: 16.7°C Humidity:62.9% Barometer: 1010.5 hPa	Direct
29/03/2021 07:29	29/03/2021	07:29	Neighbour texted through “strong caustic odour inside of house with door open overnight”.	Wind Direction: 123.6° Wind Speed: 1.5m/sec Temperature: 16.5°C Humidity: 66.8% Barometer: 1010.1 hPa	Direct
31/03/2021 19:51	31/03/2021	19:51	Neighbour texted through "strong caustic smell can be smelt inside of house".	Wind Direction: 161.6 Wind Speed: 2.9m/sec Temperature: 19.4°C Humidity: 81.7% Barometer: 1009.6 hPa	Direct
01/04/2021 18:24	01/04/2021	18:24	Neighbour texted through “he can detect a strong caustic smell again this evening.”	Wind Direction: 146.9° Wind Speed: 2.0m/sec Temperature: 25.2°C Humidity: 47.8% Barometer: 1001.8 hPa	Direct
14/04/2021 07:12	13/04/2021	21:15	Neighbour texted through his complaint for the evening of the 13th April at the same time as one for the morning of the 14th April. Reporting a "strong caustic odour last night at 9.15 pm and this morning at 6.15am"	Wind Direction: 141.9° Wind Speed: 2.8m/sec Temperature: 12.5°C Humidity: 72.3% Barometer: 1020.6 hPa	Direct
14/04/2021 07:12	14/04/2021	06:15	Neighbour texted through that he experienced a "strong caustic odour last night at 9.15 pm and this morning at 6.15am"	Wind Direction: 252.9° Wind Speed: 0.8m/sec Temperature: 6.7° Humidity: 95.4%	Direct

Contact Date & Time	Issue Date	Issue Time	Issue Comments	Meteorology	Contact type
				Barometer: 1023.1 hPa	
21/04/2021 07:22	20/04/2021	21:00	Neighbour texted Community Relations manager at 7.22 am “Strong caustic odour at 9 o'clock last night when I went outside”.	Wind Direction: 222° Wind Speed: 2.3m/sec Temperature: 13.9°C Humidity: 91.8% Barometer: 1017.4 hPa	Direct
07/05/2021 09:29	07/05/2021	09:29	Neighbour texted through in regard to a strong caustic odour at his property on Buller Rd round 9.30 am.	Wind Direction: 155.9° Wind Speed: 2.8m/sec Temperature: 15.1°C Humidity: 89.1% Barometer: 1016.1hPa	Direct
19/05/2021 17:32	19/05/2021	17:32	Neighbour texted through in regard to a strong caustic odour smell at the time at his property on Buller Rd.	Wind Direction: 147.4° Wind Speed: 2.0m/sec Temperature: 16.7°C Humidity: 72.7% Barometer: 1014.4hPa	Direct
31/05/2021 17:05	31/05/2021	17:05	Neighbour texted through saying "Stepped outside caustic smell odour"	Wind Direction: 188.5° Wind Speed: 2.8m/sec Temperature: 13.2°C Humidity: 70.2% Barometer: 1013.6hPa	Direct
22/07/2021 07:41	21/07/2021	21:30	Neighbour texted through on 22nd July in regard to an odour complaint from the previous night at 9.30 pm.	Wind Direction: 187.3° Wind Speed: 2.1m/sec Temperature: 10.6°C Humidity: 92.3% Barometer: 1012.6hPa	Direct

Appendix C : Odour Field Assessment Report

Alcoa of Australia

Odour Field Assessments
Wagerup Refinery

27 November 2020

5779/131,802 (Rev 0)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

Table of Contents

List of Tables

List of Figures

Appendices

1. Introduction

Alcoa of Australia (Alcoa) operates the Wagerup Alumina Refinery to produce alumina from bauxite mined at the nearby Willowdale mine site, with environmental approvals provided under both Part IV (Ministerial Statement MS 728) and Part V (Licence L6217/1983/15) of the *Environmental Protection Act 1986*. The refinery is currently licenced to produce 2.85 million tonnes of alumina per annum (Mtpa).

Assessments of future air emissions and odour impacts would be required as part of the approvals process for any future expansions works that has the potential to change emissions. In respect of odour emissions, an understanding of the current odour emission footprint is a pre-requisite to assess the potential changes in odour emissions from an expanded refinery. Odour emissions have historically been evaluated from source measurements and dispersion modelling, as well as from field studies that examine the extent and significance of odour emission impacts at locations in the nearby communities.

In June 2019, the Department of Water and Environmental Regulation (DWER) published an updated guideline for assessment of odour emissions (the Odour Guideline; DWER 2019). That document supersedes the 2002 *Odour Methodology Guideline* (DEP 2002) with significant changes in the approach and methodology specified in the Odour Guideline for assessment of odours.

Alcoa has previously engaged Strategen-JBS&G to review historical reports on ambient odour assessments carried out from 2007 to 2015 to determine their suitability to provide a baseline from current refinery operations (Strategen-JBS&G 2020).[1] Those historical assessments were conducted using the 2002 methodology which has been superseded by the Odour Guideline.

The review concluded that the historical data are unlikely to reflect the current odour impacts and an additional ambient odour assessment program is required to generate an odour emission impact baseline representative of current refinery operating conditions and emission controls using methodology prescribed in the Odour Guideline.

To that end, Alcoa engaged Strategen-JBS&G to design and implement an ambient odour assessment program for the refinery operations that meets the requirements of section A4-3 of the Odour Guideline. This includes Odour Field Assessments that will form the baseline for current refinery operations using the DWER 2019 odour Guideline methodology. The design of the program and results from the field work are presented in this report.

[1] Includes Residue Storage Area (RSA) operations

2. Objective

The primary objective of the Odour Field Assessment program described in this report is to provide a baseline of odour impacts for current refinery and residue operations, using the most recent odour assessment methodology prescribed by DWER, that will supersede previous assessments conducted from 2007-2015. The previous assessments reflected the odour emissions impacts at the time, as assessed using methodology from 2002. Various odour emission controls have since been implemented which are expected to have reduced the extent of impacts at off-site locations. As such a new study has been commissioned that will utilise the current methodology.

3. Terminology

A range of terminologies have been historically used by the regulators and odour practitioners for assessment of odour intensities in the environment. The terminology adopted by DWER has been used in this report to ensure consistency with the Odour Guidelines. Details of current and historical terminology is provided in Table 3.1.

Table 3.1: Ambient odour assessment terminology

Term	Description	Reference	Comment
Odour field assessment (OFA)	A program of targeted field surveys and analysis designed to characterise ambient odour for new and existing premises	DWER 2019	Previously known as field odour assessments and field odour surveys (see Envall reports)
Measurement cycle	A discrete assessment of odour intensity conducted at a location over a 10 minute period, involving recording of odour intensity scores every 10 seconds	DWER 2019	Equivalent to "field odour assessment" from Envall (2006, 2015)
Field odour survey(s) or odour survey(s)	A number of individual odour assessments, each of 10 minute duration	Envall 2006, 2015	
Field odour assessment or Odour assessment	A discrete assessment of odour intensity conducted over a 10 minute period, involving recording of odour intensity scores every 10 seconds	Envall 2006, 2015	Equivalent to "measurement cycle" from DWER (2019)
Intensity or odour intensity	The relative perceived strength of odour	DWER 2019	Quantified using a numerical scale from 0 to 6
Assessor or panellist	A person who carries out odour field assessments	DWER 2019	DWER definition: "A person or group of people who have been tested and are qualified to undertake odour measurements in an odour laboratory or in the field in compliance with AS 4323.3:2001 and EN 16841-2 and VDI 3940-3 standards respectively."
Assessment campaign	A discrete number of measurement cycles conducted over consecutive days as part of an OFA	This report	

4. Previous odour assessments

A review of four odour field studies previously carried out by Environmental Alliances (Table 4.1) has been carried out (Strategen-JBS&G 2020). Those odour studies were conducted with consideration to the relevant guideline at that time, i.e. DEP 2002, which have been superseded by the Odour Guideline. The requirements of those guidelines were considered during the review process to determine if the historical data are relevant in light of changes to odour assessment guidelines from 2002 to 2019.

The locations processes, odour impact history and local meteorological and topographical conditions were considered as part of this review.

Table 4.1: Historical reports

Report	Author	Publication date
Alcoa Wagerup Odour and VOC Monitoring and Modelling Plan. Field Odour Surveys 2015.	Environmental Alliances	October 2015
Alcoa Wagerup Refinery Field Odour Surveys Winter 2007	Environmental Alliances	October 2007
Alcoa Wagerup Refinery Field Odour Surveys Winter 2006	Environmental Alliances	March 2007
Alcoa Wagerup Refinery Residue Disposal Areas Field Odour Surveys June 2005	Environmental Alliances	October 2005

Key finding from the review were:

- Historical OFA data (as intensity scores) from 2006 and 2015 campaigns can inform spatial extent of odour impacts for various weather conditions to assist with the planning for development of the pre-expansion odour baseline.
- Conversion of historical intensity scores into scoring format from the Odour Guideline was problematic and not recommended.
    - This suggests new OFAs are required to generate intensity data consistent with the new guideline methodology.
- Calculation of odour concentrations from intensity scores and dispersion modelling to predict Ground Level Concentrations (GLCs)for comparison is no longer supported by DWER and is not recommended for the baseline.
- The use of criteria modelling to assess risk of amenity impacts is not favoured by DWER thus is not required for the baseline.
    - The baseline (pre-expansion) data will be compared with post-expansion data to ascertain extent of any change in odour impacts.
    - The acceptability of odour impacts post-expansion requires development of impact criteria, which DWER has not included in the Odour Guideline.
- DWER has rejected the use of the odour-hour concept to inform likely impacts on amenity.
    - A multi-percentile based criteria is advocated but further research is required to generate a robust protocol that informs likelihood of loss of amenity based on field observations.
- The historical odour assessment reports do not include any information or data on refinery process operating conditions. As such the use of historical data to provide a baseline representative of current operating conditions (and associated odour emission footprint) is problematic.
    - In particular, it is not known if the differences observed in 2015 results compared with 2006 data is due to change in process operating conditions or natural variability in emissions or differences in meteorology, or combination of some or all of these factors.

- A new field odour campaign was recommended to provide data consistent with the Odour Guideline that is representative of odour emissions from pre-expansion operating conditions.

5. Approach and Methodology

5.1 Odour assessment methodology

The Odour Guideline describes a framework for conducting OFAs. The OFA methodology as summarised below, is based on German Standard VDI 3940 Part 3 and European Standard EN16841-2:2016.

The assessors tracked odour plumes from the refinery at downwind locations by smelling the odours using a standard protocol. The protocol involves the assessors walking across the direction of prevailing wind and stopping approximately every 10-20 m to assess the presence of the odour.

Once the extent of the odour plume is established, measurement cycles are carried out at suitable locations across the plume to determine the variability by rating the odour intensity (OI) every 10 seconds using a zero to six numerical scale (Table 5.1) over a ten-minute period. A total of 60 observations are made at each odour measurement cycle location, i.e., each measurement cycle. The score definitions reflect the strength of odour (of a particular character from a known source) above the recognition threshold, i.e. a very weak odour means a very weak refinery odour, and not a very weak unidentified odour from an unknown source.

Table 5.1: Odour intensity scale Intensity score

Intensity score	Descriptor	Comment
0	Nil odour	No odour was detected
1	Very weak odour	Recognition threshold where odour from a particular source is evident, but only just evident
2	Weak odour	Odour from the source is more clearly evident
3	Distinct odour	Odour is well established
4	Strong odour	Odour is stronger
5	Very strong odour	Odour is stronger again and becomes quite unpleasant
6	Extremely strong odour	Totally unpleasant odour, assessor could only tolerate for short periods

Odour character was recorded using the following descriptors based on the types of odour associated with the refinery (Table 5.2).

Table 5.2: Odour character

Code	Descriptor
A	Wet cement
B	Digestion
C	Condensate
D	Residue
E	Liquor
F	Agriculture vegetation
G	Other

The assessors were familiarised with these odour characters prior to conducting the OFA. Odour character Category G ("other") allows any other types of odour to be noted. An example is smoke from nearby fires or emissions from passing vehicles. These type of non-refinery odours were logged but were omitted from the processing of the data for visualisation.[2]

Each day of an assessment campaign involved five assessors each conducting a nominal 20-25 measurement cycles, each cycle of 60 observations.

The OFA gives rise to a large number of individual observations in a short time frame, thereby capturing the inherent variability and transient nature of odour impacts.

[2] If necessary, the frequencies and intensity scores for non-refinery odours can be extracted from the data to inform the significance of those sources compared with refinery odours.

The following table details the methodology and the applicable guidance/standard.

Table 5.3: Summary of OFA method

Method component	Details	Applicable guidance/standard
Assessor calibration	Assessors calibrated on an annual basis	AS/NZS4323.3:2001
Assessors and coordinator	A minimum of five panel members used for each assessment campaign with one coordinator	EN16841-2 Section 6.2.3
Odour familiarisation	The team was familiarised to known refinery odour sources within the refinery	EN16841-2 Section 7.3.4
Targeted meteorology	Low to moderate wind speeds across the refinery towards receptors north and south of the refinery during winter.	Determined from the review of historical odour surveys
Plume identification	In a location downwind from the odour source, the extent of the plume was identified by assessors stopping approximately every 10-20 m and assessing the presence of the odour	EN16841-2 Section 5
Odour measurement targeted within plume	Measurement cycles were carried out to determine variability by rating the odours every 10 seconds using a numerical scale (Table 5.1) over a ten-minute measurement period	EN16841-2 Section 8.2
Intensity scale	Numerical scale (Table 5.1)	VDI3940.3 Table 1
Determination of percentage odour time	The fraction of the total number of odour intensity scores > zero during the single measurement cycles Note: these data are not used to calculate percentage odour hours as per the Odour Guideline	VDI3940.3
Meteorological field measurements	Portable anemometer located within the assessment area measuring wind speed, wind direction, temperature; cloud cover from visual observations to facilitate determination of atmospheric stability class	Indicative only
Meteorological reference measurements	Data from Alcoa's Bancell Rd stations	AS3580.14-2011

Two separate assessment campaigns were carried out. The assessment campaigns were overseen by a coordinator whose focus was to facilitate determination of suitable measurement cycle locations and coverage of receptor locations. The coordinator was not part of the team of assessors carrying out measurement cycles but was responsible for ensuring assessors were generating reliable results and not experiencing odour fatigue.

5.2 Odour assessors

Five assessors were deployed to carry out each assessment campaign under the direction and instruction of Strategen-JBS&G's Principal Dr Peter Forster. All assessors had been calibrated by a NATA accredited odour laboratory as per AS/NZS4323.3:2001 for their responses to n-butanol, with all assessors returning butanol sensitivities between 20-80 ppb as per the standard specification. Note that the assessor names are not listed in this report; details can be provided under confidential cover including calibration records if required by regulatory agencies.

5.3 Target weather conditions

The OFA campaign was targeted during winter when prevailing meteorological conditions (e.g. inversions) are conducive to a higher potential for odour impacts. The three-day weather forecasts as provided by Alcoa and the Bureau of Meteorology (BOM) 7-day forecast were monitored to identify suitable conditions under which to conduct the measurement cycles. Winds from the northerly and southerly sectors were preferred to assess odours potentially impacting Hamel and Yarloop areas. Suitable conditions were defined as light to moderate winds blowing across areas that were accessible to assessors and whether overnight inversion conditions were forecast.

