ASK Consulting Engineers Pty Ltd
ABN: 55 622 586 522 ACN: 128 491 967
PO Box 3901 South Brisbane QLD 4101
P: 07 3255 3355 F: 07 3844 7180
www.askconsulting.com.au
mail@askconsulting.com.au

Dog Kennels and Training Facility

8 Austin Place, Orchard Hills

Odour Impact Assessment

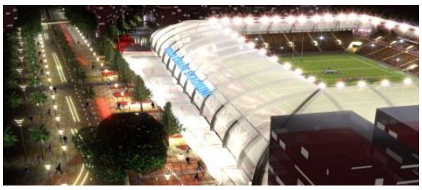
Report: 8108R01V05.docx

Prepared for:

Assistance Dogs Australia

29 October, 2018



Document Control				
W:\8100\8108 - Orchard Hills Dog Kennels\ASK Out\8108R01V05.docx				
Document Ref	**Date of Issue**	**Status**	**Author**	**Reviewer**
8108R01V01	4 July, 2017	Final	MR/AM	AM/MY
8108R01V02	13 December 2017	Response to RFI	MY	AM
8108R01V03	21 December 2017	Updated daily routine	MY	AM
8108R01V04	16 October 2018	Updated for revised plan	MY	AM
8108R01V05	29 October 2018	Minor updates	MY	AM

Document Approval	
Approver Signature	A P Martin
Name	Andrew Martin
Title	Air Quality Manager

Contents

1.	**Introduction**	**5**
2.	**Study Area Description**	**7**
3.	**Proposed Development**	**9**
3.1	Overview	9
3.2	Management Practices and Operations Relevant to Odour	11
4.	**Air Quality Criteria**	**12**
4.1	Penrith Local Environmental Plan 2010	12
4.2	Department of Environment and Conservation	12
5.	**Regional Climate**	**13**
5.1	Weather Stations	13
5.2	Existing Wind	13
5.3	Existing Temperature, Rain and Humidity	16
6.	**Existing Air Quality**	**17**
7.	**Assessment Methodology**	**18**
7.1	Overview	18
7.2	Choice of Modelling Year	18
7.3	TAPM Meteorological Modelling Configuration	19
7.3.1	TAPM Fundamentals	19
7.3.2	TAPM Configuration	19
7.3.3	TAPM Validation	19
7.3.4	Meteorological Data Assimilation	20
7.4	Graphical Information System	22
7.5	Calmet Modelling Configuration	23
7.6	Calmet Results	24
7.7	Odour Emission Inventory	26
7.7.1	Overview	26
7.7.2	Odour from Dog Kennels	26
7.7.3	Odour from Dog Waste Disposal (OSCA Bite Size Composter)	28
7.8	Calpuff Configuration	29
8.	**Dispersion Modelling Results**	**31**
8.1	Limitations	31
8.2	Results	31
9.	**Recommendations & Conclusion**	**33**
9.1	Recommendations	33

9.2 Conclusion 33

References **34**

Appendices

Appendix A Glossary **35**

Appendix B Proposed Daily Kennel Routine (Provided by ADA) **36**

Appendix C Odour Management Plan **37**

1. Introduction

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by Therian Pty Ltd to provide air quality consultancy services for the Assistance Dogs Australia (ADA) dog kennel and training facility, to be located at 8 Austin Place, Orchard Hills. The subject site is located to the south of the Western Motorway as shown in **Figure 1.1**.

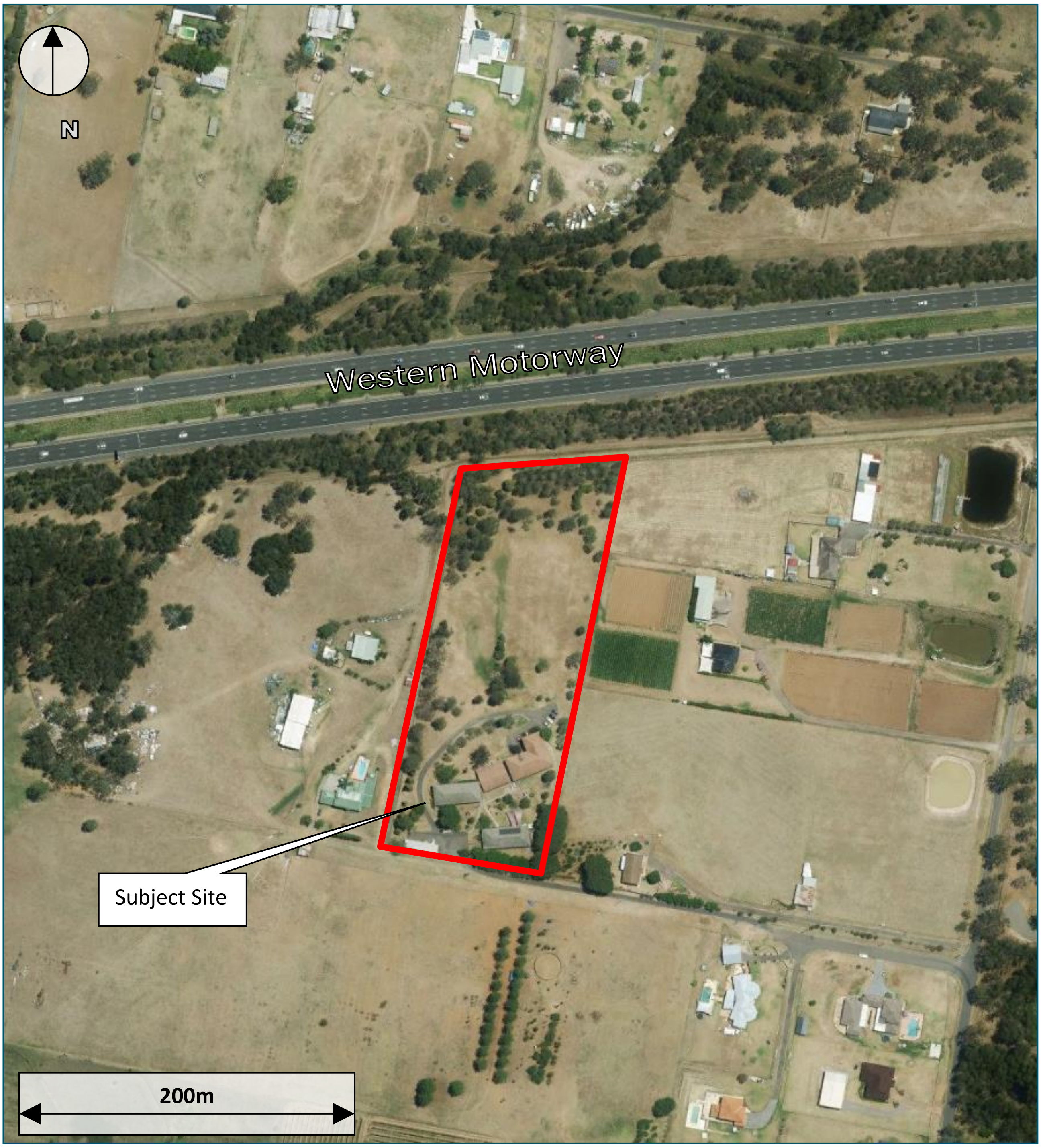


Figure 1.1 Location of Subject Site (Image from Google Earth Pro)

This report presents an assessment of odour impacts associated with the operation of the facility. Previous versions of this report (8108R01V01 dated July 2017 and 8108R01V03 dated 21 December 2017) had been lodged with the Development Application for the project. Due to changes in the plan layout, the assessment of odour impacts had been revised in this report, which is based on the following tasks:

- Review the project and the associated potential odour emissions.
- Review the subject site.
- Review the operation of a similar dog kennel and training facility operated by Guide Dogs Australia to understand potential sources of odour emissions.
- Develop an odour emission inventory based on review of publicly available information.
- Model meteorological conditions using TAPM and Calmet.
- Establish the state of the local climate including seasonal rainfall temperatures, humidity, wind roses, and inversion heights.
- Model the dispersion of odour emissions based on proposed activities using Calpuff to estimate levels of odour reaching sensitive receptors.
- Analyse the results of meteorological and pollutant dispersion modelling, and compare modelling results with the relevant air quality criteria.
- Prepare an odour management plan including objectives, strategies, performance indicators, specific control measures, monitoring & reporting, corrective actions and review mechanisms (**Appendix C**).

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

2. Study Area Description

The subject site is currently occupied by four existing buildings (Thorndale Cottages) and large areas of grassland. The development proposes to re-use the existing buildings on-site. The surrounding land uses follow:

- Western Motorway and road corridor to the north.
- Rural residential dwellings on large allotments to the west, east and south-east.
- Cleared land and crops to the south across Austin Place.

The subject site for the development is zoned as RU4 Primary Production Small Lots. Animal boarding or training establishments are nominated to be permitted with consent. It is noted that adjoining land is also zoned as RU4. The site is within the Penrith Local Environmental Plan area.

The nearest sensitive receptors are summarised in **Table 2.1** including their northing and easting locations and are shown in **Figure 2.1**.

Table 2.1 List of Sensitive Receptors with UTM Coordinates (WGS84 Z56)

ID	Number of Storeys	Name / Address	Approximate Distance and Direction from Site Boundary	Easting (m)	Northing (m)
A	2	17 Calverts Road	20 metres to the west	290271	6259274
B	1	17 Calverts Road	30 metres to the west	290280	6259362
C	2	19-29 Calverts Road	124 metres to the east	290537	6259419
D	2	31-37 Calverts Road	74 metres to the east	290476	6259362
E	2	39-49 Calverts Road	47 metres to the east	290425	6259239

Figure 2.1 Location of Site and Sensitive Receptors (Image from Google Earth Pro)

The receptor locations listed in **Table 2.1** and identified in **Figure 2.1** have the potential to be impacted by the proposed development. They were selected based on the presence of a residence, and the distance and direction of the receptor from the site and other receptors.

3. Proposed Development

3.1 Overview

The development includes the following components:

- Building A - offices and staff amenities
- Building B - conference rooms, cafe and kitchenette
- Building C - storage and agility rooms
- Building D - guest accommodation rooms
- Building E - kennel building including outdoor runs for the dogs
- Building F - caretakers residence
- Three outdoor dog training yards
- External potty areas
- Waste storage bins and/or waste composter
- Carparking areas and driveways

Vehicular access to the site is proposed via Austin Place at the southern boundary of the site. The site layout plan is shown in **Figure 3.1**.

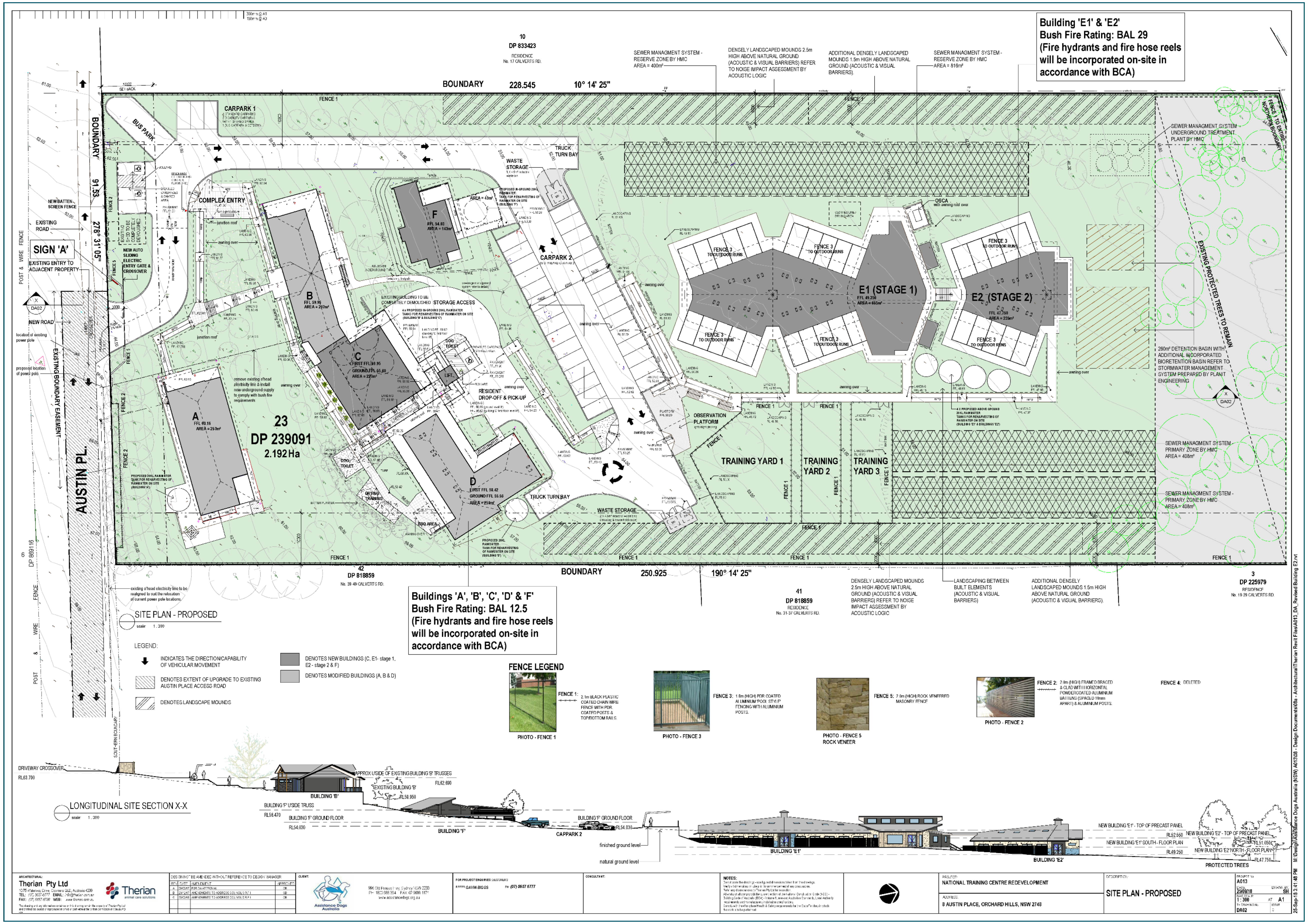


Figure 3.1 Site Layout Plan

3.2 Management Practices and Operations Relevant to Odour

The operating hours for the facility are as follows:

- Dog welfare staff hours: 7:00am to 9:00pm (7 days)
- Administration hours: 9:00am to 5:00pm (Mon to Fri).

