Report

Warrah Ridge Farm 1095 – Odour and Dust Assessment

Pace Farm Pty Ltd

Job: 21-224

Date: 14 March 2023

Astute Environmental Consulting

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1 INTRODUCTION

Astute Environmental Consulting ("Astute") was engaged by PSA Consulting on behalf of Pace Farm Pty Ltd ("Pace") to perform an odour and dust assessment of the proposed Warrah Ridge Layer Farm 1095 located at Warrah Ridge on the Liverpool Plains, in New South Wales.

1.1 Background

Pace proposes to submit a Development Application for an Egg Production Farm on land described as Part Lot 52 DP1168698, Lot 170 &171 DP751033 and Lot 1 DP576340 ("the site").

The site will be known as Layer Farm 1095 and will consist of eight sheds with 31,000 birds per shed for a total of 248,000 birds. The proposed layout for the site is shown in Figure 1-1.

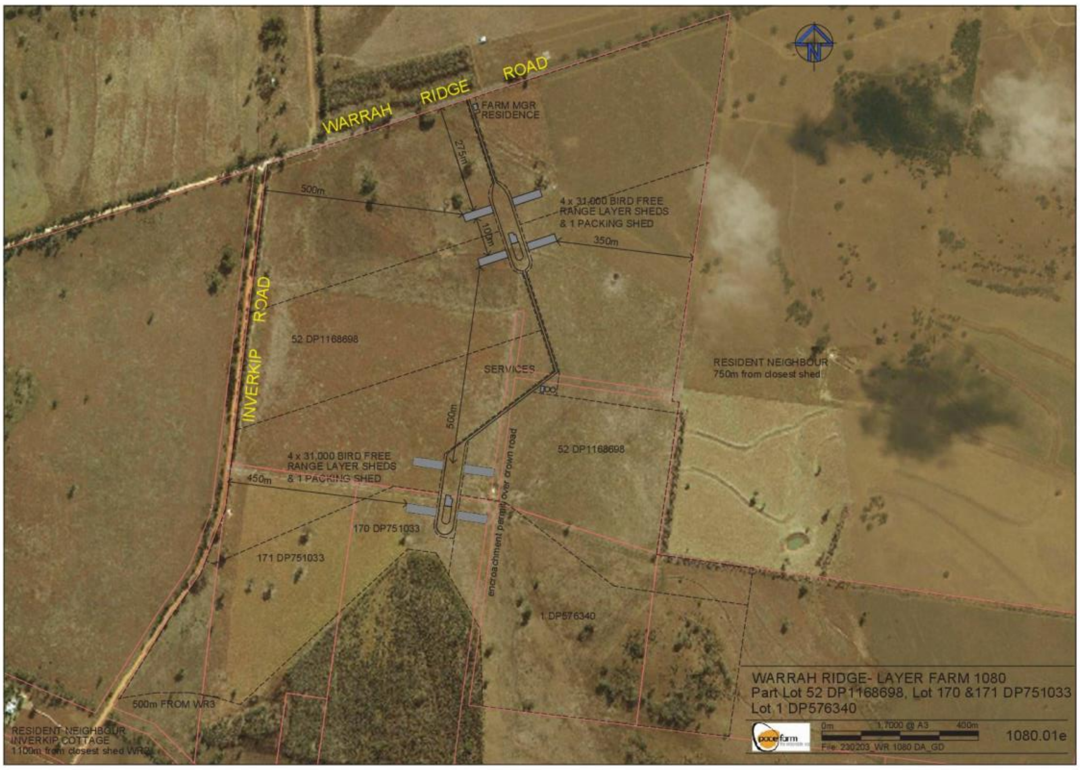


Figure 1-1: Proposed Farm and Surrounding Area (Source: Pace Farms)

1.2 Scope of Work

The scope of work for the assessment included:

- Obtaining information about the proposed sheds;
- Analysing regional weather data;
- Analysing on site weather data;
- Modelling meteorology for the area using TAPM/CALMET;
- Estimating odour and dust emissions based on data in Poultry CRC (2011);
- Predicting odour dispersion using CALPUFF;

- Assess Layer farm 1095 in isolation and cumulatively with the approved Warrah Ridge Farm 687[1]); and
- Preparing a report.

The modelling methodology used is summarised in Figure 1-2.