Measurement cycles were carried out commencing from early morning (either immediately prior to sunrise or within 2 hours after sunrise) to identify impacts from overnight inversion conditions; and continued across the mornings in an attempt to capture the impacts of breakup of overnight inversion conditions that may cause "fumigation" from elevated source emissions. Fumigation occurs during clear sky conditions as the thermal convection eddies reach the height of the plume. The measurement cycles completed on the 8 July 2020 did not commence until the afternoon, with the morning spent completing calibration and administrative requirements.

Measurement cycles were not scheduled if rain was forecast, since odorous substances may be "washed out" of the air, thereby providing a lower risk of odour impacts that would occur on a dry day with similar wind conditions.

Measurement cycles continued into the afternoons when wind conditions tended to stabilise from a particular direction. Where possible, plume tracking was followed to identify to spread of odours at ground level at various distances downwind from the refinery sources.

5.4 Assessment campaigns

The OFA was conducted over two measurement campaigns:

- 8-11 July 2020 (first assessment campaign)
- 29-31 July 2020 (second assessment campaign).

These dates were chosen from consideration of the weather forecasts as discussed in Section 5.3.

5.5 Data visualisation for reporting

Pie charts overlaying aerial images have previously been used to depict data, e.g. Envall 2015. The large amount of data collected in this OFA precludes that approach and the results have been displayed in stacked bar charts to facilitate visualisation of results from each day of the assessment campaigns.

6. Results of odour assessments

6.1 Refinery operations

Alcoa confirmed that refinery processes that can influence odour emissions were operating under stable conditions for the duration of the two assessment campaigns with the exception of the Liquor Burning Facility, which was off-line for 8-10 July 2020 with heating commenced from 11 July 2020 prior to feed being restored sometime after the measurement cycles had been finalised on that day.

Odour emissions from the Liquor Burning Facility are controlled by a regenerative thermal oxidiser (RTO) and are a relatively small contributor (< 4%) to overall refinery odour emissions footprint (Alcoa 2020). As such, the absence of emissions from the Liquor Burning Facility for the first assessment campaign is unlikely to materially impact on the extent of odour impacts observed.

Details are summarised in Table 6.1 for the first assessment campaign and second assessment campaign.

Table 6.1: Key process operating conditions during odour assessment campaign 8-11 July 2020

Process element	Units	Maximum	95th percentile	Average	Minimum
Digestion Production	t/day, moving hourly average	8574	8534	8142	6644
Calcination Production	t/day, moving hourly average	9312	9228	7962	7046
Mill 3 Run Status	Fraction of each hour	1.0	1.0	1.0	0.1
Mill 4 Run Status	Fraction of each hour	1.0	1.0	1.0	1.0
Mill 5 Run Status	Fraction of each hour	1.0	1.0	0.9	0.0
Vapour Condenser 201 Temp	°C	100	100	99	99
Vapour Condenser 202 Temp	°C	101	101	100	97
35N Non Cons Fan Run Status	Fraction of each hour	1.0	1.0	1.0	1.0
Oxalate RTO Operating Temp	°C	869	857	849	803
Oxalate Kiln Feed Rate	kL/h	4.1	3.9	1.5	0.1
Liquor Burner RTO Operating Temp	°C	867	851	236	17
Liquor Burner Feed Rate	kL/h	0.0	0.0	0.0	0.0
Powerhouse Boiler 1	MW	26.1	25.8	25.4	22.6
Powerhouse Boiler 2	MW	20.0	20.0	19.2	16.8
Powerhouse Boiler 3	MW	18.8	18.7	17.8	11.9
Powerhouse Gas Turbine	MW	39.3	36.7	32.8	29.7

Table 6.2: Key process operating conditions during odour assessment campaign 29-31 July

Process element	Units	Maximum	95th percentile	Average	Minimum
Digestion Production	t/day, moving hourly average	8467	8410	8047	5527
Calcination Production	t/day, moving hourly average	8458	8400	7583	5059
Mill 3 Run Status	Fraction of each hour	1.0	1.0	0.8	0.0
Mill 4 Run Status	Fraction of each hour	1.0	1.0	1.0	1.0
Mill 5 Run Status	Fraction of each hour	1.0	1.0	1.0	0.2
Vapour Condenser 201 Temp	°C	100	99	99	99
Vapour Condenser 202 Temp	°C	102	101	100	98
35N Non Cons Fan Run Status	Fraction of each hour	1.0	1.0	1.0	1.0
Oxalate RTO Operating Temp	°C	877	854	849	823
Oxalate Kiln Feed Rate	kL/h	2.8	2.8	1.7	0.0
Liquor Burner RTO Operating Temp	°C	862	862	835	813
Liquor Burner Feed Rate	kL/h	16.5	16.5	14.9	10.0
Powerhouse Boiler 1	MW	26.7	26.4	24.9	21.0
Powerhouse Boiler 2	MW	20.0	20.0	19.5	15.8
Powerhouse Boiler 3	MW	18.7	18.7	18.5	10.9
Powerhouse Gas Turbine	MW	38.3	37.3	34.3	29.6

6.2 Odour measurement cycle locations

An aerial photo showing the locations where all measurement cycles were carried out is presented in Figure 6.1. The locations were selected based on consideration of wind direction and availability of access. Furthermore, historical odour surveys were used to inform the spatial extent of expected odour impacts.

Odour plume tracking was informed by visual observation of the directions of visible refinery plumes. Measurement cycles were either not commenced or not continued where odours were not detectable by any of the assessors. The assessment campaigns captured odour impacts during a range of wind directions providing opportunity to conduct measurement cycles at locations surrounding the refinery in all directions.

The scope of works originally proposed for the OFA identified 16 receptor locations with an intent to conduct seven measurement cycles at each location. In the field, odour was not detected in the vicinity of 11 of the 16 receptors on any days of both assessment campaigns. Specifically, odour was not detected at the receptor locations more distant from the refinery. Assessments were carried out at other locations from the specified receptors to explore the extent of the odour impacts as provided by the prevailing winds at the time.

Previous odour studies conducted by Envall were restricted to locations along public roadways. The current study has been assisted by access provided to Alcoa Farmlands, which has allowed measurement cycles to be carried out with greater spatial coverage, both laterally and longitudinal in relation to the odour plume directions.

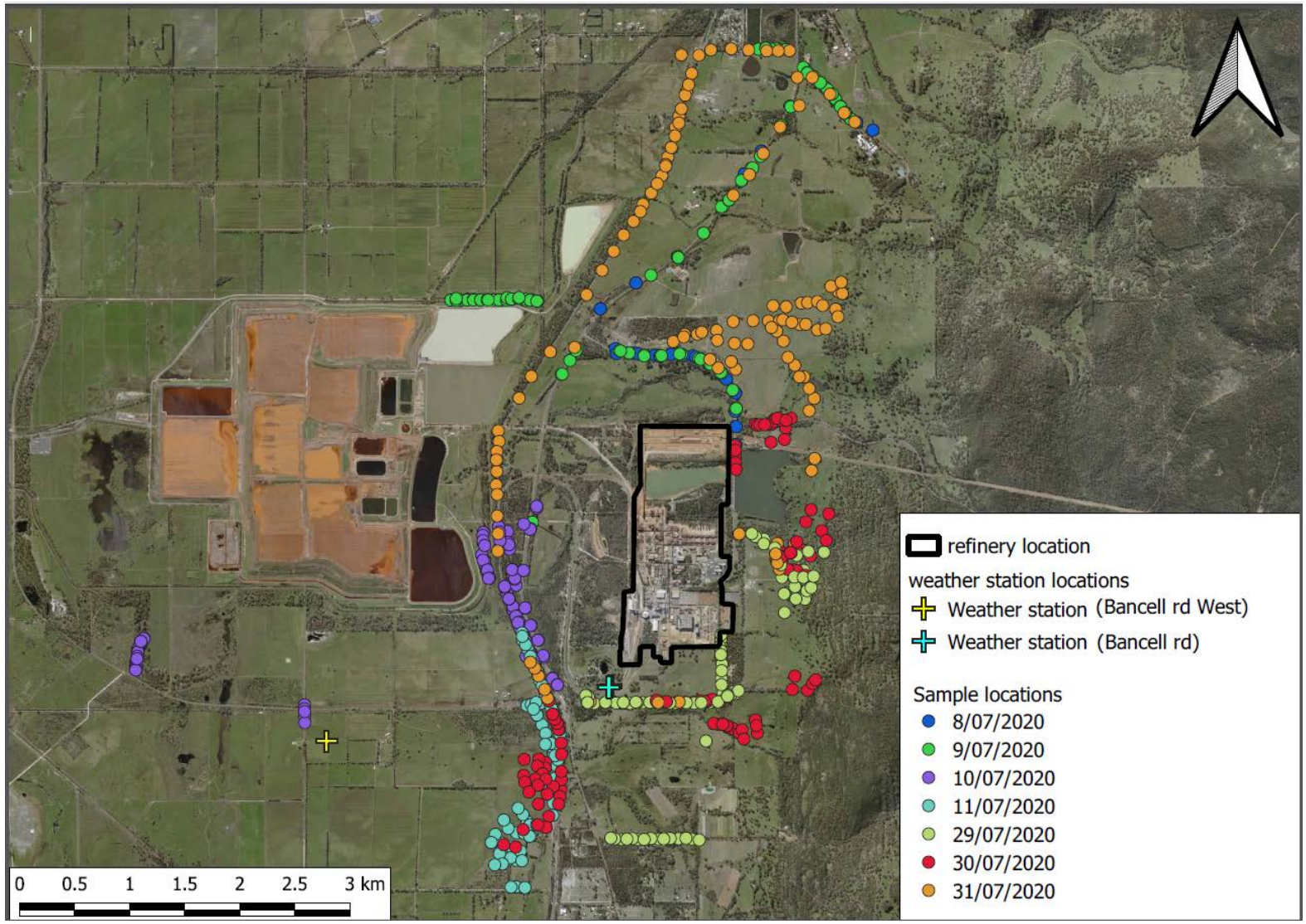


Figure 6.1: OFA measurement cycle locations

6.3 Method comparison

A comparison of the use of the intensity scale from VDI3940:3 currently adopted by the Odour Guideline with the previously used intensity scale was conducted. All five assessors conducted concurrent measurement cycles at one location. One assessor, already familiar and experienced with the previously used scale, recorded observations against that scale, while the other four assessors recorded their odour intensity observations against the scale in the Odour Guideline. No intensities greater than '3' were recorded for either method during the measurement cycles conducted for the method comparison. The following graph illustrates the results recorded using the previous intensity scale in green and the current intensity scale in blue (multiple assessors recorded in different shades of blue).

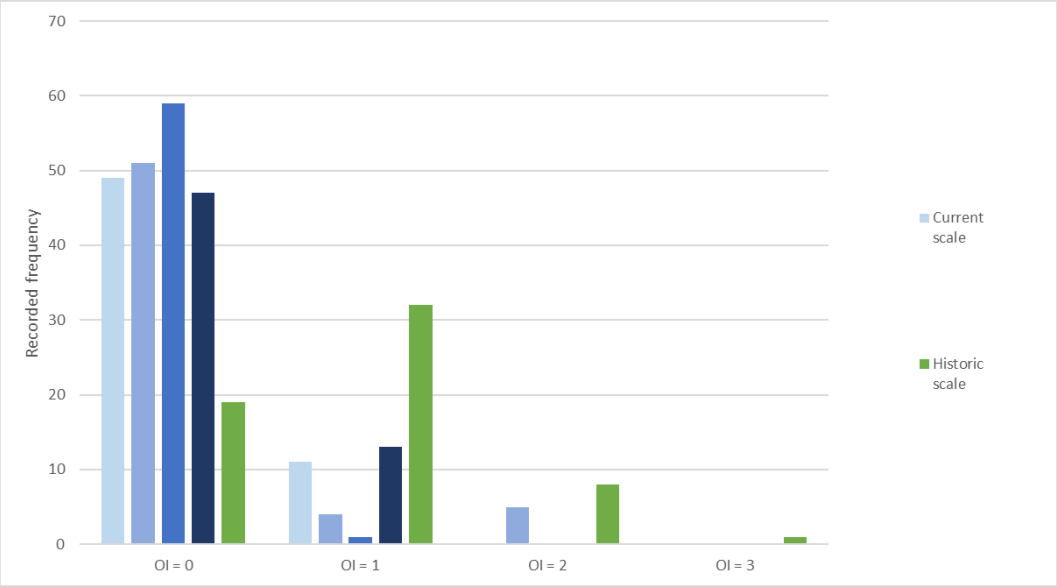


Figure 6.2: Comparison of intensity scales

The results indicate that the detection of refinery odours was more frequent utilising the previous methodology. This is as expected as an intensity of less than OI=3 on the previous scale would be below recognition threshold on the current Odour Guideline scale. Since there were several observations from multiple assessors of intensity OI=1, which is above recognition threshold on the current scale, it was expected to also see some scores higher than the recognition threshold of OI=3 on the previous scale but this did not eventuate.

Discussions with the assessor who utilised the previous scale determined that its use was problematic, since the assessor was adept at scoring using the current Odour Guideline methodology. Therefore, no further method comparisons beyond this preliminary assessment were carried out in this OFA.

6.4 OFA Results

A total of 660 measurement cycles were conducted over the two campaigns. All odour intensities recorded were OI=4 or below, with no odour intensity scores of OI=5 or OI=6 recorded during the 660 measurement cycles.

The following table (Table 6.3) details the measurement cycles conducted for the OFA including wind conditions measured at the Alcoa Bancell Road stations and assessor cloud observations. Pasquill-Gifford p-g stability categories have been estimated using the Solar Radiation-delta-t Method (USEPA 1993).

The odour intensities recorded for all measurement cycles conducted during the two campaigns for the OFA are illustrated in Figure 6.3. Raw data from field sheets for the 660 measurement cycles are provided as a separate Excel spreadsheet.