The proposed routine for the operation of the kennels as provided by ADA is included in **Appendix B** in **Table B.1** and **Table B.2**.

ASK has been advised that the following management practices will be applied in the operation of the facility:

- Dogs will be let into outside yards of a morning for toileting. Dog waste will be immediately cleaned up, with buckets provided inside each external exercise yard for deposit of dog faeces from within the yards.
- Solid dog waste produced in the kennel will be removed manually by staff, and will not be processed by the wastewater treatment system.
- The facility will be serviced by three industrial bins (two general, one recyclables).
- Waste disposal will either be facilitated by removal from the site (organised collection) or via an organic composter, specifically the OSCA Bite Size composter. It is expected that the composter will be powered via solar panels, as the use of renewable energy is desirable for the project.
- Cleaning of internal kennel areas and outdoor pen areas will commence after 8am and will occur for approximately one hour, typically from 8:30am to 9:30am. Further spot cleaning in these areas will be carried out as required throughout the day.
- Designated potty area will be located throughout the site. Dog waste in potty areas will be cleaned up immediately as per waste collection in external yards.

An Odour Management Plan (OMP) has been developed for the facility, including the management practices nominated above, and is included in **Appendix C**.

4. Air Quality Criteria

4.1 Penrith Local Environmental Plan 2010

The subject site for the development is zoned as RU4 Primary Production Small Lots. Animal boarding or training establishments are nominated to be permitted with consent. It is noted that adjoining land is also zoned as RU4. The site is within the Penrith Local Environmental Plan area.

The Penrith Local environmental Plan does not include any odour assessment criteria and therefore the criteria specified by Department of Environment and Conservation (DEC 2006) will be applied in the assessment.

4.2 Department of Environment and Conservation

The relevant criteria for assessment of the cumulative odour from a mixture of compounds are specified by Department of Environment and Conservation (DEC 2006) and reproduced in **Table 4.1**.

Table 4.1 Cumulative Odour Assessment Criteria (99%, 1 second)

Population of affected community	**Criteria (ou)**
1 or 2 (Single rural residence)	7.0
~10	6.0
~30	5.0
~125	4.0
~500	3.0
~2000 (urban area or schools or hospitals)	2.0

ASK has discussed the application of the odour criteria with NSW EPA and has been advised that the "affected community" is defined by the population of the community that the concentration criteria contour reaches. For the purposes of the assessment, the community does not have a well-defined boundary.

It is noted that the 2 ou criterion is specified by DEC for "urban areas", or an area with approximately 2,000 residents. Due to the number of nearby residential dwellings the actual "population of affected community" is likely much less than 2,000 residents, and closer to 125 (4 ou criterion) people.

As also nominated in **Table 4.1**, the odour concentration criterion is assessed against the predicted 99th percentile odour concentration. Over a period of one year, or 8,760 hours, this corresponds to the 88th highest predicted concentration, and therefore the determination of the buffer zone is based on the 88th exceedance of the odour concentration criterion of 4 ou.

5. Regional Climate

The subject site is located approximately 45 kilometres west of Sydney, and to the south-east of the Blue Mountains National Park. The climate for the regional area is discussed within this section.

5.1 Weather Stations

A search of the Bureau of Meteorology's weather station directory has revealed that the nearest station to the subject site is the Penrith Lakes AWS station , which has data available for the period from 1995 to 2016 (variable for different climate parameters). The data available from this station is discussed within the following sections.

Meteorological data from the Department of Planning and Environment Office of Environment & Heritage (OEH) ambient air monitoring station at St Marys was obtained for assimilation into the model run. This data is discussed in **Section 7.3.4**.

5.2 Existing Wind

Wind roses derived from the Penrith Lakes data over the period 2008 and 2011 to 2014 are provided in Figure 5.1 to **Figure 5.5**. These years of data were obtained since they correspond to the last five years of TAPM input data held by ASK.