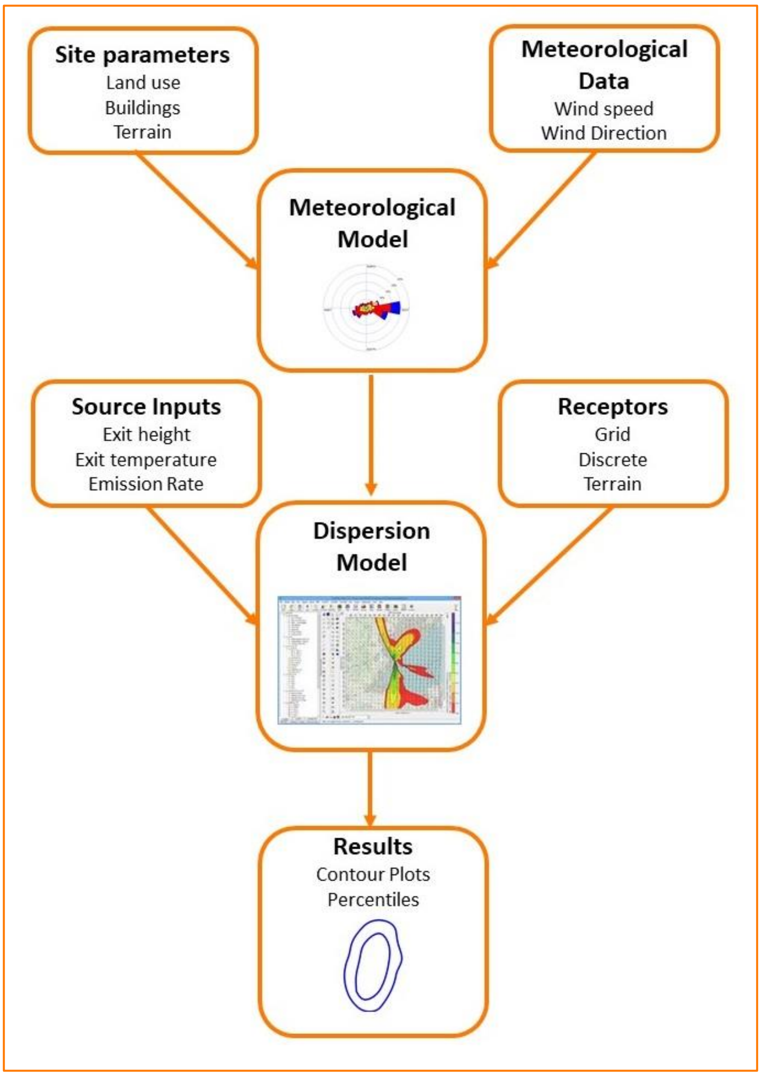


Figure 1-2: Modelling Methodology

[1] Details of the modelling performed for farm 687 can be found elsewhere.

2 ASSESSMENT CRITERIA

2.1 Odour

The odour criteria used in New South Wales are detailed in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2016)[2]. For a complex mixture of odorants (i.e. odour measured as odour units), the criterion is selected based on the population density in an area. This is based on the concept that as population density increases, the number of people who may be sensitive to an odour increases. The criteria are summarised in Table 2-1.

Table 2-1: Impact Assessment Criteria from NSW EPA (2016)

Population of affected Community	Impact assessment criterion for complex mixtures of odorous air pollutants (ou)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Whilst no specific guidance is provided in the Approved Methods, the approach often suggested by NSW EPA for setting the odour criterion for a site is as follows:

- Model the site using standard methods;
- Prepare a contour plot showing the $C_{99\ 1sec}$ = 2 ou contour;
- Count the existing houses/dwellings within the 2 ou contour and include any proposed dwellings within the 2 ou contour;
- Calculate the average population per dwelling based on the average data from the most recent Census data;
- Based on the total population, determine the criterion using Equation 7.2 in the Approved Methods.

This is discussed further in Section 5 below.

2.2 Particulate Matter

The Approved Methods (NSW EPA, 2016) also specifies the air quality assessment criteria relevant for assessing impacts from dust-generating activities. For this assessment, particulate matter less than 10 micrometres (PM_{10}) was included as the assessment parameter for dust emissions. PM_{10} is the size fraction that is generally the limiting dust parameter from poultry farms as it is generated by normal activities in the sheds (as opposed to combustion sources). This means that if the PM_{10} criteria are met, there is minimal risk of exceedances of dust deposition or particulate matter less than 2.5 micrometres ($PM_{2.5}$).

[2] "The Approved Methods"

Particulate matter criteria relevant to the proposed modification are detailed in Table 2-2.