Table 6.3: OFA details

Date	Time of day	Assessors	Number of measurement cycles	Wind conditions (as recorded at Bancell Rd 10m)	Cloud cover observations	Differential Temperature	Inferred stability class
8 July 2020	13:44 to 16:52	AM, AT, CH, LW, WS	44	Light SW winds, variable wind speeds typically 1.5 to 2 m/s during early afternoon with a downward trend to < 1.5 m/s by the final measurement cycle	Moderate (3/8 – 4/8) cloud cover reported throughout the afternoon (13:46 onwards) increasing (6/8) at the time of last measurement cycle	No low level temperature inversion recorded	Moderately/slightly unstable (B/C) Neutral (D) late afternoon
9 July 2020	08:54 to 16:59	AM, AT, CH, LW, WS	109	Very light (< 1.5 m/s) variable winds from SE during morning and S/SSW late afternoon. Peak wind speeds of up to ~2.5 m/s (from the SW) during the middle of the day (12:00to 14:00)	Clear skies recorded in the morning. Variable cloud cover (4/8 to 7/8) reported from 14:21 onwards	No low level temperature inversion recorded.	Moderately unstable (B) in morning slightly unstable (C) over lunchtime, neutral (D) late afternoon
10 July 2020	08:26 to17:11	AM, AT, CH, LW, WS	108	Calm prior to 09:30 then E winds persistent largely above 2 m/s with max 3.6 m/s. Winds lighter during late afternoon.	No cloud cover recorded	Very weak temperature inversion at commencement of measurement cycles	Moderately/slightly unstable (B/C)
11 July 2020	07:35 to 13:17	AM, AT, CH, LW, WS	80	Calm prior to 09:00 then light N winds increasing above 2 m/s direction becoming variable during early afternoon.	No cloud cover recorded	No low level temperature inversion recorded	Predominantly moderately unstable (B) after early morning neutral (D) conditions
29 July 2020	09:17 to 17:24	AT, BP, CH, LW, PM	85	N winds during the morning remained light (typically < 2.25 m/s) and variable turning WNW late morning to W during the afternoon.	No cloud cover recorded until late morning (11:39 4/8). Variable cloud recorded throughout the afternoon (up to 6/8) dispersing in the late afternoon with clear skies reported after 16:51.	No low level temperature inversion recorded	Predominantly moderately unstable (B) until later afternoon when became neutral (D)
30 July 2020	07:15 to 17:08	AT, BP, CH, LW, PM	114	Light NE winds before 9am swinging to NW by 10am remained light (< 2 m/s) prior to swinging between 12:00 and 13:00 to come from the SW for the remainder of the afternoon. Winds peaked above 2.5 m/s in the afternoon between 13:30 and 15:45 prior to dropping calm in the late afternoon.	No cloud cover recorded during the morning. Clouded over by commencement of afternoon measurement cycles (13:23 7/8) with variable cloud cover until full cloud cover (8/8) for measurement cycles recorded 15:32 onwards.	No low level temperature inversion recorded	Neutral (D) during early morning measurement cycles giving way to moderately unstable (B) around 8:45. Becoming more stable as the day progressed (C/D).
31 July 2020	06:42 to 16:22	AT, BP, CH, LW, PM	120	Winds calm and variable in the morning strengthening mid-morning to ~ 2 -2.5 m/s SSW turning WSW in the afternoon	Full cloud cover dispersing gradually over day, clear sky recorded by 15:11	Morning low level inversion (below 30m) broke up around 9 am as cloud coverage declined	Measurement cycles commenced during stable conditions (E) prior to sunrise. Stability class b/C after 9 am

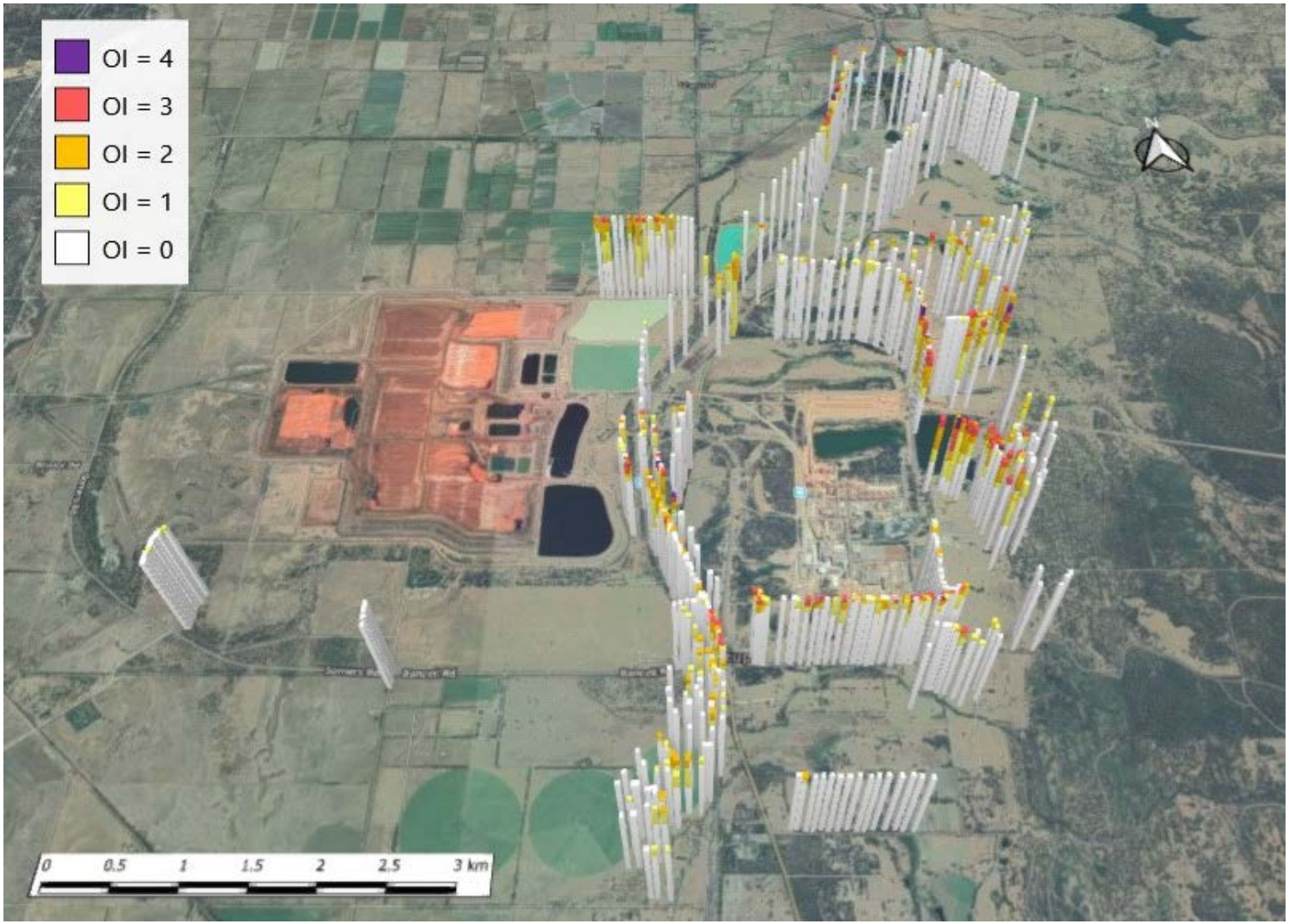


Figure 6.3: OFA measurement cycle results

6.4.1 Odour sampling summary 8 July 2020

Measurement cycles commenced in the early afternoon (13:44) on the 8 July 2020; and a total of 44 measurement cycles were conducted including some duplicate measurement cycles at the same location (Figure 6.4).

Winds were from SSW throughout the afternoon and odour was tracked north of the refinery with impacts recorded 1-1.3 km to the NNE of the refinery fence line. The maximum intensity of the odour was OI=4, which was detected ~ 1km from the refinery northern boundary.

Measurement cycles to the NNW of the refinery in the mid-afternoon recorded weak odours. During this time, winds remained light from the SW. In the late afternoon measurement cycles detected weak odours (OI=1) further afield along Waterous Road approximately 4 km N from the refinery. Detection of weak odours suggests odours emitted from the refinery were being largely dispersed before reaching that distance.

The character of the odour detected throughout the measurement cycles was recorded as Category A ('wet cement') for the majority of odour observations. Some of these observations were noted to be 'sweet' or 'organic' while still being assigned Category A.

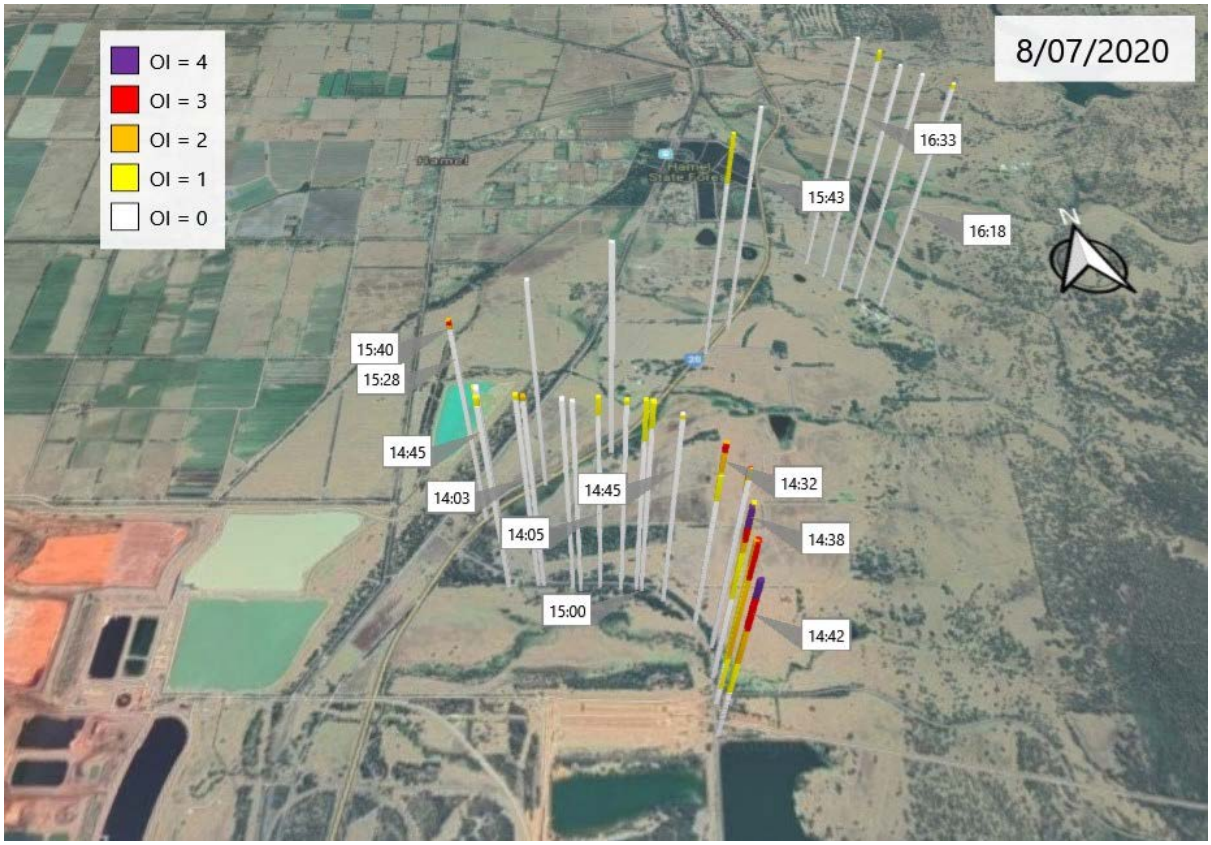


Figure 6.4: Measurement cycle results 8 July 2020

6.4.2 Odour sampling summary 9 July 2020

A total of 109 measurement cycles were carried out on the 9 July 2020. Tracking the plume in the morning was hampered by very light (<1 m/s) and variable winds (as measured at the Bancell Rd AWS 10 m sensor). From 10:00 to midday the wind speed increased and were recorded as blowing from the SSE (145-180 degrees) by the Bancell Road AWS 10 m and 30 m wind sensors, . At this time, the winds recorded at Bancell Rd West AWS 10 m sensor were light from the SW. Weak odour was detected ~1 km to the NNE of the refinery. During this time a 'wet cement' odour was detected at locations along the South Western Highway to the NW of the refinery site.

Odour was also detected at the eastern end of Kubank Road along the northern boundary of the RSA during measurement cycles from 11:12 to 12:29. A maximum OI=3 was observed and all the odour were reported to have the 'wet cement' character.

The Bancell Rd West wind direction data suggested that odours from the RSA may have impacted at those locations, whereas the Bancell Rd data suggests refinery odours may have been detected.

The wind swung in the middle of the day to south westerly before strengthening. During the afternoon, winds from a more southerly direction were recorded and became lighter once again as the day progressed.

Negligible refinery odour was detected during the afternoon measurement cycles despite efforts to track the plume to the north of the refinery based directly on plume direction observations. Smoke was detected in some of the afternoon measurement cycles; however, it appears odour arising from the refinery was well dispersed.

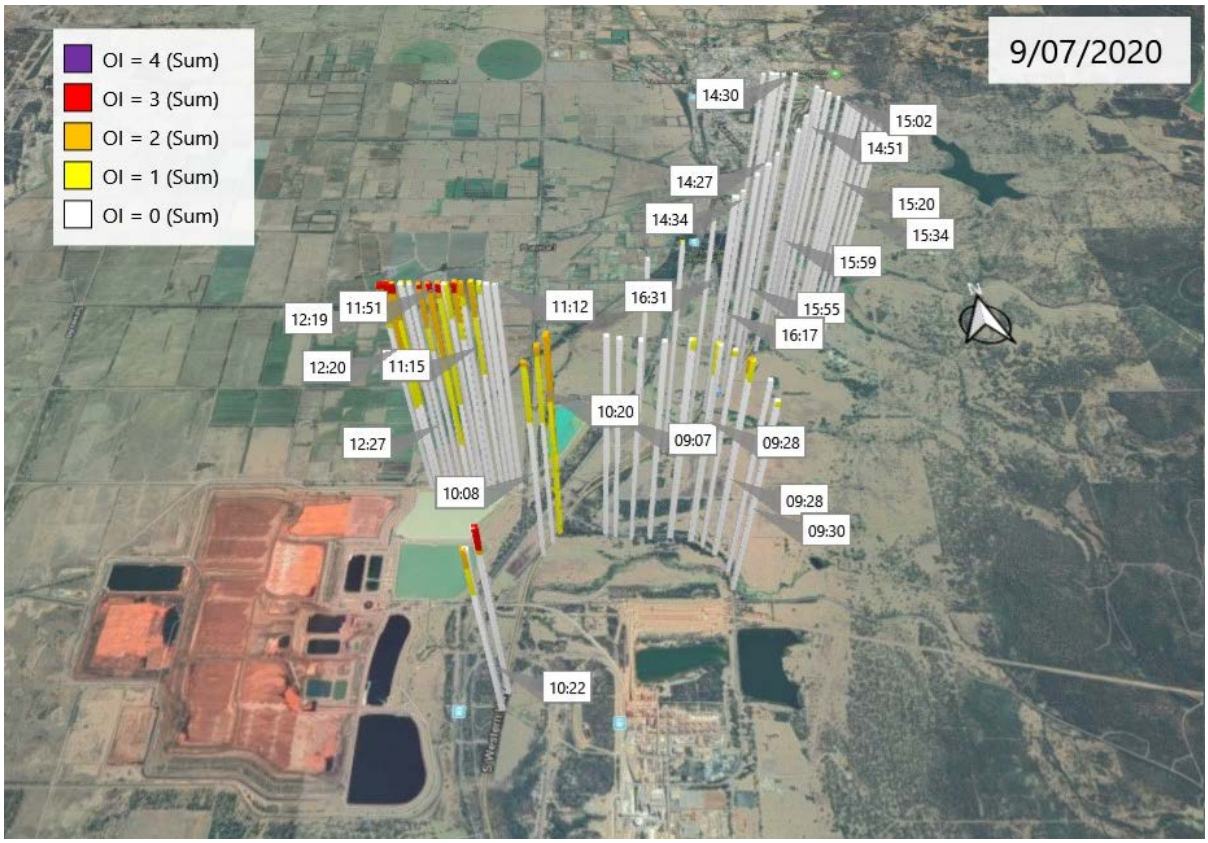


Figure 6.5: Measurement cycle results 9 July 2020

6.4.3 Odour sampling summary 10 July 2020

On 10 July 2020, 108 measurement cycles were conducted, predominantly in the morning when odours were detected along the South Western Highway to the west of the refinery site (