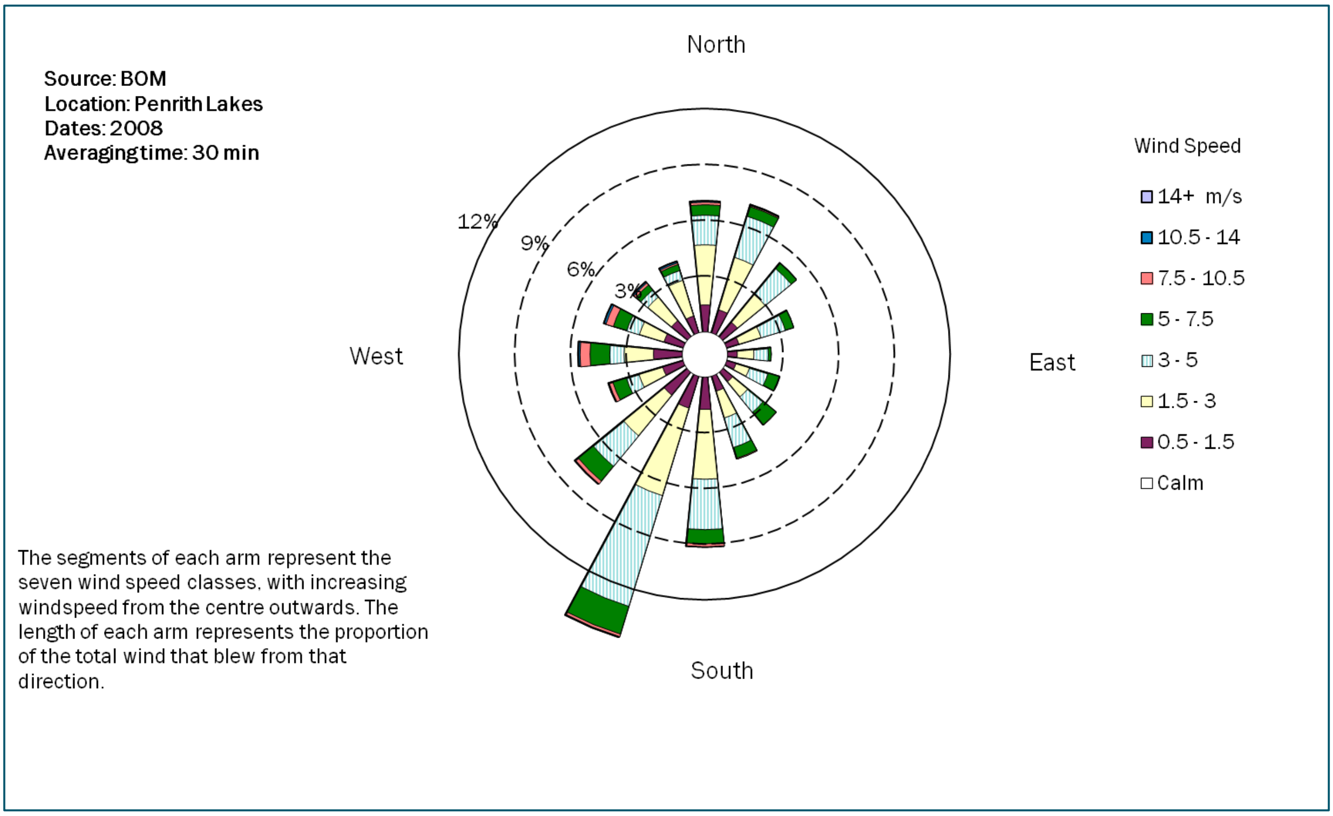


Figure 5.1 Wind Rose for Penrith Lakes in 2008

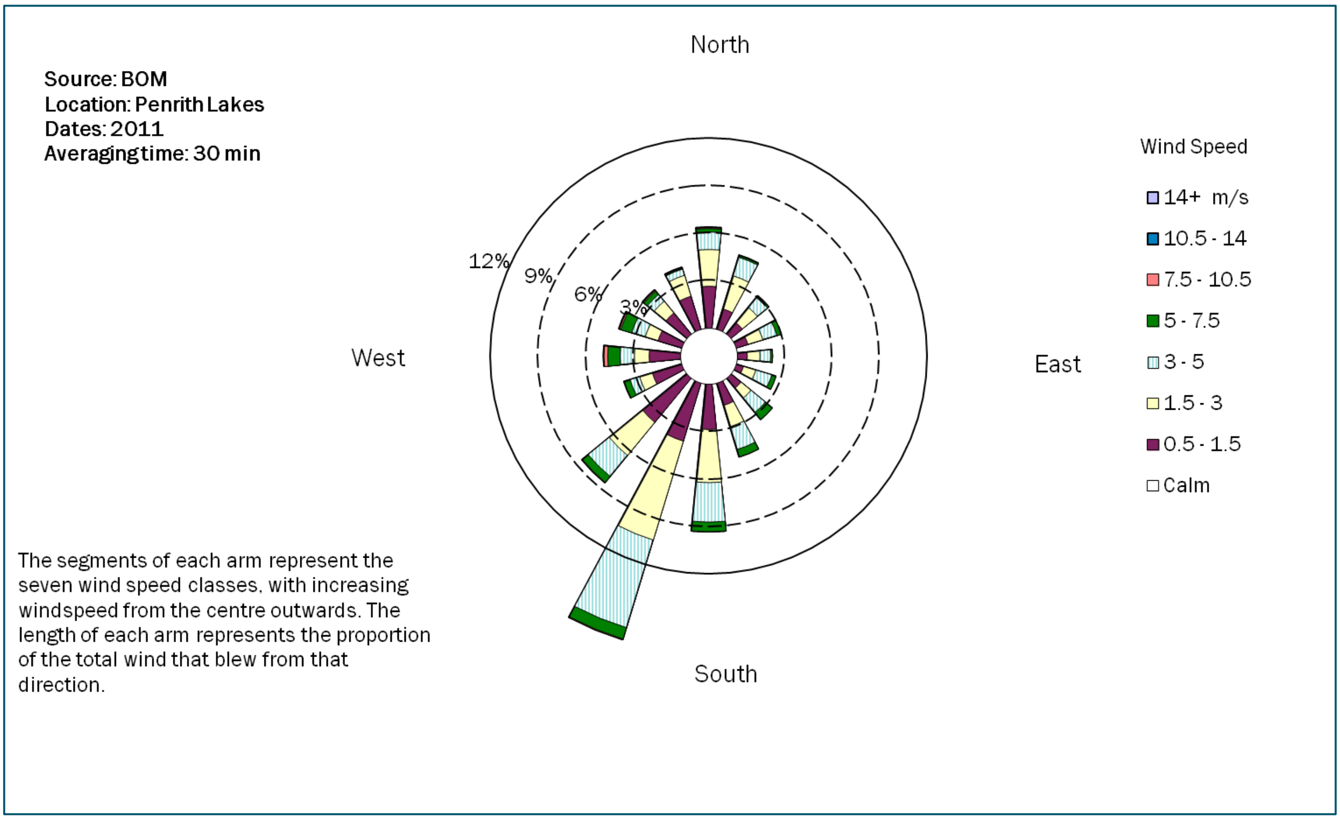


Figure 5.2 Wind Rose for Penrith Lakes in 2011

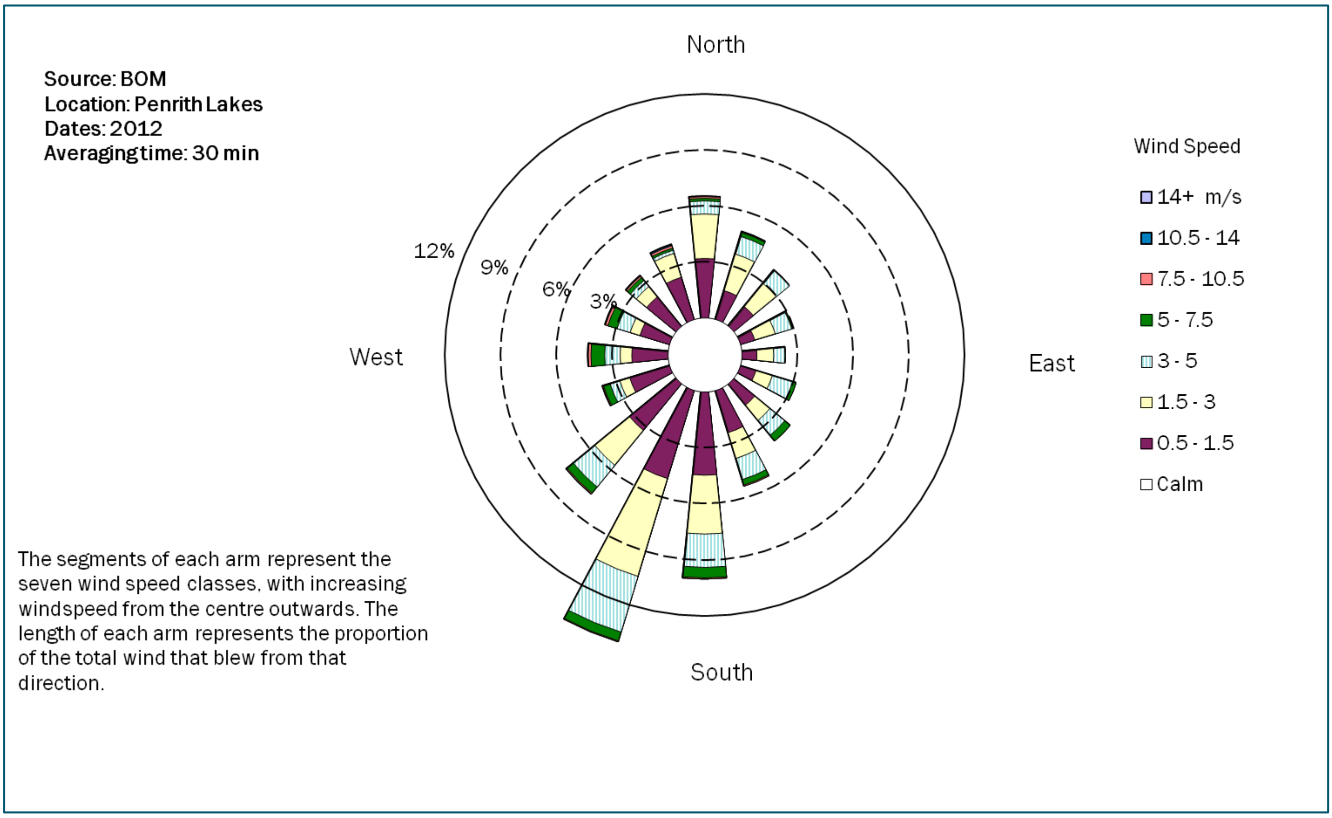


Figure 5.3 Wind Rose for Penrith Lakes in 2012

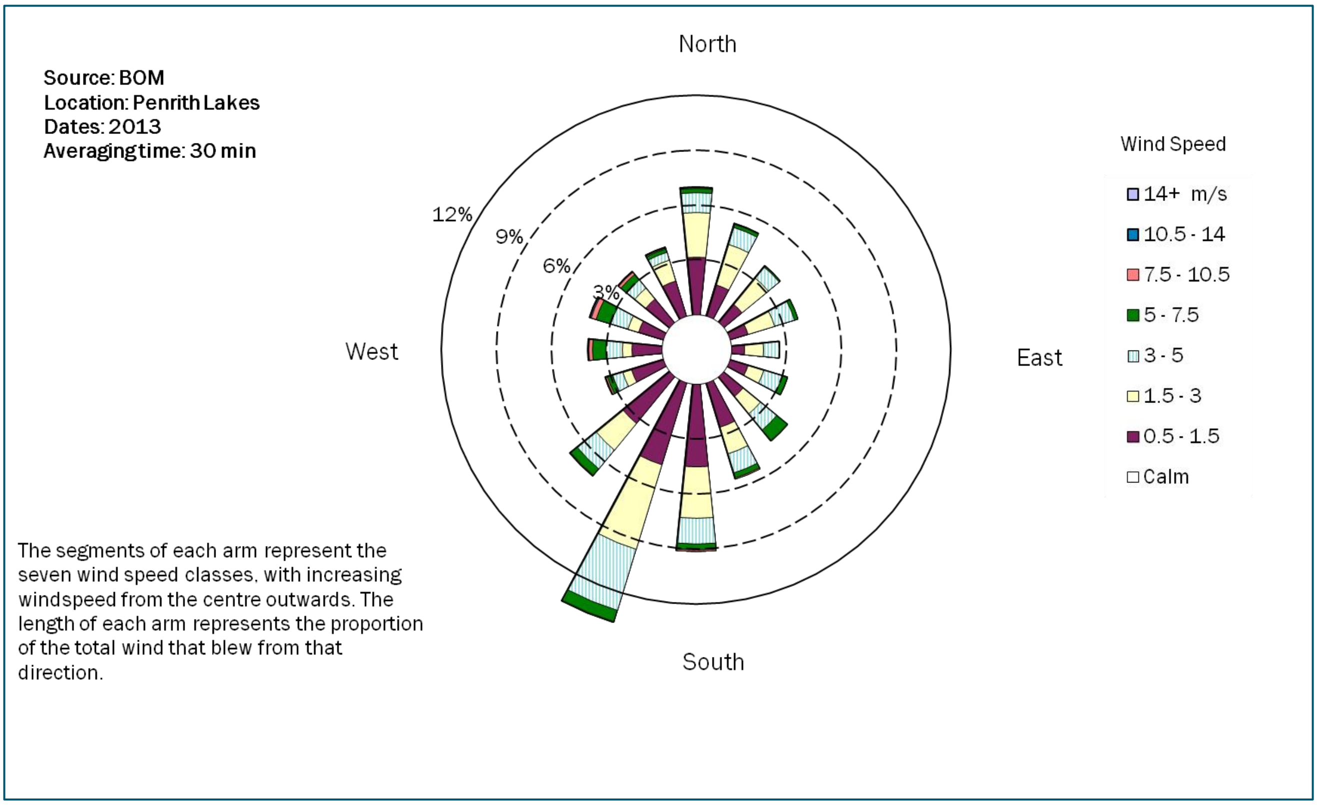


Figure 5.4 Wind Rose for Penrith Lakes in 2013

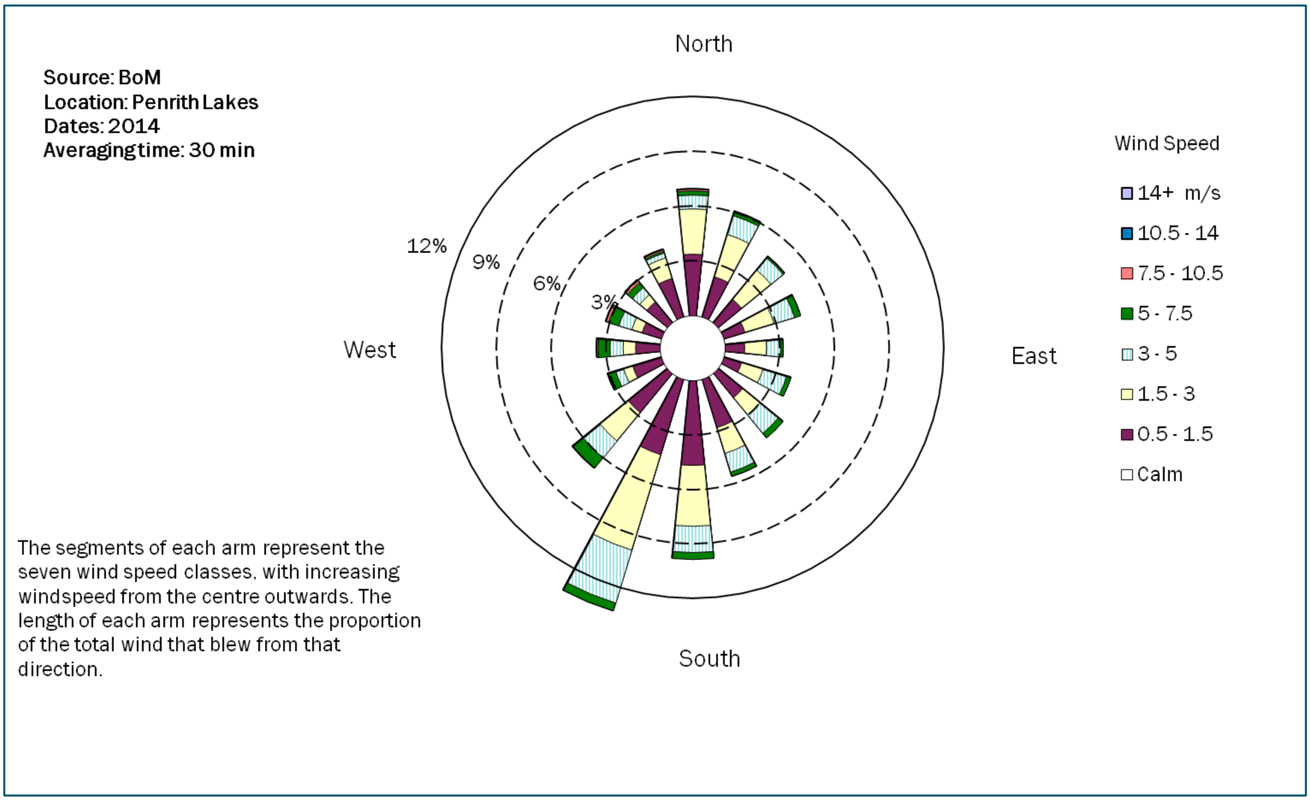


Figure 5.5 Wind Rose for Penrith Lakes in 2014

5.3 Existing Temperature, Rain and Humidity

Long-term weather and climate data from the Penrith Lakes AWS weather station are summarised in **Table 5.1**. Climate statistics are available from this weather station for the years 1995 to 2015 for temperature, 1995 to 2016 for rainfall, and 1995 to 2010 for relative humidity.

Table 5.1 Climate Statistics for Penrith Lakes AWS

Month	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°C)	Mean Monthly Rainfall (mm)	Highest Monthly Rainfall (mm)	Lowest Monthly Rainfall (mm)	Mean 9am Relative Humidity (%)	Mean 3pm Relative Humidity (%)
Jan	31	19	101	308	19	73	47
Feb	29	19	127	275	15	79	53
Mar	28	17	72	186	18	80	52
Apr	24	13	53	259	2	76	49
May	21	9	40	150	4	81	52
Jun	18	7	52	226	3	85	55
Jul	18	5	30	82	4	83	50
Aug	20	6	31	161	0	72	41
Sep	23	9	31	94	4	64	40
Oct	26	12	53	256	5	60	41
Nov	27	15	86	206	13	68	46
Dec	29	17	62	164	26	69	45
Mean	25	12	62	197	9	74	48

6. Existing Air Quality

The only regional sources of odour are occasional vegetation fires. Unlike other air quality criteria, odour criterion relate to the source under assessment and any associated odours. Odours from other sources are not considered a cumulative impact unless associated with the same source.

For the purpose of comparison with criterion, regional background odour is normally assumed to be zero.

7. Assessment Methodology

7.1 Overview

In order to predict what happens to the pollutants after they are emitted to air, a mathematical model is used to simulate their dispersion and deposition. It is accepted by regulatory agencies that this type of modelling has associated uncertainties. These are normally addressed by using statistics over long simulation times, and deriving emission rates based on published emission factors or data representing high emission conditions.

With sources close to ground level, the critical wind conditions tend to be near-calm i.e. low wind speeds. Gaussian plume models such as Ausplume and Aermod cannot model calm conditions and have low accuracy in light winds, especially in valleys where katabatic flows are present and where drainage flows turn to follow the valley. Calpuff, being a non-steady-state Lagrangian puff model, is able to simulate stagnation over time, which is critical in near-calm conditions. Its meteorological pre-processor Calmet performs diagnostic simulation of terrain effects on the wind field. It has a specific slope flow algorithm that predicts katabatic flows (Scire, J.S. & Robe, F.R., 1997).