Table 2-2: Particulate Matter Impact Criteria (NSW EPA, 2016)

Pollutant	Averaging Period	Concentration (µg/m³)
PM_{10}	24-hour maximum	50
	Annual mean	25

3 MODELLING METHODOLOGY

3.1 Representative year

The selection of a representative meteorological year for dispersion modelling is important. Typically, a single year of data is included in an assessment. In the Farm 687 assessment (Astute Environmental Consulting, 2021) five years of meteorological data were analysed from the Tamworth Airport which is approximately 60 km to the northeast of the farm. The period analysed was from 2013 to 2017.

The year 2014 was selected as the most representative with priority given to wind speed, the key meteorological parameter in dispersing odour and dust. Furthermore, 2014 was the most complete dataset for both the Tamworth BOM station and Tamworth NSW EPA station.

During the application process for Farm 687, Pace Farms installed an automatic weather station (Section 3.7) however a year's worth of data wasn't available at the time. To date over two years of data has been collected by a MEA weather station.

To ensure on site data is included in this report, the on-site meteorological data for 2021 has been incorporated into this modelling by nudging TAPM[3].

3.2 TAPM

TAPM (version 4), is a three-dimensional meteorological and air pollution model developed by CSIRO. The model is a prognostic model which uses synoptic-scale data to predict hourly meteorology in the area modelled. Details about TAPM can be found in the TAPM user manual (Hurley, 2008a) and details of the model development and underlying equations can be found in Hurley (2008b). Details of validation studies performed for TAPM are also available and include Hurley et. al. (2008c).

TAPM v4 predicts meteorological data including wind speed and direction in an area using a series of fluid dynamics and scalar transport equations (Hurley, 2008b) and it has both prognostic meteorological and air pollution (dispersion) components. The benefit of using TAPM is that key meteorological aspects including the influence of terrain induced flows are predicted both locally and regionally.

The TAPM default land use database was further refined to include more agricultural and cropping land with some scattered low density bushland within the 1 km modelling domain. The default and adjusted land-use files are presented in Figure 3-1. The TAPM setup is summarised in Table 3-1 and is consistent with good practice and the requirements in NSW EPA (2016).

[3] This assessment uses on site meteorological data and doesn't rely purely on TAPM generated data.

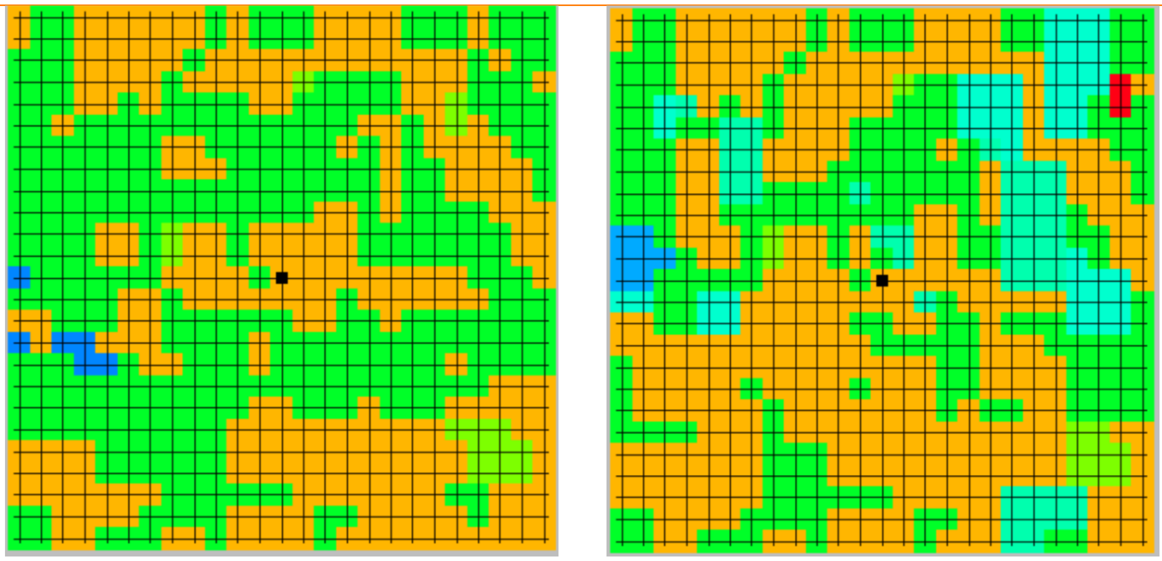


Figure 3-1: Default TAPM (left) and Adjusted Land use (right) for the Site

3.3 CALMET

CALMET is the meteorological pre-processor to CALPUFF and generates wind fields which include slope flows, terrain effects, and can incorporate factors including terrain blocking. CALMET uses meteorological inputs in combination with land use and terrain information for the modelling domain to predict a three-dimensional meteorological grid (which includes wind speed, direction, air temperature, relative humidity, mixing height, and other variables) for the area (domain) to be modelled in CALPUFF.