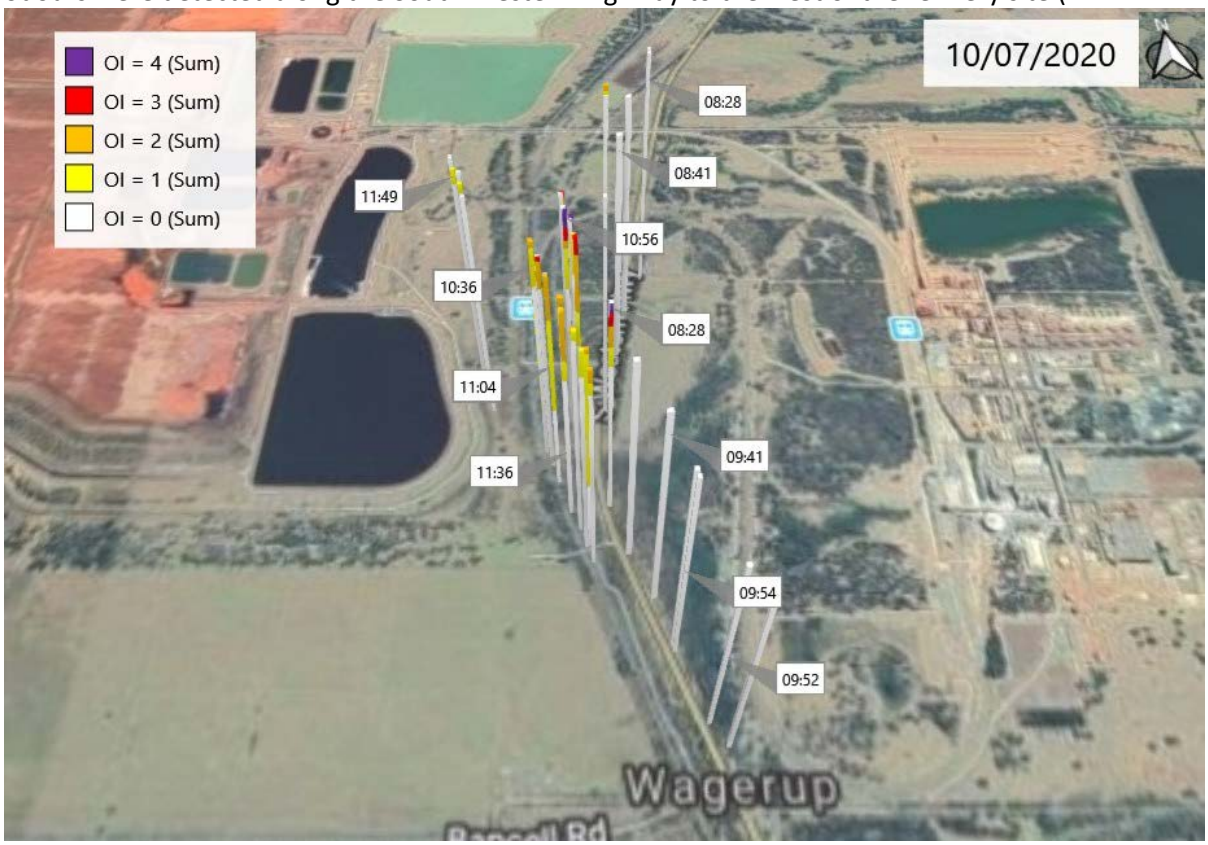


Figure 6.6). The maximum intensity scores were OI=4; and these were distributed in three measurement cycles by different assessors recorded at different times (08:39, 11:07 and 12:41).

Efforts were made to track odour from the residue storage areas (RSA) in the afternoon and any odour that may have persisted from the refinery. Very weak odours were eventually detected in the area directly to the SW of the RSA (Figure 6.7), which are more likely from that source than the refinery. Moving closer to the refinery did not detect odour until the measurement cycles returned to the highway directly west of the refinery boundary where weak "wet cement" odours were detected.

Odour plume location assessments did not detect any odours west of the RSA along Somers Rd, approximately 1.3 km from the nearest active area of the RSA; measurement cycles were therefore not conducted at those locations.[3]

[3] The odour team drove around the western side of the RSA (Somers Rd), stopping at various points to determine the presence of RSA odour but no odour was observed.

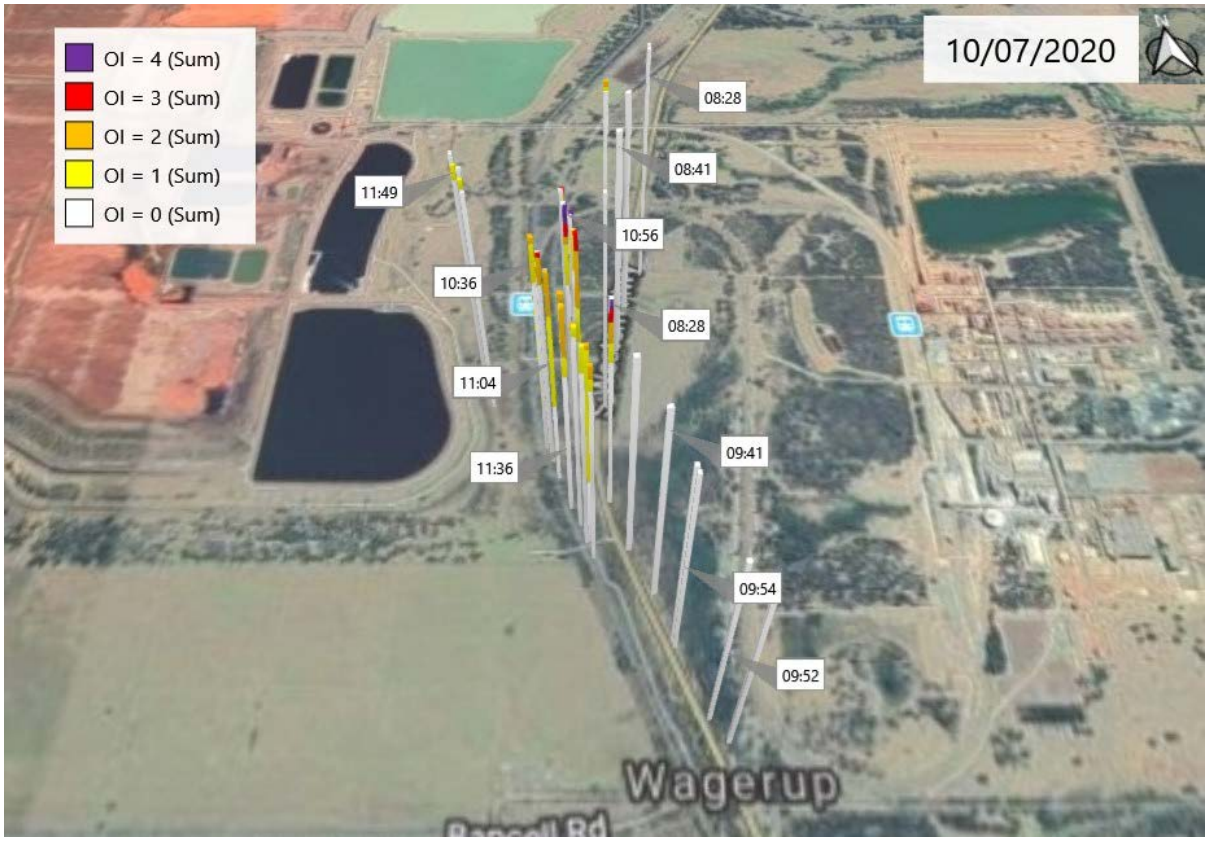


Figure 6.6: Measurement cycle results 10 July 2020 AM

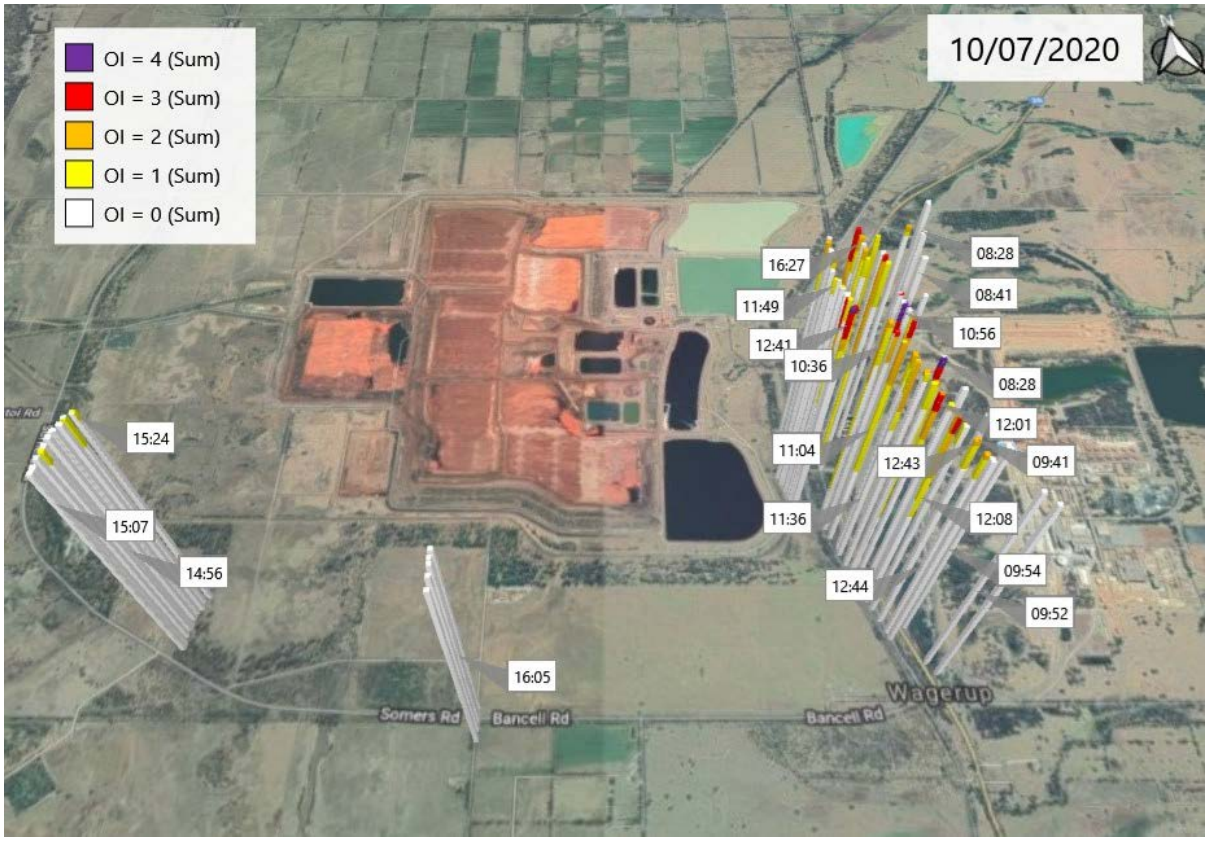


Figure 6.7: Measurement cycle results 10 July 2020 PM

6.4.4 Odour sampling summary 11 July 2020

Very light winds hampered efforts to track odour to the southwest of the refinery in the first measurement cycles on the morning of 11 July 2020. As the wind strengthened from 09:00 (recorded above 1 m/s at Bancell Rd 10m sensor) odour, up to an intensity of OI=3, was detected close to the highway approximately 1 km SW of the refinery boundary. Attempts were made to track the odour in a SW direction heading away from the refinery to determine the extent of the impacts. Some weak odour was detected up to 2.5 km away from the boundary when winds became a little lighter and of variable direction and odour was no longer detected at that distance.

Subsequent measurement cycles closer (~800 m) to the SW corner of the refinery determined that weak odour was still being carried in a SW direction. This suggests odour was largely being dispersed within 2.5 km under the light wind conditions at that time.

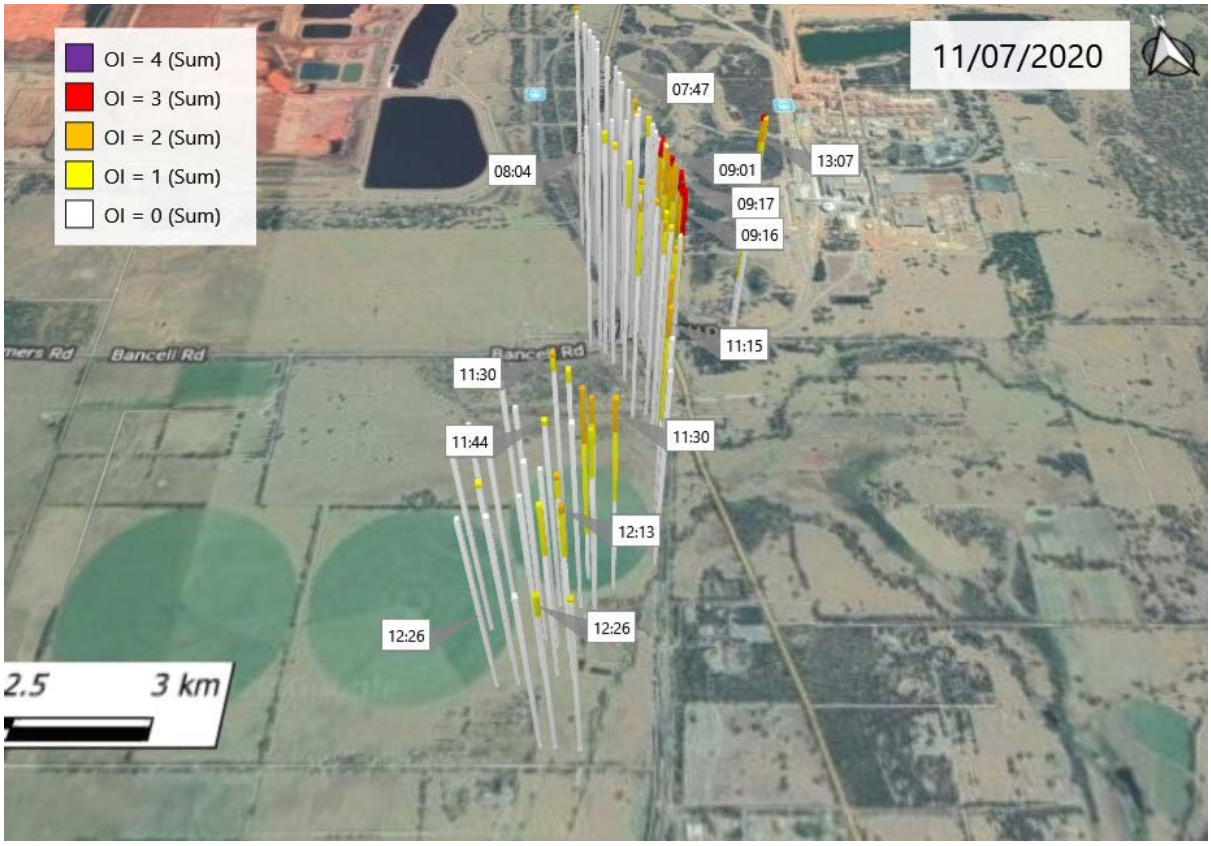


Figure 6.8: Measurement cycle results 11 July 2020

6.4.5 Odour sampling summary 29 July 2020

A total of 80 measurement cycles were conducted on the 29 July 2020 (Figure 6.9). Initial measurement cycles, conducted during light winds from the N, determined odours to the south of the refinery falling away as measurement cycles moved to the east. Only one measurement cycle detected odour when moving further south.

Around this time, the wind speed dropped, and the direction turned to be from a westerly direction for the remainder of the day. In the early afternoon (13:36) measurement cycles initially detected odours to the SE of the refinery. Little odour was detected in subsequent measurement cycles heading north towards the eastern boundary of the refinery until odour, with a maximum intensity of OI=4 recorded in two measurement cycles, was detected approximately 500 m from the eastern boundary fence.

An attempt to track the extent of this odour to the east determined the odour was not detectable ~800 m from the boundary; this finalised the measurement cycles for the day. The majority of odour

observations were ‘wet cement’ however Category C (‘condensate’) was reported in one morning measurement cycle and two afternoon measurement cycles while liquor was also reported in three afternoon measurement cycles.