Due to the low source height for emissions sources associated with the Project, the worst conditions may be near-calm conditions. Thus Calpuff (Version 6.4.2) was chosen as the most appropriate model. The predictions undertaken for this assessment are based on the following method:

- The activity scenario selected for modelling was based on the highest potential to cause impact to nearby sensitive receivers.
- Odour emissions estimates were based on the review of odour emission data presented within publicly available literature.
- Prediction of input meteorology was completed using TAPM developed by the CSIRO Division of Atmospheric Research. TAPM has a prognostic 3 dimensional meteorological component which can be used to generate hourly meteorological data for input into dispersion models.
- TAPM input meteorology was enhanced using Calmet, the meteorological pre-processor for Calpuff.
- Odour concentrations were predicted using Calpuff.

7.2 Choice of Modelling Year

To determine the meteorological year of data to use in the assessment, climate data (including rainfall and wind speed and direction) was requested for the years 2008, 2011, 2012, 2013 and 2014 from the BoM weather station at Penrith Lakes (Penrith Lakes AWS), located approximately 9 kilometres north-west of the subject site. Note: climate data for the years 2009 and 2010 were not requested as ASK does not own the TAPM meteorological data for these years. The percentage of calm conditions, the percentage of low wind speeds (0.5 to 1.5m/s), and the level of rainfall recorded at the Penrith Lakes station are presented in **Table 7.1.**

Table 7.1 Wind Speed and Direction Analysis (Year 2008, 2011 to 2014)

Year	2008	2011	2012	2013	2014
Percentage Calm	9.8%	14.3%	15.9%	15.2%	14.2%
0.5 - 1.5m/s (all directions)	17.7%	28.5%	35%	33.9%	34.9%
Annual Rainfall (mm)	867.2	704.6	905.4	763	693.6

Due to the high percentage of calm periods and low wind speeds and lowest rainfall levels, the year 2014 was determined to be the worst case for potential odour impacts from low sources and therefore meteorological data from this year was used in the modelling.

7.3 TAPM Meteorological Modelling Configuration

7.3.1 TAPM Fundamentals

The meteorological component of The Air Pollution Model (TAPM) was used to provide wind fields over the region.

The databases required to run TAPM are provided by CSIRO and include global and Australian terrain height data, vegetation and soil type datasets, sea surface temperature datasets and synoptic scale meteorological datasets.

The Australian terrain data is in the form of 9-second grid spacing (approximately 0.3 kilometres) and is based on data available from Geosciences Australia. Australian vegetation and soil type data is on a longitude/latitude grid at 3-minute grid spacing (approximately 5 kilometres) and is public domain data provided by CSIRO Wildlife and Ecology.

The synoptic scale meteorology dataset used is a six-hourly synoptic scale analysis on a longitude/latitude grid at 0.75 or 1.0-degree grid spacing (approximately 75 kilometres or 100 kilometres). The database is derived from US NCEP reanalysis synoptic product.

TAPM dynamically fits the gridded data for the selected region to finer grids taking into account terrain, surface type and surface moisture conditions. It produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

7.3.2 TAPM Configuration

The year 2014 has been used for the meteorological simulation as discussed in **Section 7.2**.

TAPM was setup using four nested 30 x 30 grids centred on latitude -33°47.0’ south, longitude 150°44.0’ east, which are coordinates within one kilometre of the site. The four nested grids were as follows:

- 750 km x 750 km with 30 km resolution
- 250 km x 250 km with 10 km resolution
- 75 km x 75 km with 3 km resolution
- 22.5 km x 22.5 km with 900 m resolution

Thirty (30) vertical levels were used with lower level steps at 10, 25, 50, 75 and 100 metres up to 8 kilometres in altitude. Boundary conditions on the outer grid were derived from the synoptic analysis. Non-hydrostatic pressures were ignored due to the gentle terrain and moderate resolution.

TAPM land use data was updated using the latest aerial photography available being August 2015 from the Google Earth Pro.

7.3.3 TAPM Validation

The TAPM GIS visualisation tool was used to examine the windfields generated by the model. The last few hours of the year were reviewed to ensure the model completed the run correctly. The windfields in the inner grid throughout the month of June were examined in detail to understand the local wind patterns, influence of topography. The following patterns were observed:

- Local topography did not substantially influence wind conditions. However the edge of the Blue Mountains has a substantial influence with morning drainage flows and lower wind speeds in the afternoon along that side of the domain.
- South-westerlies dominated for most of that month.
- Afternoon winds were mostly moderate to strong south-westerlies.
- Morning and night winds were mostly light south-westerlies.

7.3.4 Meteorological Data Assimilation

Meteorological data from the Department of Planning and Environment Office of Environment & Heritage (OEH) ambient air monitoring station at St Marys was obtained for assimilation into the model run. This station is located on Mamre Road at latitude -33°47’43” longitude 150°46’01”, 3 kilometres to the east-south-east of the subject site. Based on the length of shadows on aerial photography, the height of the weather mast was assumed to be 10 metres.

A windrose of the OEH data is shown in **Figure 7.1** with 26% near calm (<0.5 m/s) conditions. TAPM was run without assimilation of this data and the windrose for the same period is shown in **Figure 7.2**. TAPM predicted a lower proportion of light wind conditions, which is typical. There also appears to be a rotational difference with the observational data appearing to be approximately 45° anti-clockwise of the TAPM data. According to OEH, the observational data is aligned to true north. Its predominant wind directions are north and south. A wind rose for the nearest BoM site (Penrith Lakes AWS) is shown in **Figure 7.3**. This is consistent with the OEH St Marys data. Therefore the OEH observational data was included into the TAPM model for generating data for the project.

The validation process described in **Section 7.3.3** was repeated with similar results. The assimilated data fluctuated more than the surrounding modelled data, which is typical. It also showed a small anti-clockwise shift but was otherwise reasonably consistent in time to the direction and amplitude of the modelled data. Reasonably smooth transition was observed at the edge of the zone of influence of the assimilated data.