A 20 km x 20 km domain with a terrain resolution of 100 m was modelled with the centre of the domain to the northeast of the site. A terrain resolution of 30 m was used throughout the domain and was initially taken from the SRTM dataset using CALPUFF view. This was then converted to a 100 m resolution for the model runs.

Land use was initially based on the Australia Pacific Global Land Cover Characterisation (GLCC) dataset at 1km resolution. The land use was then manually edited at 100 m resolution based on a recent aerial photograph of the area using Google Earth Pro and CALPUFF View.

3.4 CALPUFF

CALPUFF (Exponent, 2011) is a US EPA regulatory dispersion model and is a non-steady state puff dispersion model that simulates the effects of varying meteorological conditions on the emission of pollutants. The model contains algorithms for near source effects including building downwash, partial plume penetration as well as long range effects such as chemical transformation and pollutant removal. CALPUFF is widely recognised as being the best model for odour studies as it handles light wind conditions and terrain effects better than simpler steady state models such as AUSPLUME and AERMOD. As such it is accepted as a regulatory model in all states of Australia.

CALPUFF simulates complex effects including vertical wind shear, coastal winds including recirculation and katabatic drift. The model employs dispersion equations based on a Gaussian distribution of puffs released within the model run, and it takes into account variable effects between emission sources.

Key modelling inputs used in this assessment are summarised below in Table 3-1.

Table 3-1: TAPM, CALMET and CALPUFF Setup

Model	Parameter	Value
TAPM (v 4.0.5)	Number of grids (spacing)	30km, 10km, 3km, 1km
	Number of grid points	25 x 25 x 25 (vertical)
	Year of analysis	2021
	Centre of analysis	31°35'00" South (latitude), 150°33'30" East (longitude)
	Meteorological data assimilation	Yes – onsite weather station (Section 3.7) ROI = 2,000 m Quality = 1 Z levels = 2
CALMET (v 6.334)	Meteorological grid domain	20km x 20km
	Meteorological grid resolution	0.10km
	South-west corner of domain	X = 258.000 km, Y = 6493.500 km
	Surface meteorological stations	N/A
	Upper air meteorological data	N/A
	3D Windfield	m3D from TAPM (1km) input as in initial guess in CALMET
	Year of analysis	2021
	Terrad	4.0 km
	Cloud	4 - Gridded cloud cover from Prognostic Relative Humidity at all levels
	IKINE	1
CALPUFF (v6.40)	Method used to compute dispersion coefficients	2 - dispersion coefficients using micrometeorological variables
	Minimum turbulence velocity (Svmin)	0.2 m/s
	Building downwash included	No
	Default settings	All other CALPUFF defaults have been used in line with OEH (2011).

The proposed sheds will be tunnel ventilated and therefore have been represented as pseudo point sources at the fan end of the sheds. This means that each shed had a point source on the tunnel fan end of each shed with a diameter the same as the shed width. The vertical velocity in the point source was varied as a function of the maximum predicted ventilation rate to ensure that the momentum of the plume (and thus plume mass) was maintained. The vertical momentum was set to zero by using the 'rain hat' switch in CALPUFF. This ensures that the plume did not move vertically in the model but starts near ground level and disperses slowly from there. The shed exit temperature was assumed to be consistent with shed target temperatures.

Building wake has been shown to have a negligible effect on the predicted concentrations of low-level sources such as chicken sheds therefore building wake has not been included in the modelling.

3.5 Emissions Estimation

3.5.1 Odour

The basis of the emissions estimation method is that of McGahan and Galvin (2018). The method is based on measurements at various tunnel ventilated layer operations and assumes that the new farm will operate consistently with those farms.

The first step in the method is to estimate the required airflow at any given point in time based on the ambient temperature and number of birds present. This was achieved using Equation 1 where Q is airflow in m³/s/1000 birds and T is the ambient temperature in °C.

$$Q = 0.1104 \times e^{0.1118 \times \mathrm{T}}$$

Equation 1

The next step is to estimate odour emissions based on the airflow and was performed using Equation 2 where odour emission rate (OER) is ou/s/1000 birds and Q is the total shed airflow in m³/s. Note that the minimum shed flow rate was set to 0.23 m³/s/1000 birds and the maximum set to 3.09 m³/s/1000 birds based on Poultry CRC (2011). The methodology assumes large birds are continually present and the sheds are full over the whole year.

$$\frac{OER}{1000\ birds} = 104.25 \times \ln(Q) - 183.73$$

Equation 2

An example profile for the layer sheds (31,000 birds) generated using Equation 1 and Equation 2 is shown below in Figure 3-2.