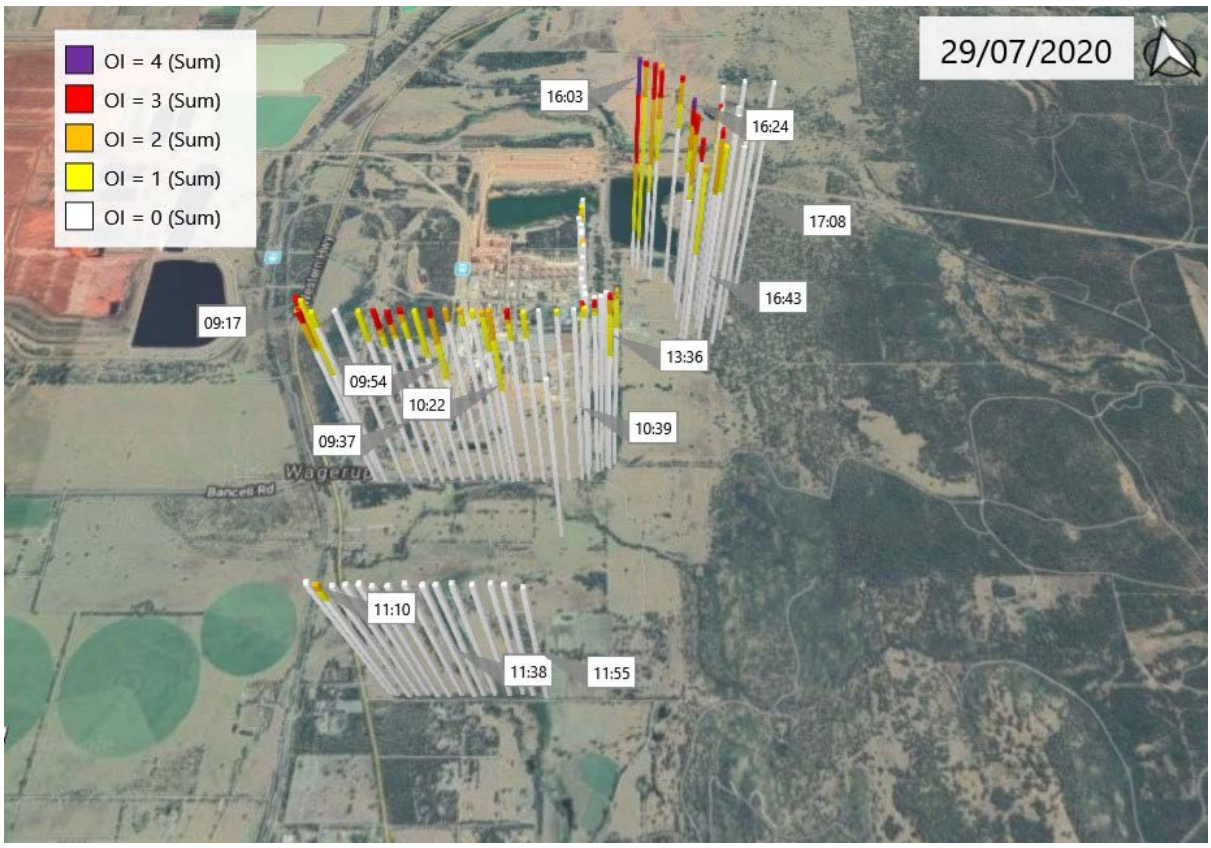


Figure 6.9: Measurement cycle results 29 July 2020

6.4.6 Odour sampling summary 30 July 2020

Winds were somewhat variable on the 30 July 2020 leading to measurement cycles spanning from the SW to the NE of the refinery (Figure 6.10). Initial measurement cycles in the morning, during winds from the NE, were conducted to the SW of the refinery detecting odours up to an intensity of OI=3 approximately 1 km from the refinery boundary.

Odours became weaker as measurement cycles moved away in a SW direction; however, it is notable there was also a lull in the winds at this time which possibly means odours would not have been transported so far. Odours were later detected ~500 m directly south of the refinery around 11am when winds had strengthened a little.

After 12pm, the winds were somewhat lighter again and had turned to a more westerly direction. Odour proved hard to track and was finally picked up to the NE of the refinery around 14:00 with intensity of up to OI=3 recorded. Measurement cycles determined odour within 600 m directly to the west of the refinery between ~14:30 and 16:00 prior to it being detected at a similar distance to the NE by 16:33. Again, the dominant odour character was ‘wet cement’.

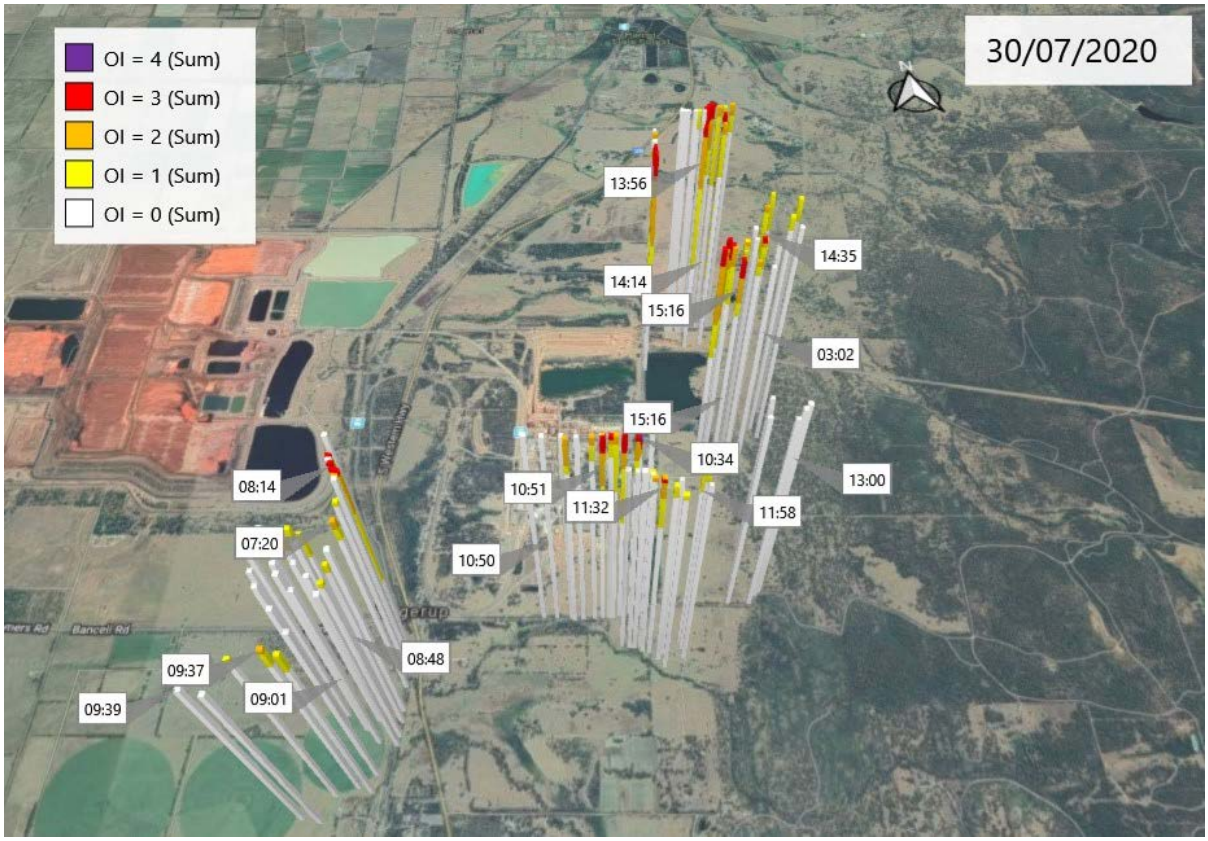


Figure 6.10: Measurement cycle results 30 July 2020

6.4.7 Odour sampling summary 31 July 2020

On the 31 July 2020, a total of 120 measurement cycles were conducted (Figure 6.11). Light variable winds in the early morning made plume tracking challenging and measurement cycles to the south west of the refinery failed to detect odours. Some odour was detected to the north of the refinery around 08:00 with two measurement cycles recording intensities of up to OI=4 with a "wet cement" character. One assessor recorded a "burnt rubber" smell for one of the measurement cycles, which is unlikely to reflect a refinery odour source.

Moving south along the south western highway, few measurement cycles detected odour and the focus returned to north of the refinery as the winds had settled to be from the SSW. Measurement cycles approximately 3.8 km north of the refinery conducted around midday failed to detect odour, and the efforts were subsequently moved back closer to the refinery (~1.8 km). 'Wet cement' odours were again detected.

Measurement cycles to the east of the refinery between 14:00 and 15:00 also detected 'wet cement' odours up to intensity OI=3. Odour was later (after 15:45) detected ~1.1 km to the NE of the refinery up to an intensity of OI=4 with a 'wet cement' character.

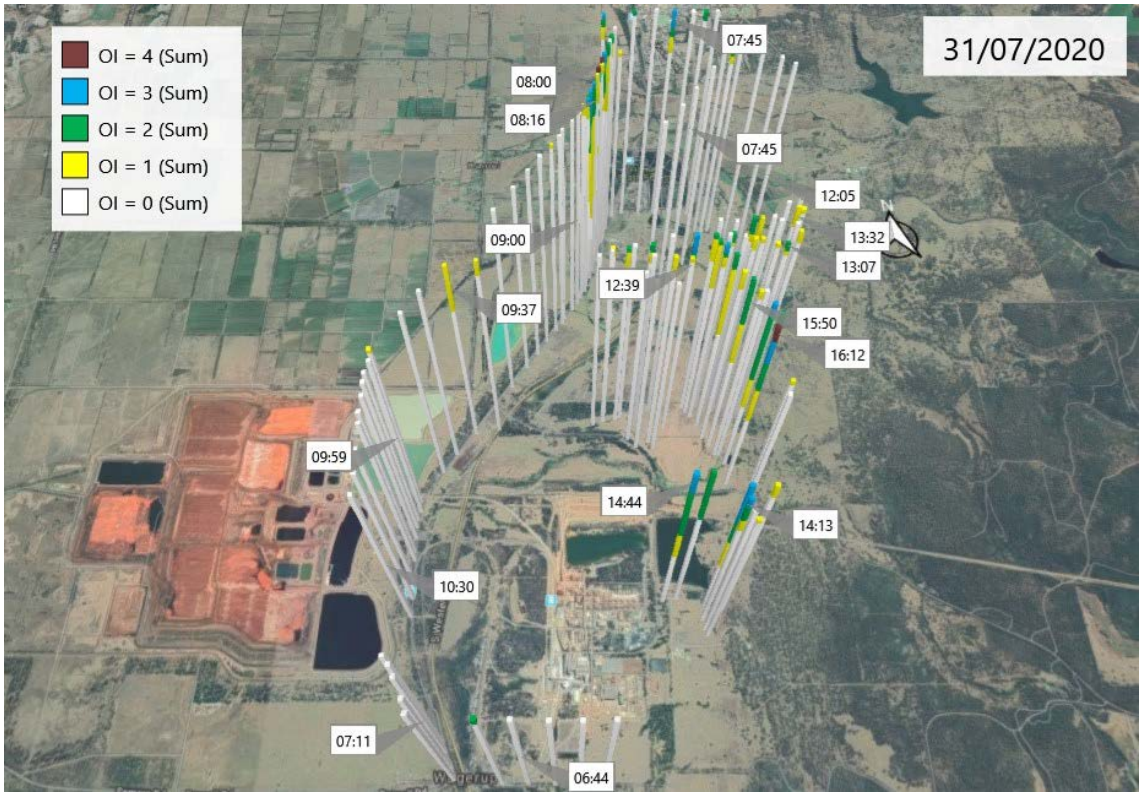


Figure 6.11: Measurement cycle results 31 July 2020

6.5 Non-Alcoa odours

Assessors were instructed to record observations of odours from non-Alcoa sources to provide an understanding of potentially confounding odours at nearby locations.

Agricultural odours from sources such as livestock and grass were frequently observed. Other non-refinery odours detected included smoke, wild fennel, a sweet smell with an unknown origin, burnt rubber, vehicle exhausts and passing trains. Smoke odour appeared to be primarily due to burn-off of waste vegetation (mainly tree branches, trunks and stumps) in private properties.

The strong sour/rotting smell at the east end of Boundary Rd previously reported by Envall in the 2006 and 2015 surveys was not detected despite the numbers of measurement cycles and plume tracking assessments conducted at that location.

7. Comparison of OFA results with Envall 2015 study

Alcoa has provided a list of emissions reductions projects carried out since 1998 at the refinery, which shows the most recent project was carried out in 2015 to redirect Calciner 1-3 vacuum pump exhausts to the calciners for incineration (Alcoa 2020).

The Envall 2015 study was carried out from 19 June to 20 July 2015. The vacuum pump exhaust project had been completed at that time.

A direct comparison of findings from this OFA and Envall 2015 is precluded by the change in methodology for the field assessments. However, the spatial extent of more significant odour impacts can be used to compare the two studies.

On a small number of occasions during the 2015 program, Envall recorded odour intensity scores of OI=3 (which represent recognition threshold using the methodology at that time) at locations up to 2.5 km from the refinery. However, the vast majority of results with that score (or higher) were obtained at locations closer to the refinery (or RSA).

The findings from the present study are largely consistent with the 2015 findings in respect of distance from Alcoa sources where odours can be detected at a recognition threshold. Odours observed on 31 July 2020 extended to approximately 2.9 km north of the refinery but otherwise they were limited to locations closer to the refinery or RSA.

Within the significant limitations imposed by comparison of data acquired using two different methodologies and the inherent variability in meteorology from the respective studies, these findings suggest no significant change in the extent and significance of odour impacts has occurred from 2015 to 2020 operations.

8. Conclusions

The following conclusions can be made from consideration of the results of the OFA:

- Refinery odours were detected at locations 2 to 3 km from the refinery operating area.
- Where odours were detected at those locations, the intensity scores were predominately OI=1 with scores of OI=2 and above less frequently recorded.
- Odours from the RSA appear limited to approximately 1 km from the nearest active area.
- The intensity of odours rapidly decreases with increasing distance from the refinery under unstable atmospheric conditions.
- Odour emitted during inversion events where calm to low wind speeds occurred tended to be more significant at locations closer to the refinery, with stronger and more consistent winds required to drive odours further from the sources.
- A comparison of odour observations reported from the 2015 Envall study and this OFA suggests no significant change in the spatial extent of odour impacts has occurred since that time.

The observations made in the OFA reflect the odour emissions signature from normal refinery operations, with the exception that the Liquor Burning Facility was off-line during the first assessment campaign. It is understood that liquor burning is a relatively small contributor to the overall refinery odour emissions and as such, the results from this OFA are not expected to be affected by the absence of emissions from that source.

9. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

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In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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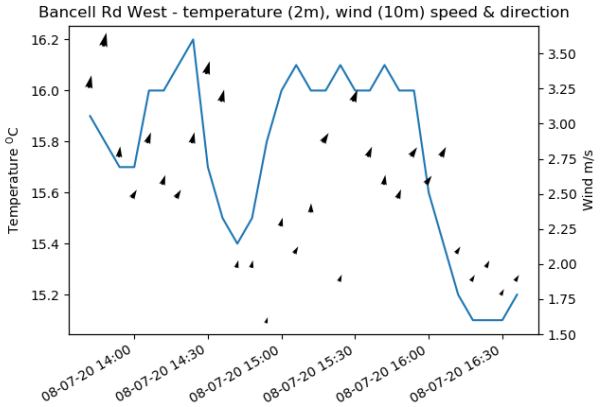
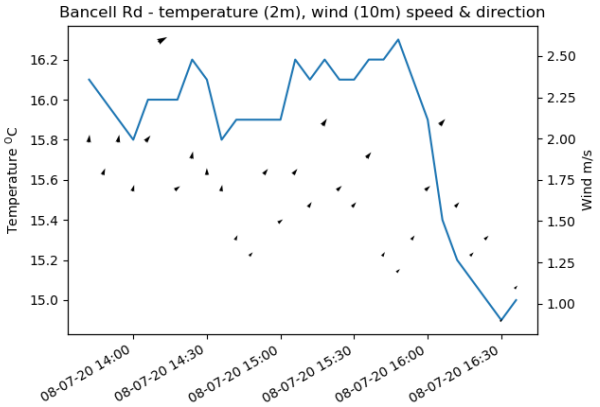
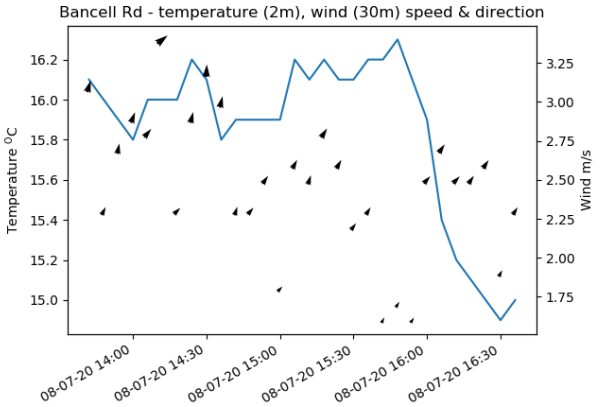
Appendix A Meteorology

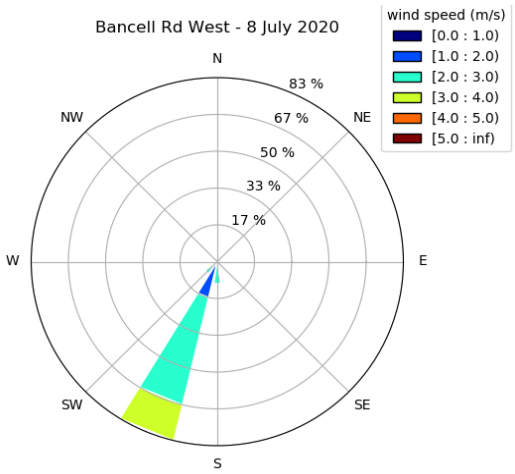
Note: Temperature is depicted by the blue trendline; wind is described by the black barbs; wind speed is represented by both the position of the barbs against the secondary y axis and the scale of the barb; wind direction is depicted by the direction of the barb (wind blowing towards the point of the barb). Wind roses depict winds during the period illustrated in the temperature wind charts.

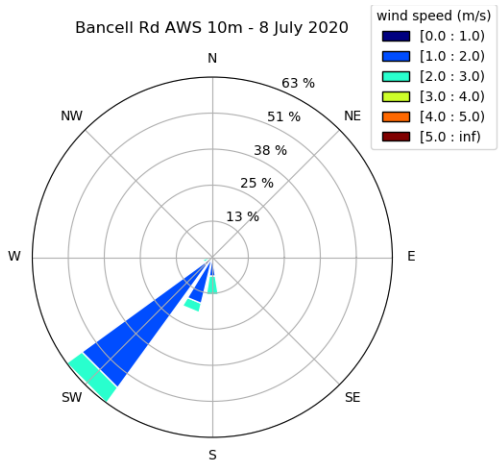
8 July 2020

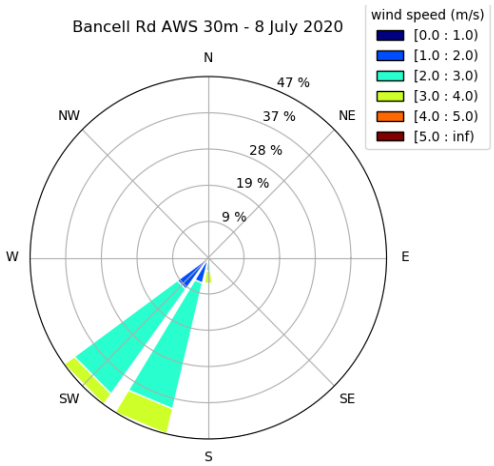




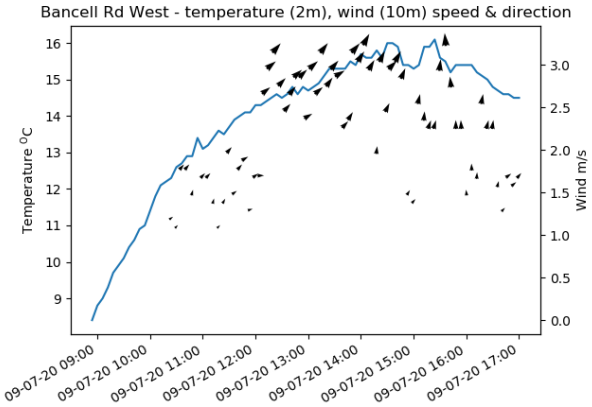








9 July 2020


Bancell Rd West - temperature (2m), wind (10m) speed & direction
Temperature °C
Wind m/s
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09-07-20 10:00
09-07-20 11:00
09-07-20 12:00
09-07-20 13:00
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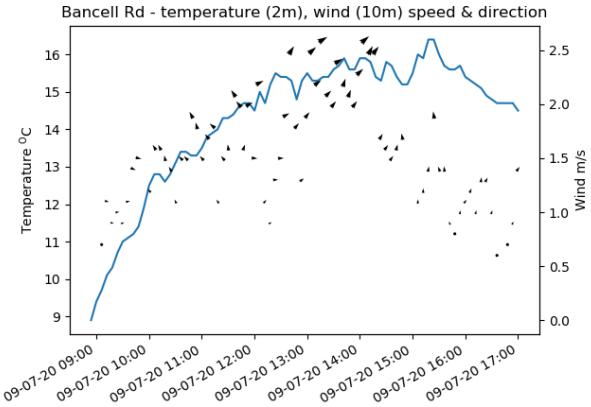
09-07-20 17:00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Temperature °C
Wind m/s
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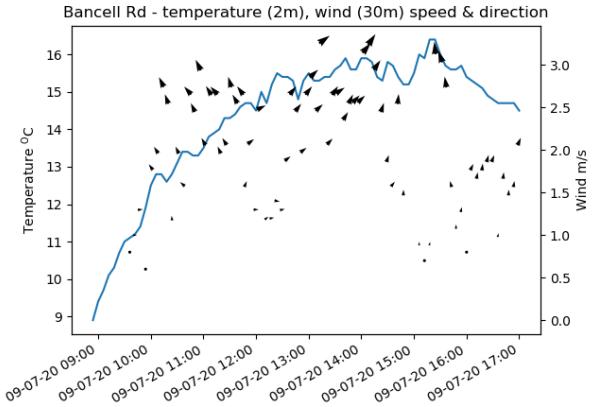
Bancell Rd - temperature (2m), wind (30m) speed & direction
Temperature °C
Wind m/s
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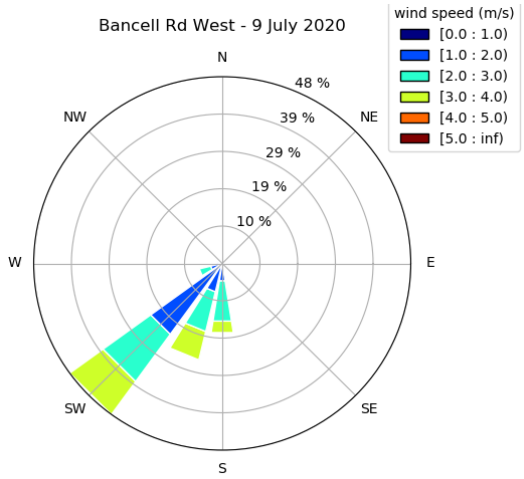
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[1.0 : 2.0)
[2.0 : 3.0)
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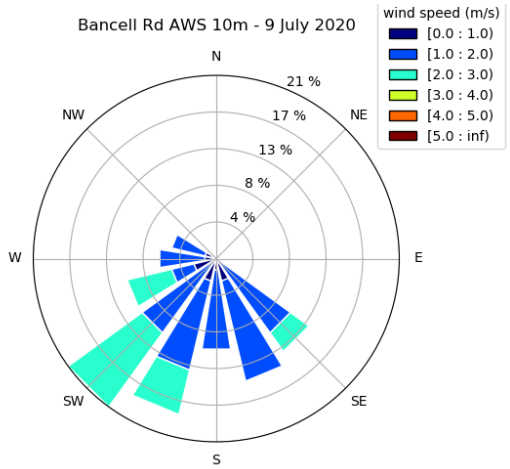
Bancell Rd AWS 10m - 9 July 2020
wind speed (m/s)
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[2.0 : 3.0)
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17 %
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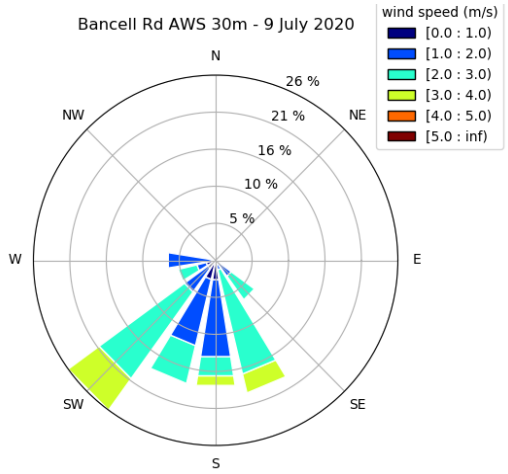
8 %
4 %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N
NE
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SW
W
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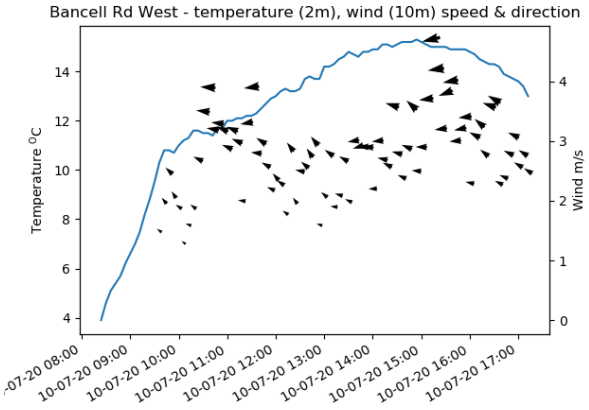
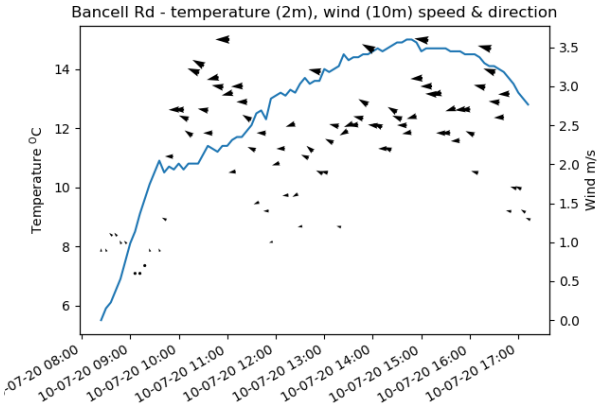
26 %
21 %
16 %
10 %
5 %