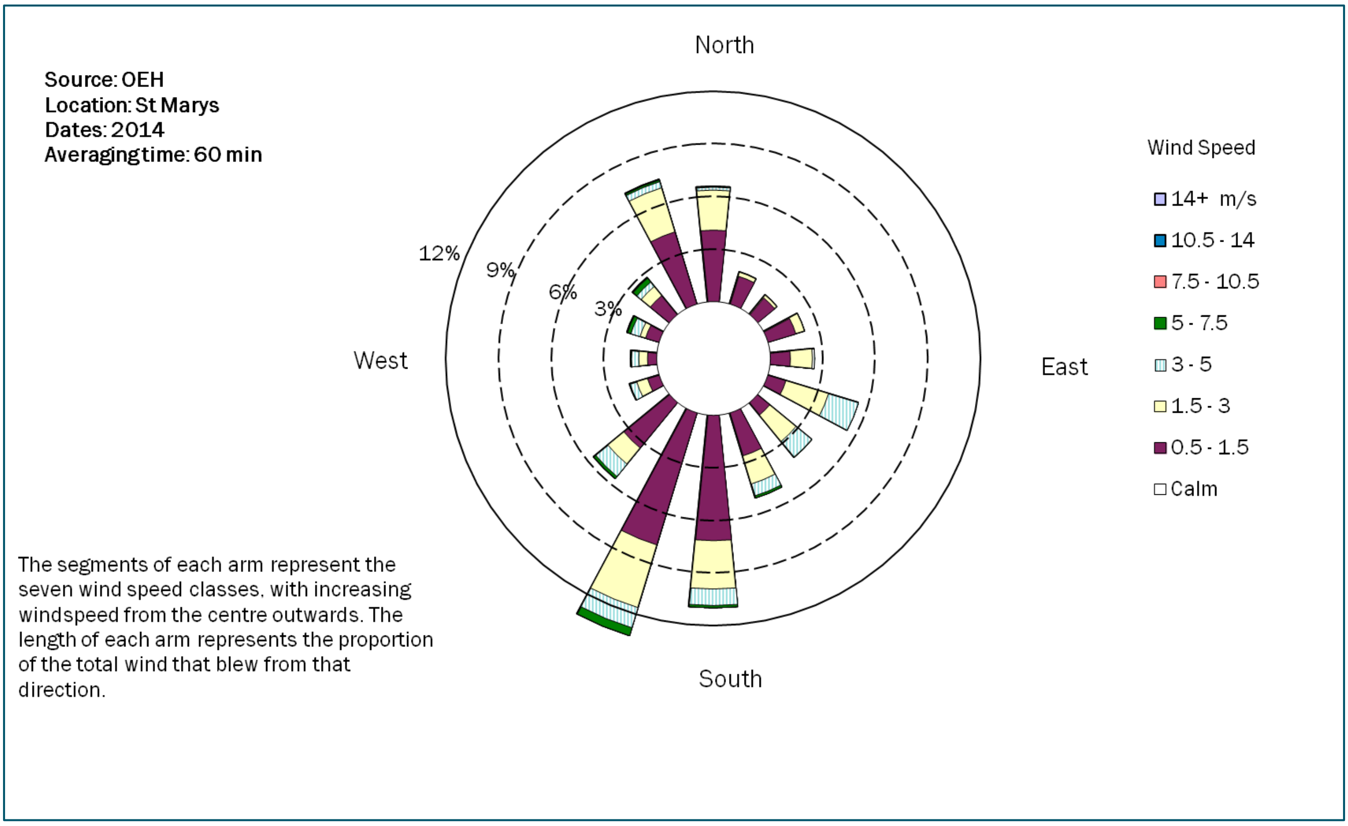


Figure 7.1 Wind Rose of St Marys 2014 Weather Station Data

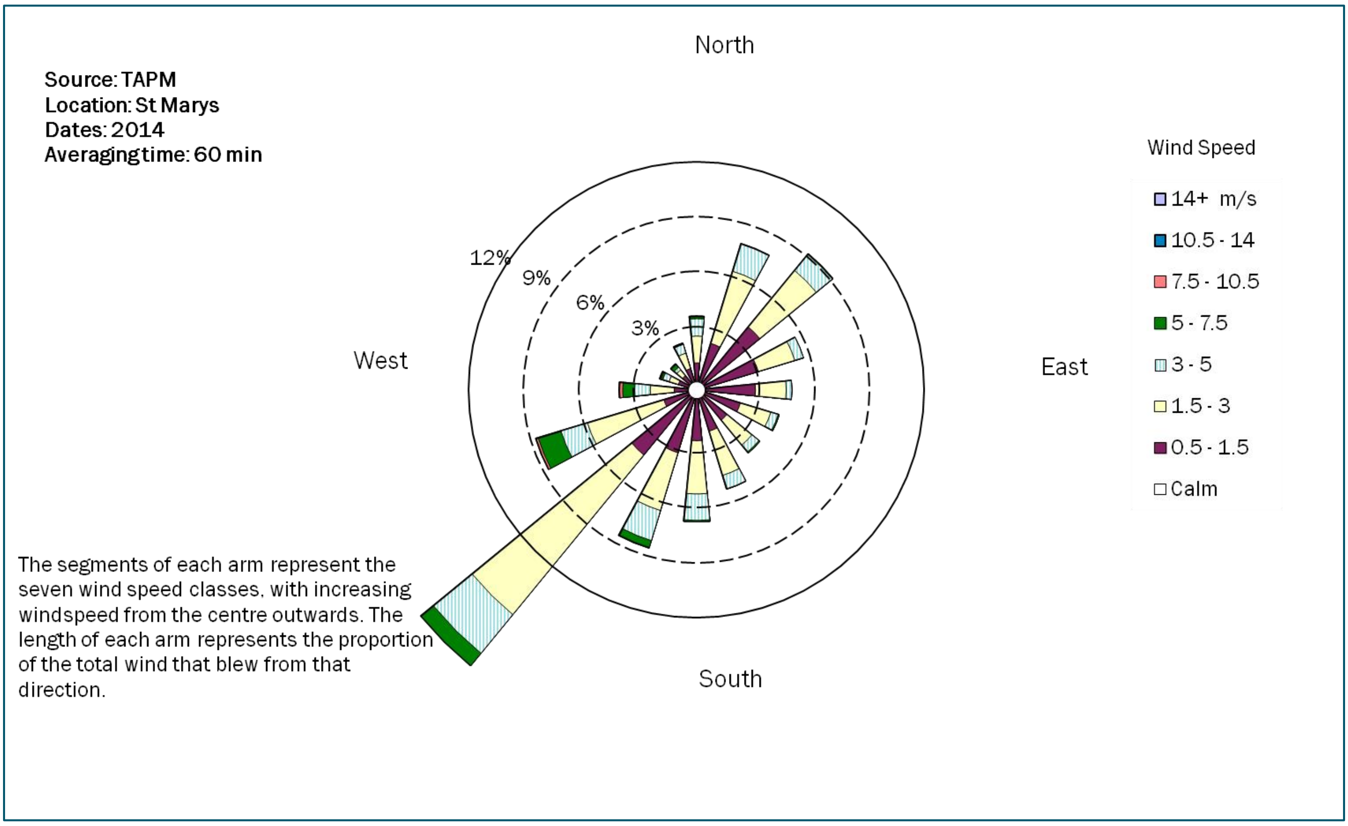


Figure 7.2 Wind Rose from TAPM for 2014 near St Marys Weather Station

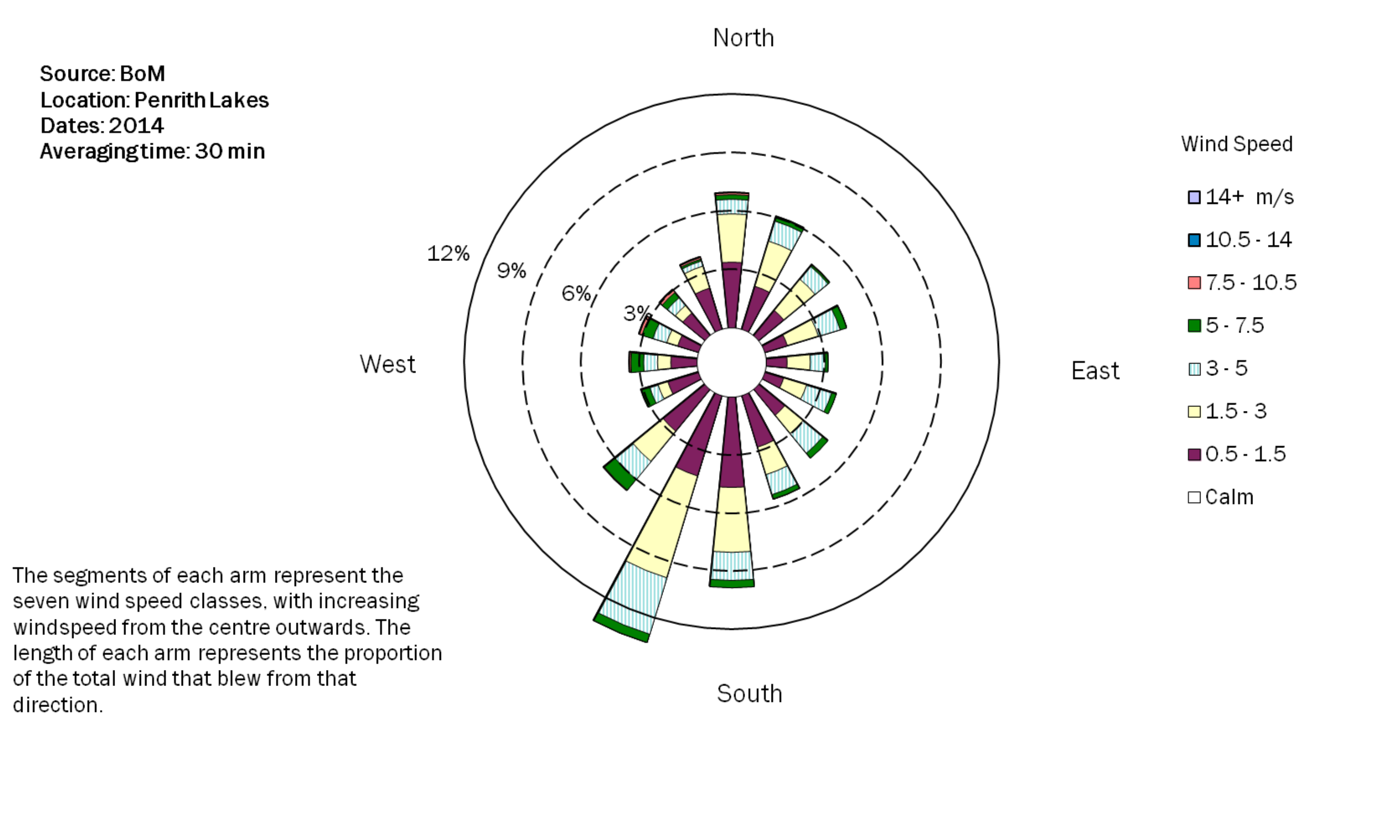


Figure 7.3 Wind Rose from Bureau of Meteorology weather station at Penrith lakes for 2014

7.4 Graphical Information System

For the purpose of providing topographic data for the detailed modelling, the coordinates of a rectangular grid representative of the area around the proposed site were derived using WGS84 coordinates from Google Earth Professional. The south-west corner coordinates were (287300, 6256300), north-east corner coordinates were (293300, 626300) and the grid interval was 100 metres with zero height receptors.

The WGS84 and GDA94 grids are identical to an accuracy of less than one metre. All coordinates in this report are rounded off to the nearest metre and are valid for both coordinate grids.

Gridded topographic data for Calmet was created by importing Shuttle Radar Topography Mission (SRTM) elevations on a 1-second grid (approximately 30 metre spacing). This is illustrated in **Figure 7.4**.

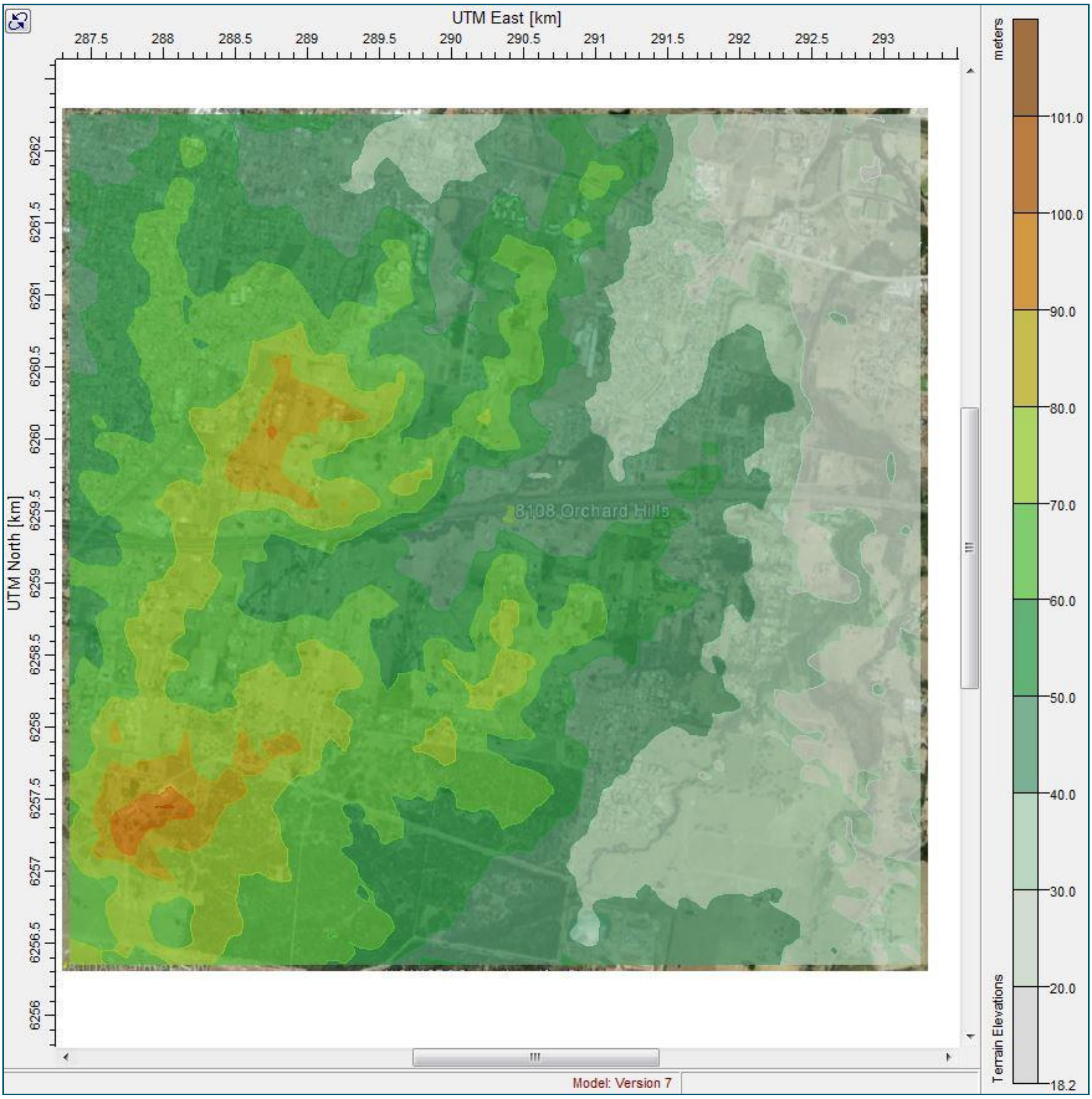


Figure 7.4 Topographic Data used in the Calmet Model

7.5 Calmet Modelling Configuration

The Calmet configuration used is consistent with NSW OEH guidance (TRC 2011).

The model was run over the full year of 2014 based on a 3-dimensional grid produced using the Caltapm utility program to convert TAPM data to MM5 format suitable for Calmet to read. The Calmet grid was set to grid spacing of 100 metres and 60 by 60 grid points. Twelve vertical layers were modelled with cell face heights of 0, 20, 40, 80, 160, 300, 450, 650, 900, 1200, 1700, 2300, and 3200 metres. This is greater than normal number of vertical layers in order to provide better resolution of vertical layers.

Mixing height calculation parameters were set to default values. The maximum mixing height was set to 3000 metres. Temperature prediction parameters were set to default.

Divergence minimisation was used. The critical Froude number was set to 1. Slope flow effects were included. The radius of influence of terrain features was set to 1.2 kilometres being approximately half the distance between ridges.

The output from Calmet was a three dimensional grid of wind-field data for incorporation into Calpuff.

7.6 Calmet Results

The frequency distributions of occurrences of winds for each direction sector and for each wind class (wind rose) as generated by Calmet are illustrated in **Figure 7.5**. As expected, this shows a similar pattern to both the TAPM modelled and measured winds at nearby locations as shown in **Figure 7.1** to **Figure 7.3**. Predominant winds were from the south-west quarter including 22% of light winds less than 0.5 m/s.

Figure 7.5 Wind Rose from Calmet output for 2014 at Orchard Hills

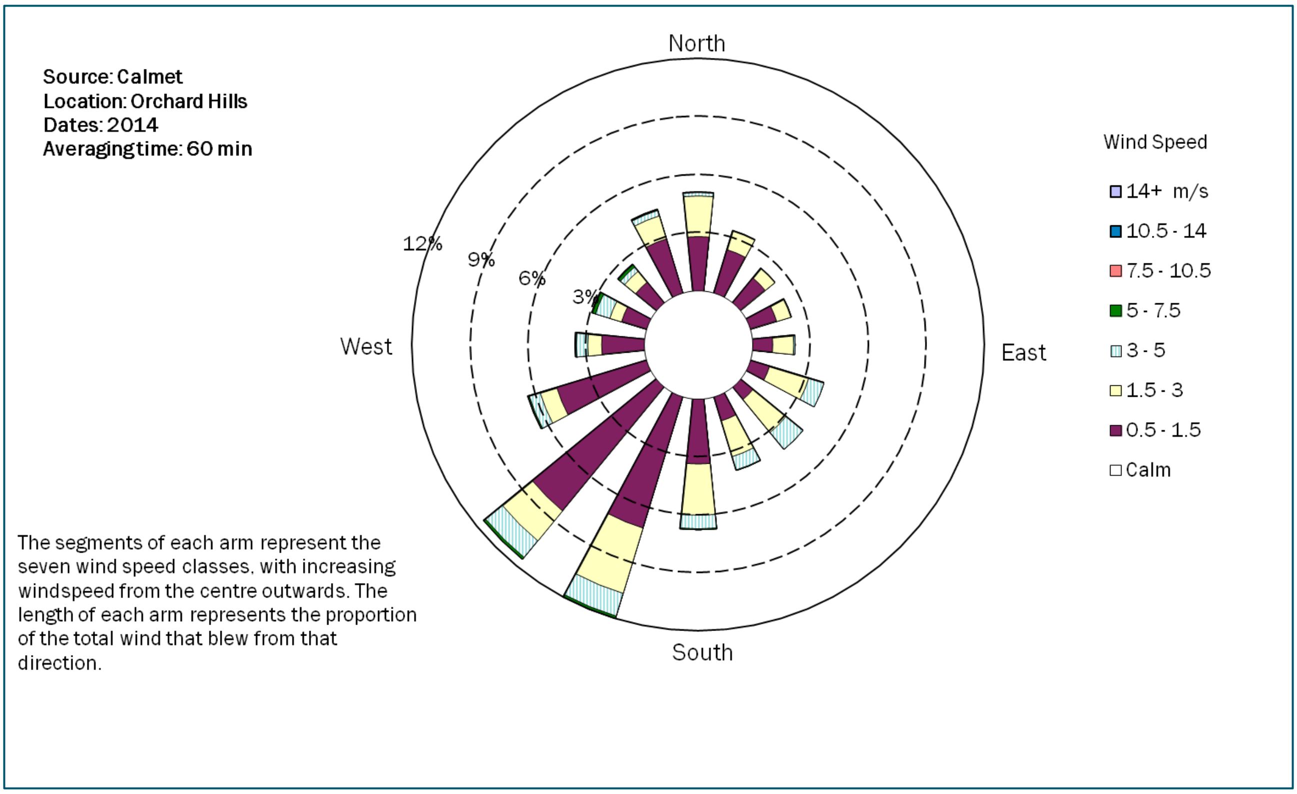


Figure 7.5 and **Figure 7.6** show, respectively, the frequency of stable conditions throughout the day, and the variation of mixing height throughout the day. Day time conditions are either neutral or unstable.