9 July 2020


Bancell Rd West - temperature (2m), wind (10m) speed & direction
Temperature °C
Wind m/s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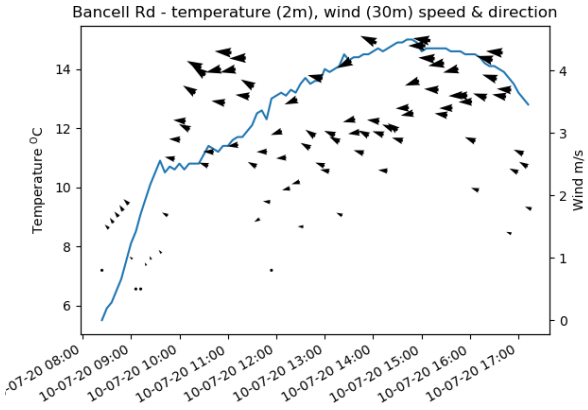
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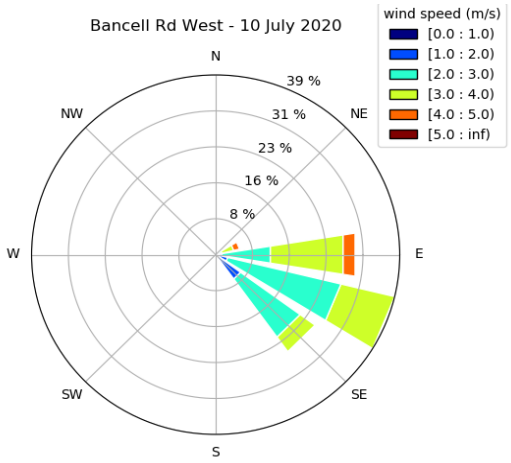
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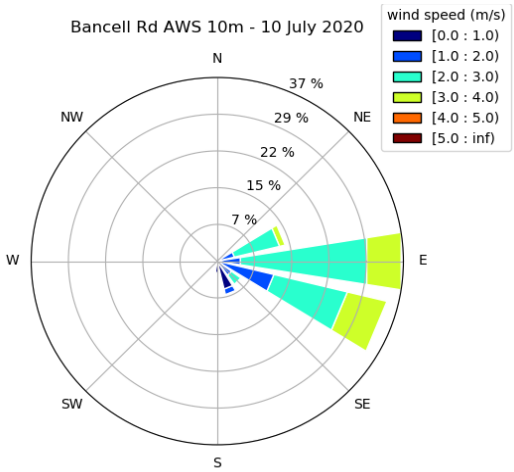
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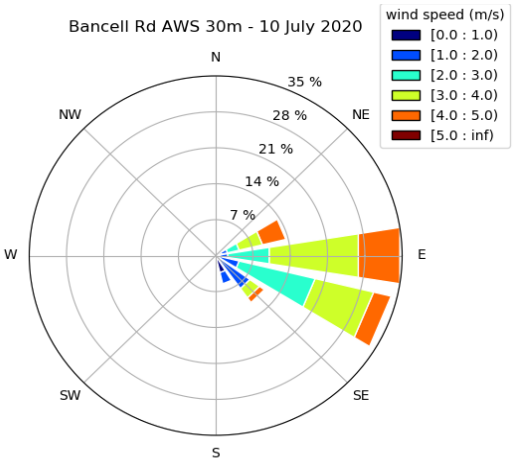
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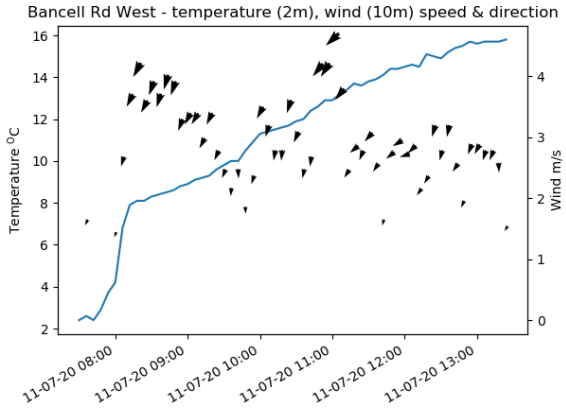
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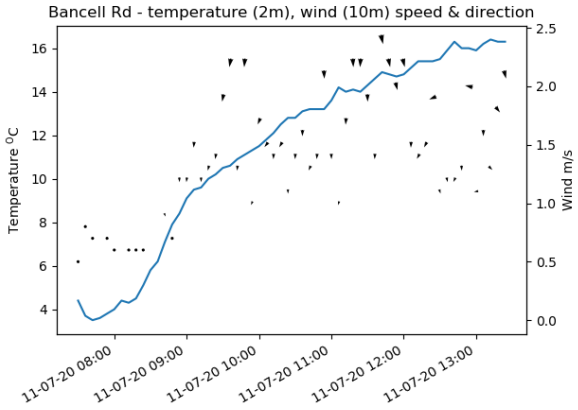
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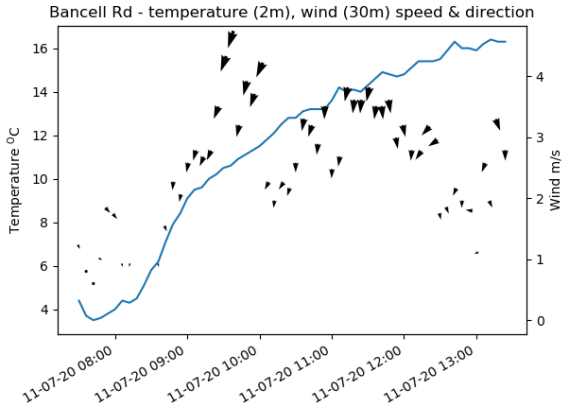
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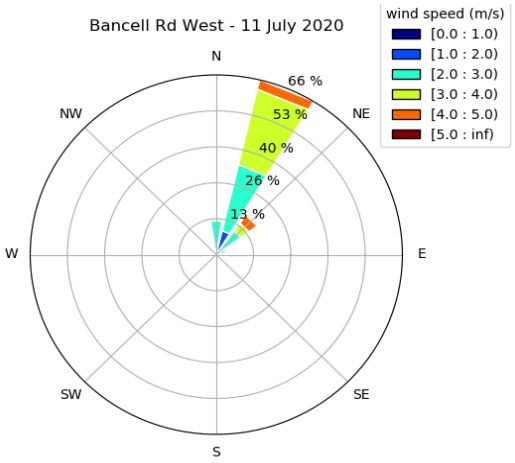
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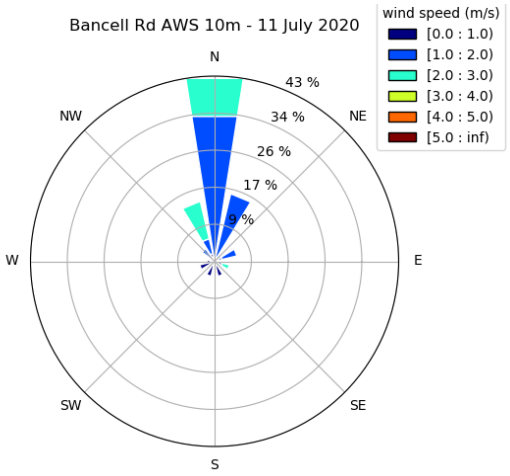
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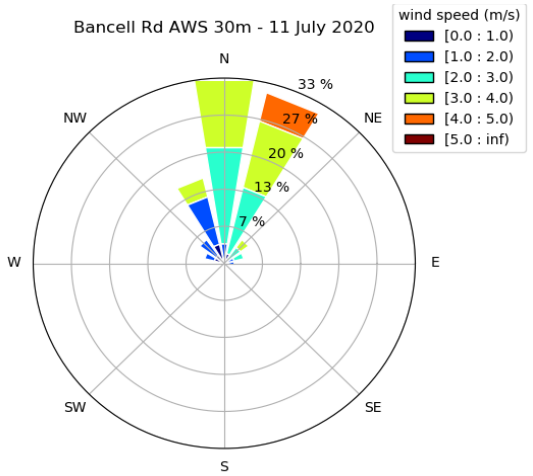
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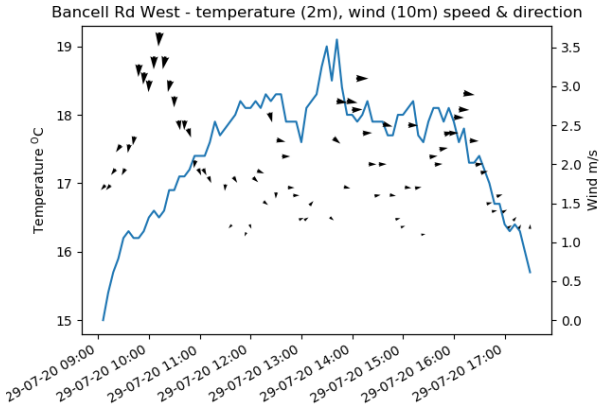
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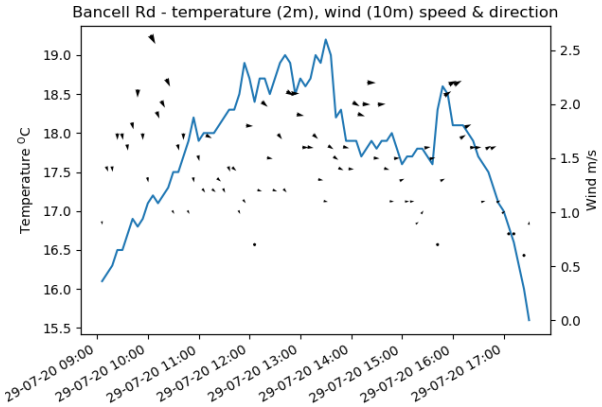
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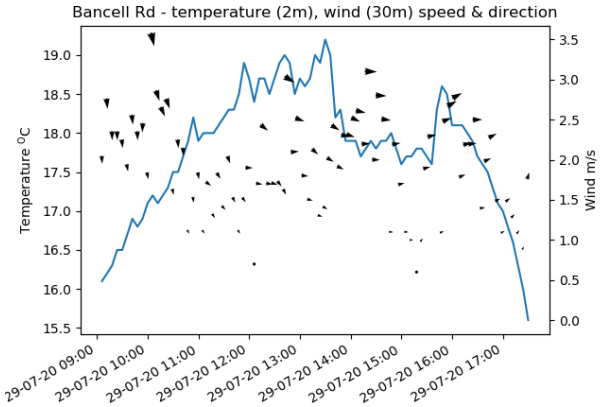
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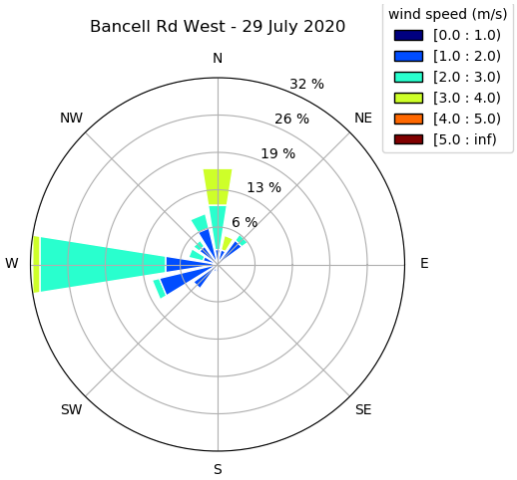
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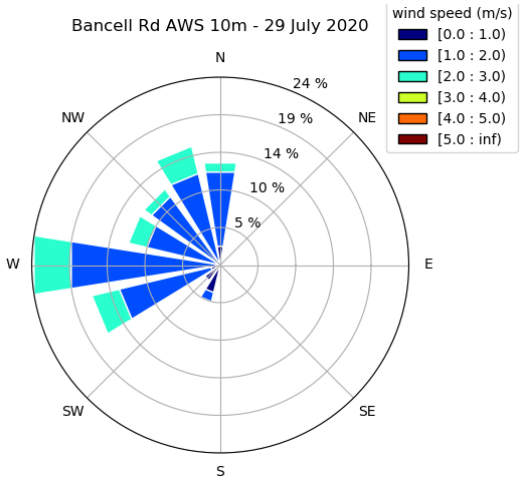
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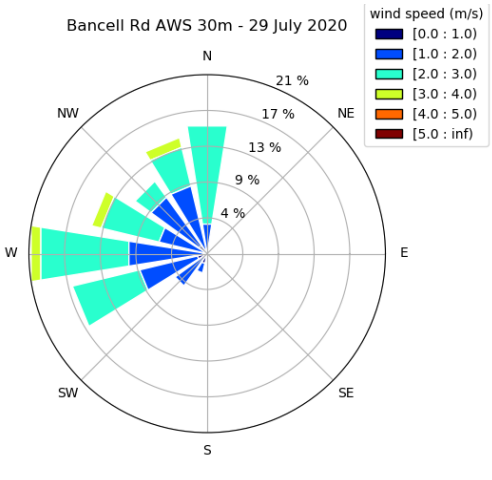
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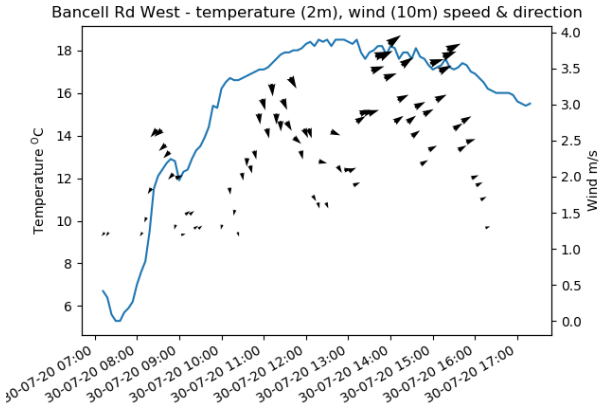
30 July 2020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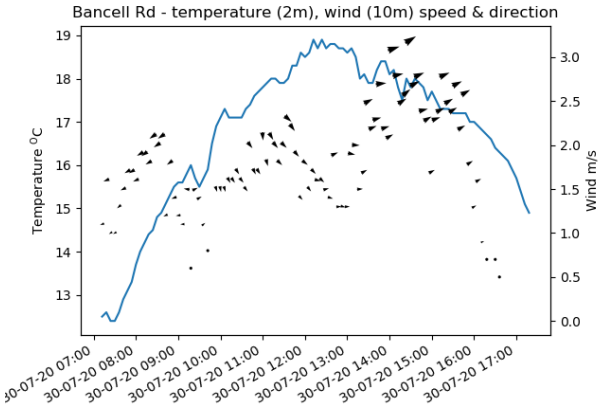
Wind m/s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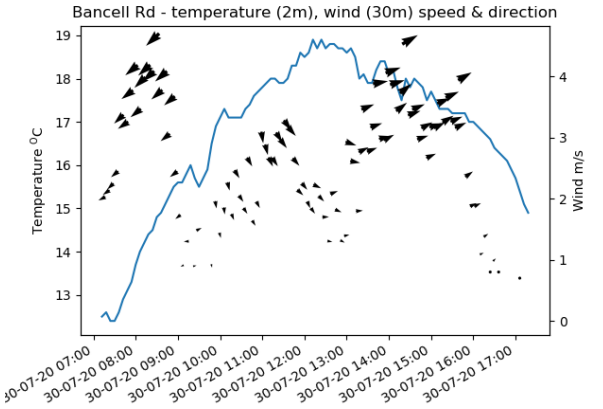
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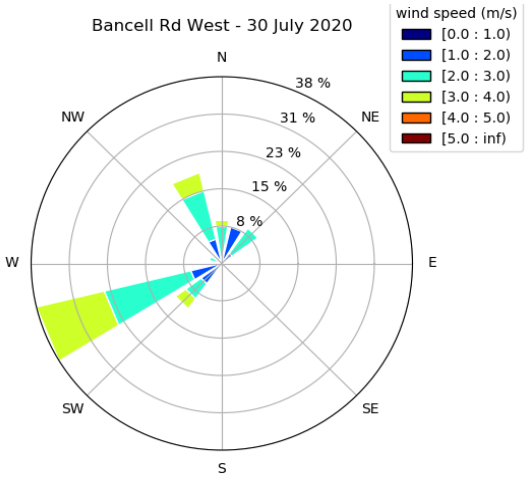
Wind m/s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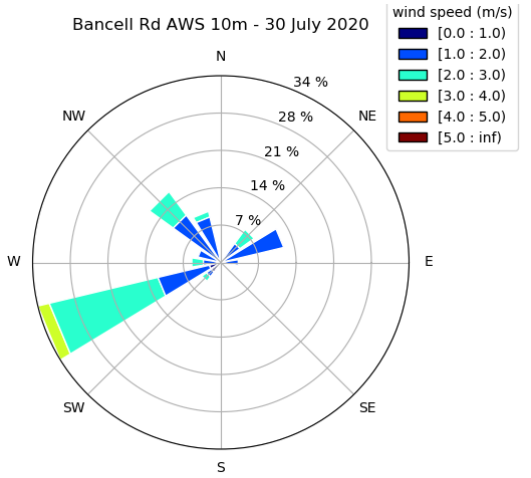
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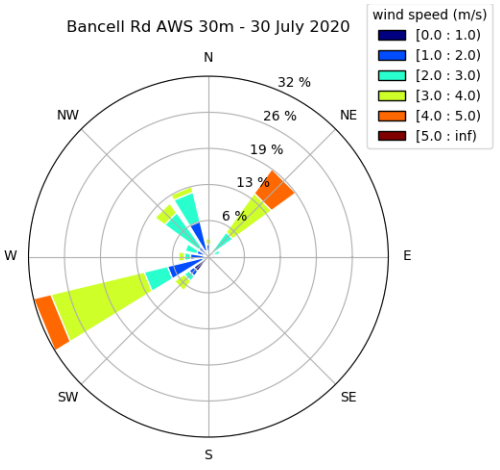
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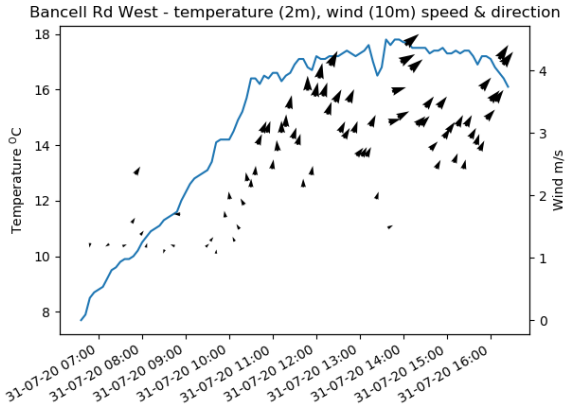
31 July 2020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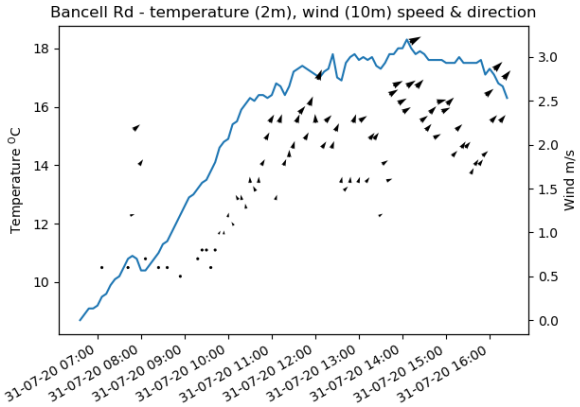
Wind m/s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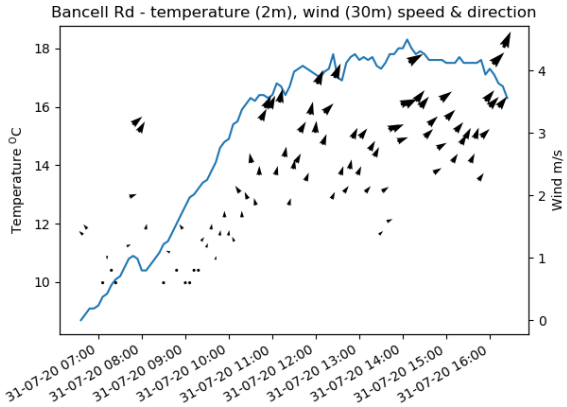
Wind m/s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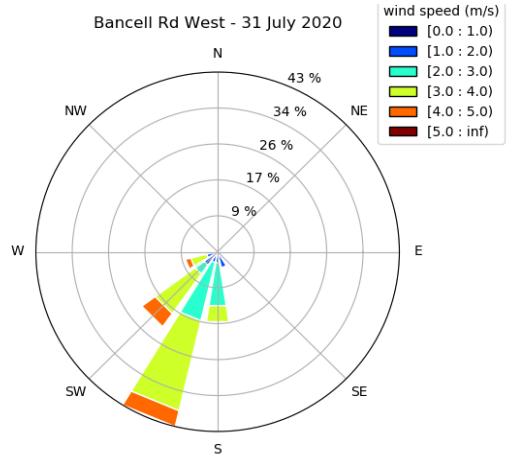
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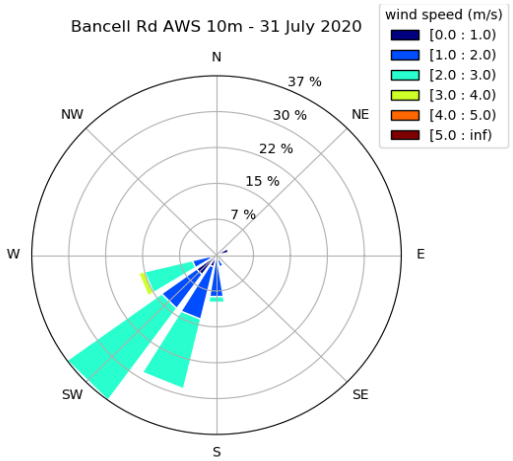
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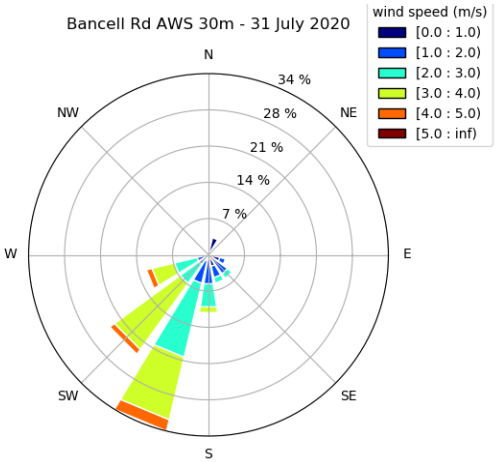
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Document Distribution