In the morning the mixing height rises up gradually reaching an average of approximately 1.2 kilometres by the afternoon, then reforming at ground level again at nightfall.

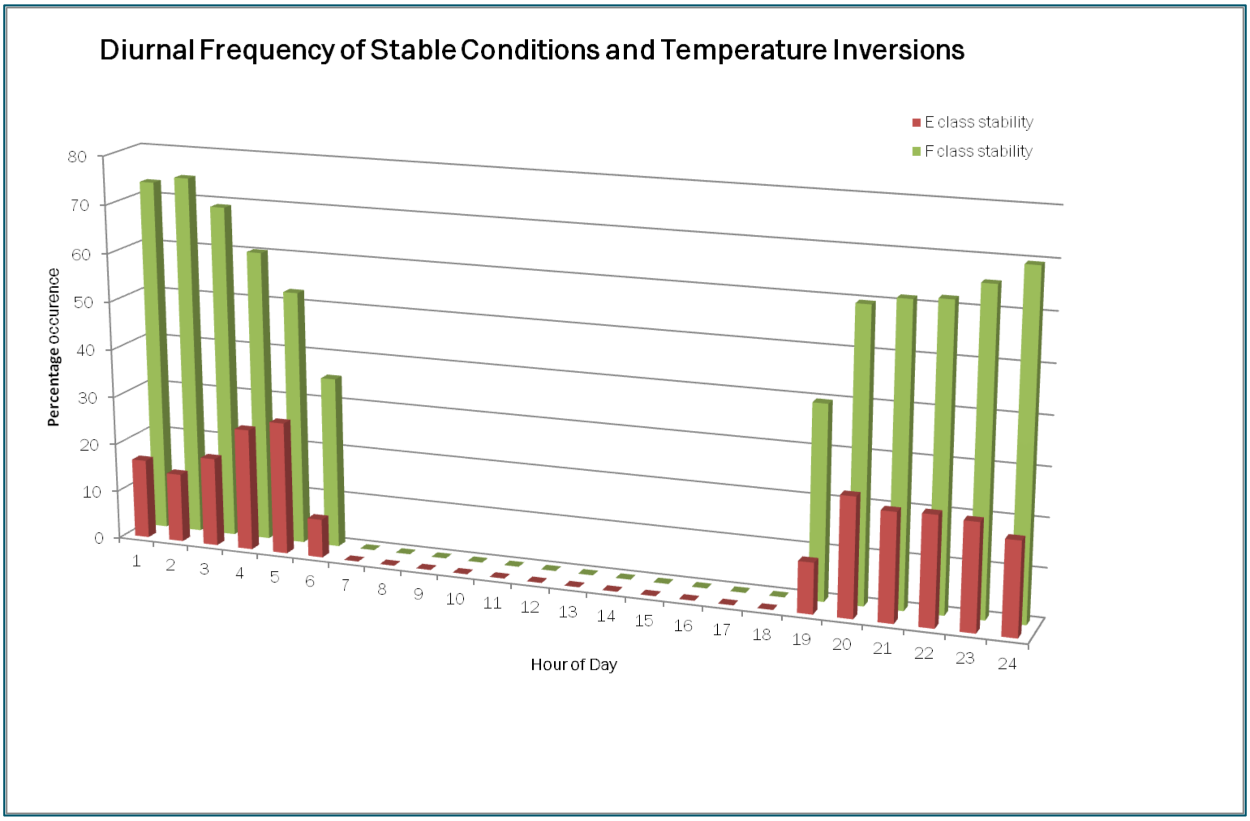


Figure 7.6 Diurnal Frequency of Stable Conditions

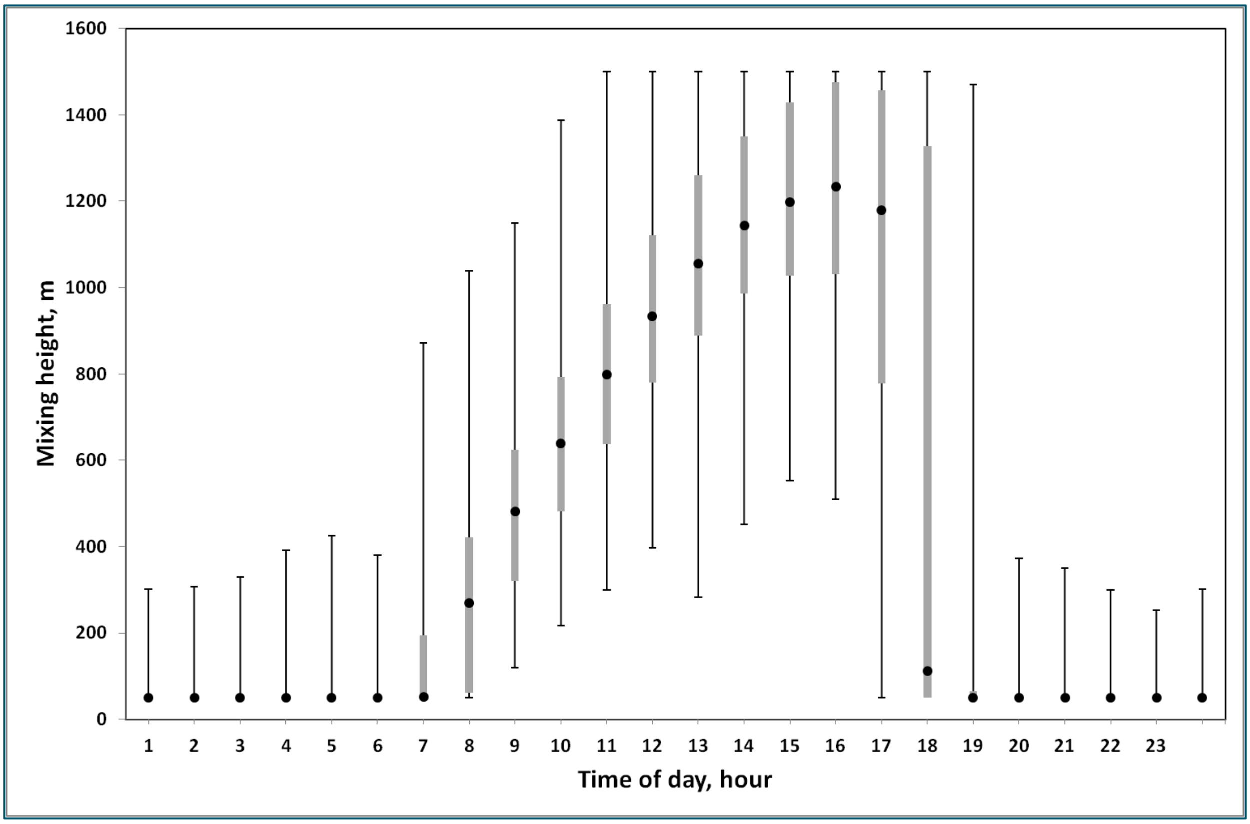


Figure 7.7 Prediction of Mixing Height from Calmet Model

7.7 Odour Emission Inventory

7.7.1 Overview

To assess odour emissions from new developments it is common practice to apply emission factors or data available for similar activities. In this instance, there is only one known source of information for odour emissions from dog kennels: an odour impact assessment conducted by Holmes Air Sciences for a dog kennel and cattery proposed to be located in Glossodia, NSW.

The odour impact assessment conducted by Holmes Air Sciences nominates the following potential odour emission sources:

- odour from wastewater/sewage treatment system
- dog waste disposal
- odour from dog kennels

The Holmes Air Sciences report also discusses odour emissions from dog waste produced in external exercise yards. Similarly to the proposed ADA facility, the waste collection procedures of the facility assessed in the Holmes Air Sciences included immediate collection of waste and storage in sealed containers (bagged and binned), and on that basis odour emissions from waste in exercise yards was not considered to result in significant odour impacts. On this basis, odour from dog waste in exercise yards has not been considered in dispersion modelling of odour emissions.

ASK has been provided the following information regarding the proposed wastewater treatment system for the facility (as shown in Appendix 1 of HMC 2018):

- The kennel drainage system is vented at the building sewage vents as per the Plumbing Code to prevent odour build-up from interior drains.
- Wastewater treatment will be undertaken in sealed tanks, with an elevated vent with a wind-driven exhaust fan typically above the last treatment tank.
- The treatment system will include aerobic digestion, secondary treatment and disinfection.
- Treated wastewater will be pressure dosed in the aggregate distribution bed layer below the surface of the proposed sand mounds.
- The treatment tanks are to be located in the north-west corner of the site approximately 100 metres from the nearest residence.

Based on the details above, odour emissions from the wastewater treatment system are likely to be minimal, and therefore odour from this source has not been considered in dispersion modelling of odour emissions.

Odour emissions from dog waste disposal and the dog kennels themselves are considered within this assessment and are discussed further in **Section 7.7.2** and **Section 7.7.3**.

7.7.2 Odour from Dog Kennels

Odour emissions from the dog kennels have been estimated based on the odour monitoring undertaken by Holmes Air Sciences at a dog kennel in Heathcote, Victoria. This monitoring was undertaken for the odour assessment of the Glossodia project.

Odour monitoring at the Heathcote kennel was undertaken during the morning and afternoon. The Holmes Air Sciences report states that cleaning of the Heathcote kennel occurred in the morning, and that odour emissions during cleaning periods was higher than during normal operation due to the use of cleaning products which included masking agents. The description of the odour samples from the Holmes Air Sciences report for the morning and afternoon samples are as follows:

- Morning samples: masking agent (cleaning products)
- Afternoon samples: musty, wet dog, must stick and shampoo.

Based on the odour monitoring conducted at Heathcote, the Holmes Air Sciences report calculated the odour emission rate per dog based on the morning (219.4 ou.m^3/s/dog) and afternoon (43.0 ou.m^3/s/dog) samples. These odour emission rates have been applied in the assessment of the proposed facility. To assess the potential worse case odour emissions from the kennels, it has been assumed that the kennel is at maximum capacity for the entire year. It is understood that the current proposal is for a capacity of 60 dogs.

Odour emissions from the kennel have been modelled with diurnal variation to ensure higher odour emissions during cleaning are considered in the prediction of odour impacts.

The calculated odour emission rates for the kennel are presented in **Table 7.2**. As presented in the routine timetables included in **Appendix B**, cleaning of internal kennel areas and outdoor pen areas will commence at 8:30am and will occur over a duration of one hour, and therefore odour emissions between 8:00am and 9:00am have applied the higher odour emission rate.

Table 7.2 Kennel Odour Emission Rates

Hours of the Day	Odour Emission Rate per Dog (ou.m^3/s/dog)	Assumed Total Number of Dogs	Overall Odour Emission Rate (ou.m^3/s)
8:00am to 9:00am	219.4	60	13164
Midnight to 8:00am, 9:00am to Midnight	43.0	60	2581

As noted in the kennel routine included in **Appendix B**, dogs will not always be present in the internal kennel areas, and therefore odour emissions may not be as high during periods when the internal areas are not occupied. However based on a site visit to a similar dog kennel facility in Glossodia (Guide Dogs Australia), odour is detectable within internal kennel areas without the presence of dogs, and therefore for the purposes of this assessment it has been assumed that odour emissions are of the same strength even when internal areas are unoccupied.

ASK has been advised that the kennel building will be mechanically ventilated, however detailed design of the mechanical services for the building has not yet been undertaken. For the purposes of modelling it has been assumed that the exhaust vents for the kennel building will be located within the two turrets of the kennel building located between wings A and B and between wing C. The extracted air volume applied in the modelling has been assumed based on a ventilation rate of one building volume per hour, however the volume was calculated based on the kennel wings (i.e. wings A and B, and wing C), and did not include the administration core of the kennel building.

To distribute odour emissions, two point sources were included for the kennel building (each of the turrets), with the odour emission rates presented in **Table 7.2** spread evenly (50% each) between these two vents. The emission source details for the kennel building are presented in **Table 7.3**.

Table 7.3 Kennel Building Point Source Details

Source	X Coordinate (m, UTM)	Y Coordinate (m, UTM	Source Height (m)	Estimated Volume (m^3)	Vent Diameter (m)	Vent Pipe Area (m^2)	Exhaust Velocity (m/s)	Exhaust Flow Rate (m^3/s)	Exhaust Temperature (°C)
Wings A and B	290350	6259362	7	1287	0.3	0.07	5.06	0.36	25
Wing C	290360	6259415	7	825	0.3	0.07	3.24	0.23	25

Two scenarios have been assessed in this report. In the first scenario, the kennel building point sources were modelled without rain caps. In the second scenario, the kennel building point sources were modelled with rain caps and filters. For the second scenario, the vertical momentum flux factor was set to 0 and an odour removal efficiency of 80% was assumed for the filters.

7.7.3 Odour from Dog Waste Disposal (OSCA Bite Size Composter)

ASK has been advised that there are two potential options for the disposal of solid dog waste, with these options including:

- organised waste collection using industrial bins and bagging of dog waste
- composting of dog waste using a solid waste composter, specifically the OSCA Bite Size composter.

It is understood that currently, the method for solid waste disposal has not been chosen. As discussed above, odour emissions from the waste collection (bagging and temporary disposal in industrial bins for collection by waste contractor) are not anticipated to be significant if managed appropriately. Therefore the odour assessment has assumed that solid waste disposal will be undertaken using the OSCA Bite Size solid waste composter, which is considered to have the higher potential for odour emissions and is considered to be the worst case method for waste disposal with respect to odour.

ASK has been advised that the OSCA Bite Size composter proposed to be used at the facility would include the following features:

- Two independent composting cells (one cell composting, the other cell on stand-by and able to be filled with waste).
- Built in extraction fan system with carbon filters. Extracted air will be vented via ports in the side of the composter.

Following a review of publicly available literature, no odour emission data was found for the composting or storage of dog waste. Therefore to estimate odour emissions, research was conducted into literature concerning odour emissions from storage of other animal waste. Measured odour emissions from pig waste storage units as documented by Gay *et al* (2003) are presented in **Table 7.4**. Pigs and dogs are omnivores and therefore the measured odour emissions from pig waste are considered most relevant for the purposes of this assessment, although it is noted that pig waste is likely to have a substantial urine content and thus be more odorous.

Table 7.4 Measured Odour Emissions from Pig Waste Storage Units (Gay *et al* (2003))

Type of Pig	No. of Measurements	Manure Storage Method	Geometric Mean of Measured Odour Emissions (ou.m^3/m^2/s)
Gestating sows	1	earthen basin	20
Nursery pigs	1	concrete tank	4
Nursery pigs	15	earthen basin	18
Finishing pigs	4	concrete tank	55
Finishing pigs	46	earthen basin	17
Finishing pigs	1	earthen basin	19
Finishing pigs	4	earthen basin	17
Finishing pigs	3	manure pack	2
Gestating/farrowing/nursery pigs	4	concrete tank	45

Type of Pig	No. of Measurements	Manure Storage Method	Geometric Mean of Measured Odour Emissions (ou.m^3/m^2/s)
Gestating/farrowing/nursery pigs	6	earthen basin	3
Gestating/farrowing/nursery pigs	3	earthen basin	23
Gestating/farrowing/nursery pigs	5	earthen basin	7
Weaning–to–finisher pigs	9	earthen basin	13
Nursery–to–finishing pigs	1	earthen basin	4
Nursery–to– finishing pigs	5	earthen basin	10
Geometric Mean of the Geometric Means (Calculated)	12		

Odour emissions from the composter have been modelled using the calculated geometric mean of reported measured odour emissions (see **Table 7.4**). It has been assumed that the total area of exposed waste within the two composter cells is equal to 2m^2. Based on this assumption, and other details provided by the compost supplier, the emission source details used in the dispersion model are presented in **Table 7.5**.

The composter has been modelled as a point source, due to the extraction fan system included in the composter. The proposed location of the composter is at the north-western corner of the Building E1 as shown in **Figure 3.1**.

Table 7.5 Dog Waste Composter Point Source Details

X Coordinate (m, UTM)	Y Coordinate (m, UTM	Source Height (m)	Vent Diameter (m)	Vent Pipe Area (m^2)	Exhaust Velocity (m/s)	Exhaust Flow Rate (m^3/s)	Exhaust Temperature (°C)	Odour Emission Rate (ou.m^3/s)
290340	6259394	1.5	0.21	0.035	2.9	0.1	25	24

Note: The composter includes two vents (one per cell). However emissions from the composter have been modelled as a single point source as the wake of the bin would effectively merge the two plumes. Vertical momentum flux factor was set to 0 and initial sigma y was set to 0.23 metres (assuming 1 metre minimum width divided by 4.3) and initial sigma z was set to 0.7 metres (assuming a height of 1.5 metres divided by 2.15).

7.8 Calpuff Configuration

The three dimensional wind fields from Calmet were entered into Calpuff for the full year 2014. Calpuff was run over a smaller computational grid (1 kilometre x 1 kilometre) with spacing of 100 metres, and with receptors gridded over the same domain with a nesting factor of 5 to achieve a resolution of 20 metres. Chemical transformation was not included in the modelling which causes an over-prediction of airborne concentrations.

Dry deposition was modelled with vegetation state set to active and stressed. This setting will tend to reduce deposition and hence over-predict suspended concentrations. Gravitational settling was not included since dust was not modelled.

Wind speed profile was set to the Industrial Source Complex (ISC) Rural exponents. Calm conditions were not invoked until the wind speed dropped below 0.5 m/s. Transitional plume rise and partial penetration of boundary layers were included. Briggs rise algorithm was used since the sources are not very hot.

Puff-splitting was turned off and the maximum number of puffs released per time step was set to 60.

Dispersion coefficients were derived by the model using turbulence generated by micrometeorology. The Probability Density Function (PDF) method was used to calculate vertical dispersion in convective conditions. The Heffter curve was used to compute time-dependent dispersion beyond 550 metres. The partial plume height adjustment method was used to allow winds to approach hills as terrain increases. Coefficients were set to 0.5 for unstable and neutral conditions, and 0.35 for stable conditions allowing the plume to approach the ground faster in stable conditions.

The minimum turbulence velocity, sigma v, was set to 0.2 m/s.

Following dispersion modelling, contours of pollution concentrations were generated using the GIS software Surfer 15. Surfer was then used to overlay the model outputs onto a scan of a rectified aerial photograph of the area. Contours shown in this report were generated using the Kriging method with a grid spacing of 20 metres and contours were created with smoothing set to high.

The criteria for assessing odour emissions are based on a one second exposure as nominated in **Table 4.1**. To convert the 1 hour time-step predictions from Calpuff to a one second odour concentration, a multiplying peak-to-mean conversion factor of 2.3 has been applied.

8. Dispersion Modelling Results

8.1 Limitations

The uncertainties associated with this type of assessment are normally only dealt with in a qualitative manner, but include:

- source measurement techniques
- source strength variability
- laboratory analysis of samples
- meteorological data variability
- inherent uncertainty in dispersion modelling.

Typically 95% confidence intervals are estimated to require a multiplicative factor of 2 or 3. In this case, the uncertainty is mostly due to assumptions regarding the details of emission sources and operating information. This has been addressed by assuming high emission/activity rates compared to those measured from similar operations.

In addition to these uncertainties, the modelling has many conservative assumptions that will over-predict the ambient concentrations including the following:

- Emission rates are based on full occupancy of the dog kennels for the entire year.
- Odour emissions were assumed to occur every hour of the day, even when dogs were not present within the kennels.
- The waste composter includes a carbon filter and the openings will be closed except during loading or unloading, whereas the applied odour emission rate for the compost is based on direct measurements of pig waste, and therefore the assumed odour emission rate for the composter is considered conservatively high.
- The model assumes that the high emission rates coincide with most adverse meteorological conditions, which is unlikely.

8.2 Results

Based on the assessment methodology detailed in **Section 7**, odour concentrations resulting from the operation of the facility have been predicted for the nearby sensitive receptors nominated in **Table 2.1**. The predicted odour concentrations are presented in **Table 8.1**.

Concentration contours have also been produced by the dispersion model, with the contours at which the odour concentrations at ground (1.5m high) and upper (4.5m high) levels were predicted to equal 4 ou for the assessed scenarios are presented in **Figure 8.1**. The contours are generated by extrapolation between grid points and are therefore less accurate than the predicted concentrations in **Table 8.1**. The predicted odour concentrations at ground level (1.5m high) for Scenario 2 were less than 4 ou over the entire gridded domain.

Table 8.1 Predicted Odour Concentrations at Sensitive Receptors

Receptor ID#	Height	99.9th Percentile 1 Second Odour Concentration (OU)	
		Scenario 1	Scenario 2
A	1.5	2.2	0.6
	4.5	2.5	0.7
B	1.5	3.4	1.0

Receptor ID#	Height	99.9th Percentile 1 Second Odour Concentration (OU)	
		Scenario 1	Scenario 2
C	1.5	2.4	0.7
	4.5	2.7	0.7
D	1.5	3.4	1.0
	4.5	3.7	1.0
E	1.5	3.6	0.9
	4.5	3.7	0.9

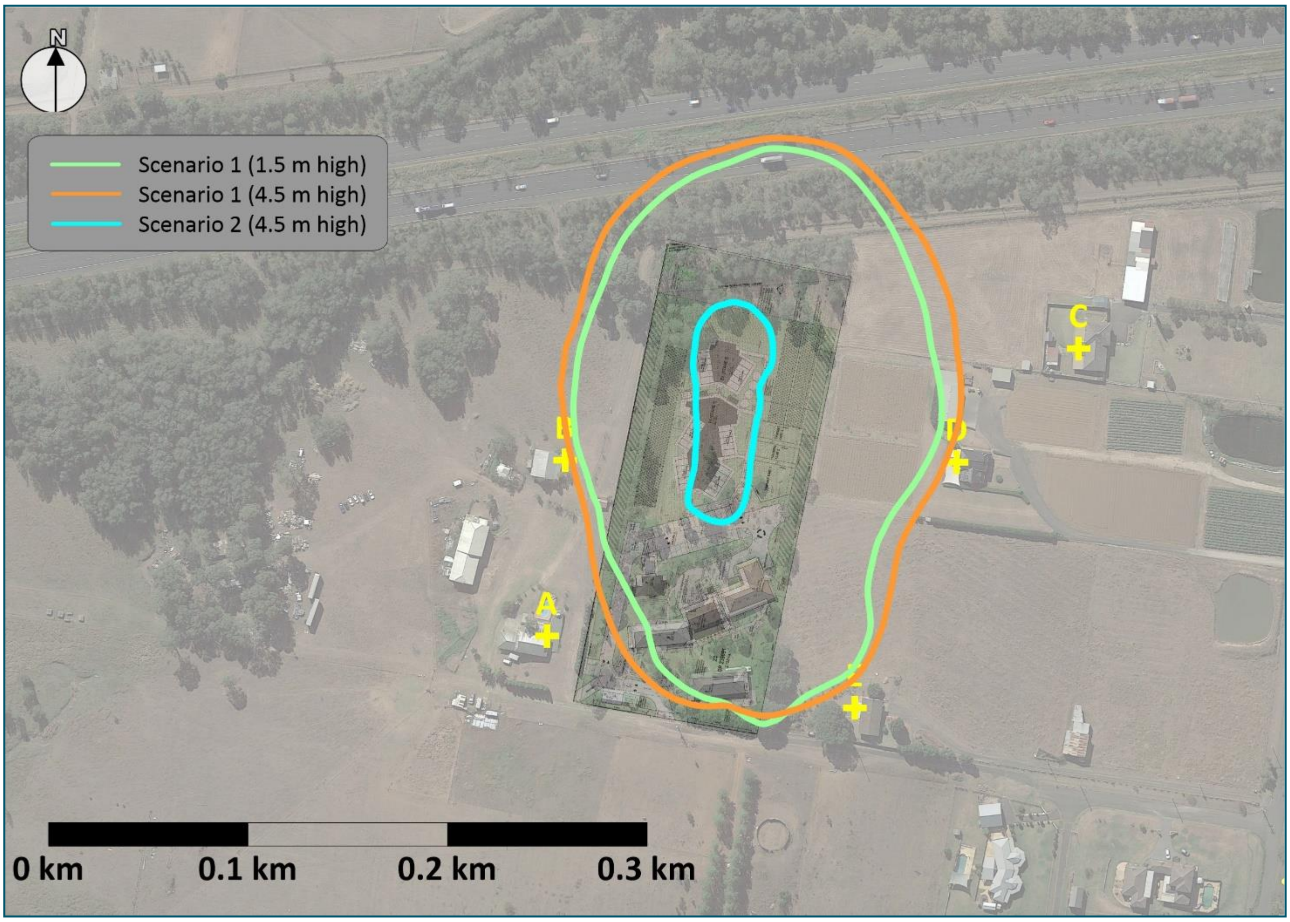


Figure 8.1 Contours at which Odour Concentration Predicted to be 4 ou

As shown by the predicted odour concentrations presented in **Table 8.1**, and the contours at which the odour concentration is predicted to be 4ou are presented in **Figure 8.1**, predicted odour concentrations at nearby sensitive receptors comply with the nominated odour concentration criterion of 4 ou (99.9th Percentile, 1 second) as discussed in **Section 4.2**. As expected, the use of a filter (Scenario 2) would result in lower odour concentrations.