Rev No.	Copies	Recipient	Date
A	Draft	J. Batten (Alcoa Wagerup)	11 September 2020
B	Revised draft	J. Batten (Alcoa Wagerup)	21 October 2020
0	Final	J. Batten (Alcoa Wagerup)	27 November 2020

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	C. Ingram & P. Forster	J. Bailes	J. Bailes		11 September 2020
B	C Ingram	P Forster	J. Bailes		21 October 2020
0	P. Forster	J. Bailes	J. Bailes		27 November 2020

www.jbsg.com.au

Wagerup Alumina Refinery

Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 8B

Noise Study

October 2021

Title:	**Noise Study**
Project:	**WGP00297 Wagerup 25A Emissions Reduction Project – FEL2**
Client:	Alcoa

Wood Doc No	AU00108-01-FN1	**Wood Job No.**	AU00108-01

Revision	Description	Prepared	Reviewed	Date
0	Issued for Use	P.Glorie	M.Pettersson	26 Mar 2021
1	Issued for Use	P.Glorie	J.McLoughlin	3 May 2021

1 INTRODUCTION

The Wagerup Emissions Reduction Project (the Project) will implement an Air Emissions Treatment scope on the building 25A tanks to enable refinery incremental growth. The Project is to re-direct vapour from Tanks 25A2 and 25A4 to the existing 35N system to Building 110 for destruction in Boilers 2 and 3 (as per existing process). The project includes new ducting and valves connecting the headspace in the 25A tanks to the existing 35N extraction system (see Figure 1-1). It is in FEL2 Pre-Feasibility stage.

The scope for this noise study is to:

- Review the available design information for the new 25A ducting system.
- Assess the design for potential noise emission sources that have the potential to impact:
    - Environmental noise levels at Wagerup approved monitoring locations and at Hamel; or
    - Occupational noise levels.
- Prepare a brief file note report that:
    - Summarises the design of the ducting system;
    - Discusses potential noise risks including estimated impact; and
    - Provides recommendations relevant to the design or further noise assessments.

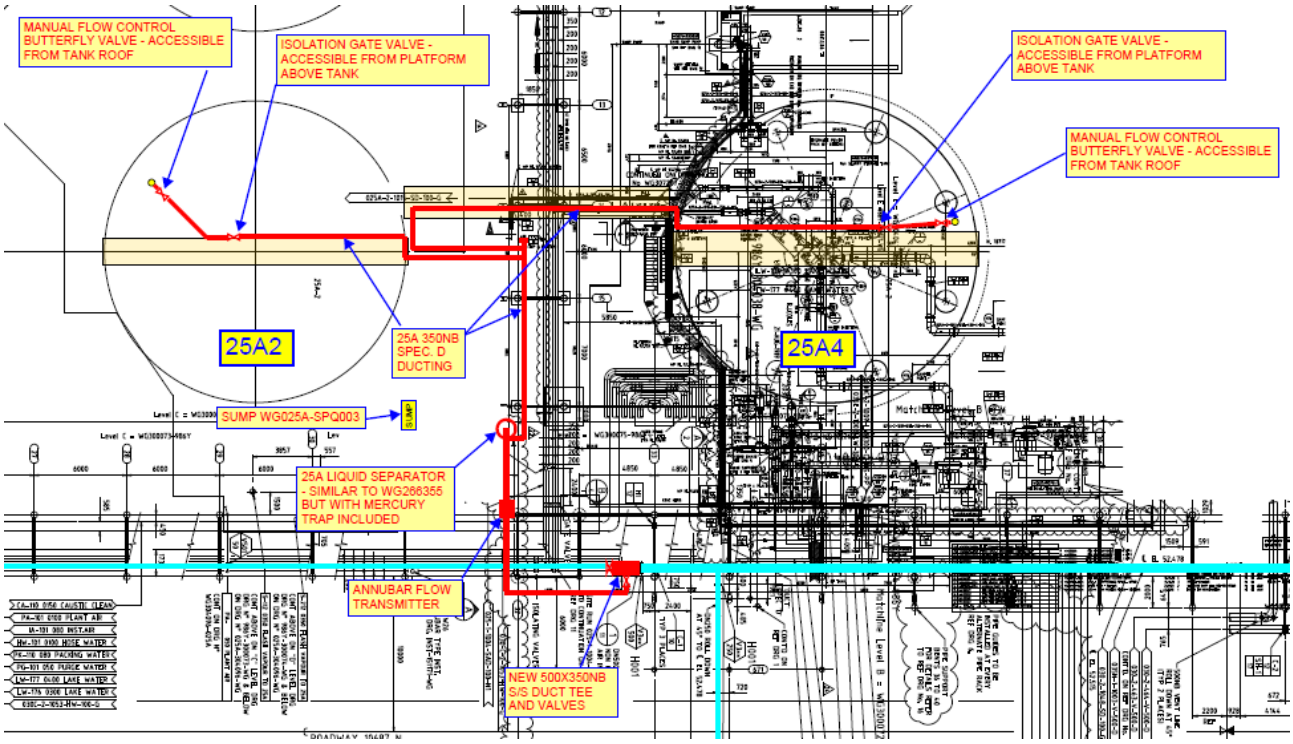


Figure 1-1: Overview of new ducting (red) and connection into existing system (blue)

2 DESIGN REVIEW

The following design information was reviewed:

- Layout drawings showing the new ducting (WGP297-ME-SK-0001-rA 25A plot plan);
- Layout drawings showing the existing system duct network (WGP297-ME-SK-0004-rA - 35N plot plan – Noise); and
- Data sheet for the existing 35N fan (WGP297-DAT-035N-NCF001 Fan Curve - T1662).

The following potential new sources of noise have been identified that could be introduced as part of the Project:

- Fan noise from the existing fan/duct network within the new duct sections; and,
- Regenerated flow noise within the new duct sections (e.g. turbulence at flow control valves).

2.1 Fan noise

A calculation to predict the fan noise levels within the new sections of duct. The key elements of the calculation are:

- The 35N system fan sound power level at the inlet as per the provided data sheet.
- The 25A duct joins in to the existing 35N duct system approximately 360m upstream of the fan.
- At the point where the 25A duct joins the existing system, the internal duct sound power level due to fan noise is predicted to be 59 dB(A).
- There is approximately 70m total of DN350 duct in the 25A system.
- It was conservatively assumed that the 25A duct is thin walled.

The fan noise breakout from the new 25A duct was determined to have a total sound power of 56 dB(A), resulting in a maximum sound pressure level of 46 dB(A) at 1m from the duct. These levels are insignificant and would have no impact on compliance with occupational or environmental noise limits.

2.2 Regenerated noise

Duct system regenerated noise can be created from turbulence in ducts, at fittings and at valves. The highest levels of regenerated noise are expected to be created at the flow control valves, where the worst case levels are expected to create external duct sound pressure levels in the order of 50 to 60 dB(A) at 1m from the duct (estimated based on empirical methods to determine in-duct noise due to volume dampers and breakout through thin walled duct). These levels are insignificant and would have no impact on compliance with occupational or environmental noise limits.

3 SUMMARY AND CONCLUSION

Wood has reviewed the design information provided for the 25A Air Emissions Treatment scope, which includes new ducting and valves connecting the headspace in the 25A tanks to the existing 35N extraction system. Fan noise from the existing fan/duct network within the new duct sections and regenerated flow noise due to turbulence at new flow control valves were identified as the most significant noise risk. However, predicted noise levels are expected to be below 60 dB(A) at 1m from the duct. These levels are insignificant and would have no impact on compliance with occupational or environmental noise limits.

4 RECOMMENDATIONS

Due to the low noise risk of this project, no further noise assessments during the design phase are recommended.

It is recommended that a site inspection/survey is undertaken following commissioning of the new ducting to verify noise from the new ducting is insignificant (which would confirm the conclusions of this report).

Wagerup Alumina Refinery

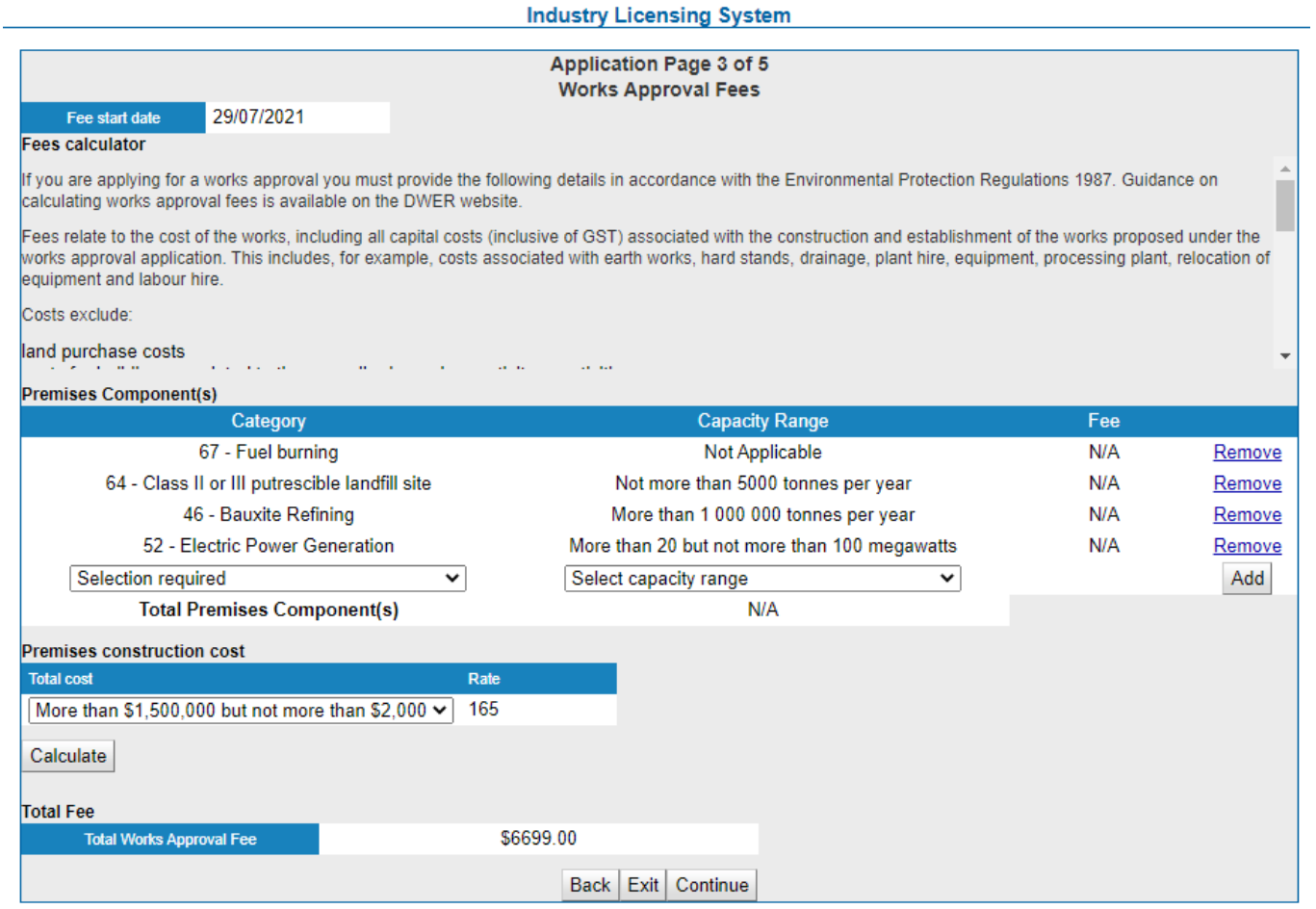
Works Approval Application for L6217/1983/15
VOC/Odour Emissions Reduction Project

Attachment 9
Fee Calculation

October 2021

Works Approval Fee Calculation

The proposed works approval application/assessment fee was calculated using the DWER Works Approval Fee Calculator www.der.wa.gov.au/WorksApprovalFeeCalculator



Industry Licensing System

Application Page 3 of 5
Works Approval Fees

Fee start date: 29/07/2021

Fees calculator

If you are applying for a works approval you must provide the following details in accordance with the Environmental Protection Regulations 1987. Guidance on calculating works approval fees is available on the DWER website.

Fees relate to the cost of the works, including all capital costs (inclusive of GST) associated with the construction and establishment of the works proposed under the works approval application. This includes, for example, costs associated with earth works, hard stands, drainage, plant hire, equipment, processing plant, relocation of equipment and labour hire.

Costs exclude:

land purchase costs

Premises Component(s)

Category	Capacity Range	Fee	
67 - Fuel burning	Not Applicable	N/A	Remove
64 - Class II or III putrescible landfill site	Not more than 5000 tonnes per year	N/A	Remove
46 - Bauxite Refining	More than 1 000 000 tonnes per year	N/A	Remove
52 - Electric Power Generation	More than 20 but not more than 100 megawatts	N/A	Remove
Selection required	Select capacity range		Add
Total Premises Component(s)	N/A		

Premises construction cost

Total cost	Rate
More than $1,500,000 but not more than $2,000	165

Calculate

Total Fee

Total Works Approval Fee	$6699.00

Back Exit Continue