9. Recommendations & Conclusion

9.1 Recommendations

The following mitigation measures are recommended to ensure odour emissions from the facility comply with the nominated odour criterion at the location of nearby sensitive receptors:

- If the vertical momentum of emissions of the kennel exhaust vents will be obstructed by rain caps, a filters should be installed to reduce odour emissions.
- If the composter is selected as the waste disposal method, the following measures are recommended:
  - Seek advice from the supplier of the composter regarding recommended feed quantities and moisture content to reduce the potential for odour emissions.
  - Exchange the carbon filter/s installed in the composter in accordance with the recommendations of the supplier.
- Compost produced by the composter is never to be stockpiled on-site, and is either applied over the site or is disposed via managed waste disposal measures. The compost produced may be offered to neighbouring residents.
- The operation of the facility should follow the recommendations of the Odour Management Plan developed for the facility, included in **Appendix C** of this report.

9.2 Conclusion

An odour impact assessment has been conducted for the proposed dog kennel and training facility, to be located at 8 Austin Place, Orchard Hills. The results of the assessment are summarised as follows:

- Based on the assessment methodology detailed in **Section 7**, odour concentrations resulting from the operation of the facility have been predicted for nearby sensitive receptors.
- As shown by the predicted odour concentrations presented in **Table 8.1**, and the odour concentration contours presented in **Figure 8.1,** predicted odour concentrations at nearby sensitive receptors comply with the nominated odour concentration criterion of 4 ou (99.9th Percentile, 1 second).
- The recommendations presented in **Section 9.1** should be implemented and maintained.

References

Holmes, K,T. (Holmes Air Sciences) (2007) Odour Assessment: Bell Bay Pty Ltd Vs Hawkesbury City Council, Report reference Glossodia_2007.

Department of Environment and Conservation (2005), Approved Methods for the Modeling and Assessment of Air Pollutants in New South Wales.

Department of Environment and Conservation (2006), Technical Framework: Assessment and management of odour from stationary sources in NSW.

Gay, S. W, Schmidt, D. R, Clanton, C. J, Janni, K. A, Jacobson, L. D, Weisberg, S. (2003) "Odor, Total Reduced Sulfur, And Ammonia Emissions From Animal Housing Facilities And Manure Storage Units In Minnesota", Applied Engineering in Agriculture Vol. 19(3): 347–360. American Society of Agricultural Engineers.

HMC 2018, “Revised Wastewater Management Report Proposed Assistance Dogs Kennels”, Report No: HMC 2015.149 revised September 2018, HMC Environmental Consulting Pty Ltd.

Navaratnasamy, M. and Feddes, J.J.R. (2004) "Odour Emissions from Poultry Manure/Litter and Barns", Research Report submitted to Poultry Industry Council, Alberta, Canada.

Appendix A Glossary

Parameter or Term	Description
ASK	ASK Consulting Engineers Pty Ltd
m/s	Metres per second
TAPM	The Air Pollution Model developed by CSIRO and used by ASK for meteorological modelling

Appendix B Proposed Daily Kennel Routine (Provided by ADA)

Table B.1 Morning Shift - Weekday Routine

- 7am – Dog welfare team members arrive and start transferring dogs from indoor overnight kennels to outdoor patios that are connected to their overnight kennel so that they can toilet
- 7am – 7:30am – As dogs are toileting in enclosed outdoor patios, staff are picking up and disposing of any dog waste
- 7:30am – 8am – Dogs are transferred from outdoor patios back into their indoor kennel so that they can be fed according to the practised feeding routine and so that all food bowls can be collected and washed
- 7:50am - 8am – Instructors & extra dog welfare team members arrive on site
- 8:10am – Instructors start collecting dogs from their kennels to commence on-site training sessions or loading the dogs into the vans to take them to another location to complete off-site training sessions
- 8:30am – 9:30am – Dog welfare team members clean the kennels and any equipment that has been used and prepare feeds for the afternoon
- 9am – Administration staff arrive
- 9:30am – 11:45am – Dog welfare team members complete either walks around the facility, monitored play sessions, grooming sessions or health checks on the dogs
- 11:30am – 11:45am – Instructors finish morning on-site training sessions or return from off-site training
- 11:45am – 12pm – Instructors and dog welfare team members are all involved in toileting the dogs in the outdoor patios before returning them to their indoor kennels while the staff have lunch
- 12pm – 12:30pm – Staff members have their lunch break
- 12:30pm – 12:45pm – Instructors and dog welfare team members are all involved in toileting the dogs in the outdoor patios before returning them to their indoor kennels
- 12:45pm – Instructors start collecting dogs from their kennels to commence on-site training sessions or loading the dogs into the vans to take them to another location to complete off-site training sessions
- 1pm – 3:45pm - Dog welfare team members complete either walks around the facility, monitored play sessions, grooming sessions or health checks on the dogs

Table B.2 Afternoon Shift - Weekday Routine

- 2pm – Dog welfare team members who started at 7am finish work and leave & late shift dog welfare team members arrive
- 3:30pm – 3:45pm – Instructors finish training sessions, toilet dogs and return all dogs to their indoor kennels
- 3:50pm – 4pm – Instructors feed all dogs according to the practised feeding routine and collect all bowls
- 4pm – Instructors finish work and leave the facility & two dog welfare team members finish
- 4pm – 4:30pm – Dog welfare team wash food bowls and prepare feeds for the next morning
- 5pm – Administration staff leave facility
- 4:30pm – 8:30pm – Dog welfare team members complete grooming sessions and health checks on the dogs
- 5:00pm – 6:00pm – Dog welfare team members allow the dogs to toilet on the outdoor patios and clean any waste. The dogs are then returned to their indoor overnight kennels.
- 9pm – Dog welfare team members make sure all dogs are secure before locking up the facility and leaving.

Appendix C Odour Management Plan

Assistance Dogs Australia

Odour Management Plan

Overview

The operation of the Assistance Dogs Australia (ADA) dog kennel and training facility has the potential to impact on the air quality environment beyond the boundaries of the site. The potential for impacts is due to odour emissions from activities and facilities on-site. This Odour Management Plan has been prepared to facilitate practices to minimise those emissions.

Objective

To minimise odour impacts from the facility on the surrounding environment, specifically nearby residential dwellings.

Operating Hours

The operating hours for the facility are as follows (7 days):

- Staff hours: 7:00am to 9:00pm
- Public hours: 9:00am to 5:00pm.

Dogs will predominantly be present at the facility 24 hours per day, 7 days per week.

Criterion

The relevant criteria for assessment of the cumulative odour from a mixture of compounds are specified by Department of Environment and Conservation (DEC 2006) and reproduced in the table below.

Cumulative Odour Assessment Criteria (99%, 1 second)

Population of affected community	**Criteria (ou)**
1 or 2 (Single rural residence)	7.0
~10	6.0
~30	5.0
~125	4.0
~500	3.0
~2000 (urban area or schools or hospitals)	2.0

For the purposes of the ADA facility, the applicable odour concentration contour is 4 ou based on the likely number of people in the affected community.

The odour concentration criterion is assessed against the predicted 99th percentile odour concentration. Over a period of one year, or 8,760 hours, this corresponds to the 88th highest predicted concentration, and therefore the determination of the buffer zone is based on the 88th exceedance of the odour concentration criterion of 4 ou.

Odour Sources

Potential odour sources include:

- dog kennels (general occupation and during cleaning)
- waste composter and/or waste storage bins
- dog waste in external areas (i.e. exercise yards, potty areas).

Odour Management Procedures & Control Measures

The following odour management procedures and measures should be incorporated in the operation of the facility:

Dog Kennels

- At the start of every morning all dog waste is to be removed and stored inside sealed containers or bags.
- Internal areas and outdoor areas should be cleaned, mopped and disinfected soon after 8am, typically 8:30am to 9:30am every day after the dogs have been relocated to outdoor pens.
- At regular intervals use odour control, such as F10 Odour Eliminator Concentrate, to reduce the chance of offensive odours escaping the kennel building.
- Urine should be mopped up and the immediate surface cleaned as soon as possible.
- All openings to the dog kennel building (i.e. doors, windows, etc) must be kept closed as much as possible during cleaning of the internal kennel areas to prevent fugitive odour being released from the kennel building.
- Outdoor pens should be spot cleaned every day after the dogs have been relocated to internal areas.
- The number of dogs kept overnight on site must not exceed 60.
- Odour filters are to be installed at the exhaust vents if the vertical momentum of emissions will be obstructed by rain caps.

Dog Waste in External Areas

- Dog waste in external areas (including exercise yards, outdoor pens and potty areas) is immediately bagged by staff and deposited within a sealed container or bin.
- Dog waste is to be composted or removed from site on a weekly or similar basis as approved by Council.

Waste Disposal via Composter

- Compost produced by the composter should never be stockpiled on-site. Compost should be:
  - applied over the site
  - disposed via a managed waste removal service
  - offered to neighbours.
- The composter should be operated following the recommendations of the supplier, particularly with regard to moisture content of the feed.
- Exchange of the carbon filter/s installed in the composter should occur in accordance with the recommendations of the supplier.

Waste Disposal via Organised Waste Collection

- Dog waste and/ or excess compost is to be removed from site on a weekly, or similar basis as approved by Council, by an authorised waste removal company.
- Temporary waste storage bins (i.e. those within kennels and in the external areas) should be emptied daily, with the bag from the temporary waste bins bagged again prior to disposal in the collection bins.
- The temporary waste storage bins and collection bins should be cleaned if odour is detected from the bin itself.

Mortalities

- Any mortalities must be removed from the kennels on the same day as occurrence and disposed of to a veterinary surgery before being transferred to an off-site crematorium, and their ashes are returned to be buried on-site.

Performance Indicators

- Odour emissions from the site do not cause an odour nuisance to surrounding properties, where nuisance is defined by the DEC criterion.
- Internal areas of the kennels and outdoor pen areas are kept clean.
- Dog waste is stored in sealed waste containers.
- Dog waste does not remain in external exercise yards or outdoor areas (i.e. outdoor pens, potty areas, etc).
- Waste storage bins and collection bins are not a source of odour.
- Odour is detectable from the composter.

Responsibility

All ADA employees are responsible for ensuring odour management procedures are implemented in the daily operation of the facility.

A designated employee should be made responsible for the review of the Odour Management Plan, and the reporting of odour complaints.

Complaint Management & Reporting

A phone number to receive complaints should be advertised. In the event that an odour complaint is received, the attending staff member should obtain the following details regarding the caller and the complaint:

1. Time and date of call.
2. Callers name, address and contact number.
3. Complaint details, including description of odour.

The attending staff member should communicate to the caller the following:

1. The facility has an Odour Management Plan.
2. The details of the complaint will be recorded.
3. The issue will be dealt with as quickly as possible.
4. Ask the complainant if they would like a return phone call regarding the actions resulting from the complaint.

Following the phone call, the following actions are to be taken:

1. If the on-duty manager did not take the call, the manager should immediately be advised of the details of the complaint by the attending staff member.
2. The manager or attending staff member should immediately investigate to identify the described odour source that the complaint relates to, and act to eliminate or manage the odour source. See **Odour Management Procedures & Control Measures**.
3. If requested, return phone call to the complainant (during a suitable time) to discuss the actions resulting from the complaint.
4. Enter complaint record into a Complaints Register including corrective actions taken.

Corrective Actions

Upon receipt of odour complaints, implement further odour suppressant measures such as increasing the application of odour eliminators or increasing the frequency of the management procedures nominated within this Odour Management Plan.

Corrective actions should be recorded and reflected in updates to the Odour Management Plan.

Review

The management procedures and control measures contained within this Odour Management Plan should be reviewed:

- annually
- upon receipt of odour complaints
- upon request by Council or other regulatory authority.

Alterations made to the Odour Management Plan should be recorded.