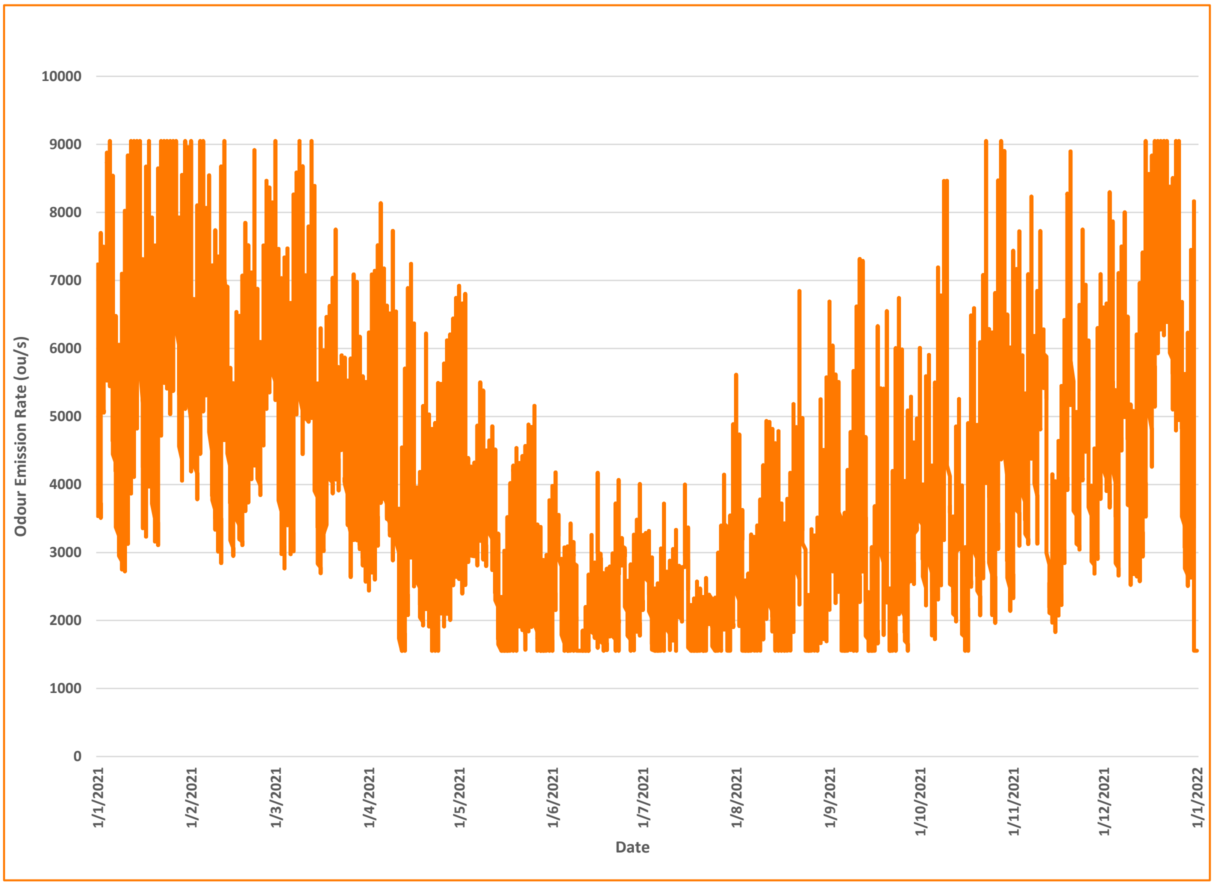


Figure 3-2: Emission Rate for Layers

3.5.2 Dust

The PM_{10} emission rates have been calculated using the relationship provided below in Figure 3-3 in conjunction with the ventilation rates estimated using Equation 1. The relationship was derived based on dust emission rate data in Poultry CRC (2011) and is shown below as Equation 3 where Q_T is the ventilation rate derived using Equation 1 for the shed size (i.e. total ventilation rate at a point in time).

$$\frac{mg/s}{1000\ birds} = 0.0375 \times e^{0.0148 \times Q_T}$$ **Equation 3**

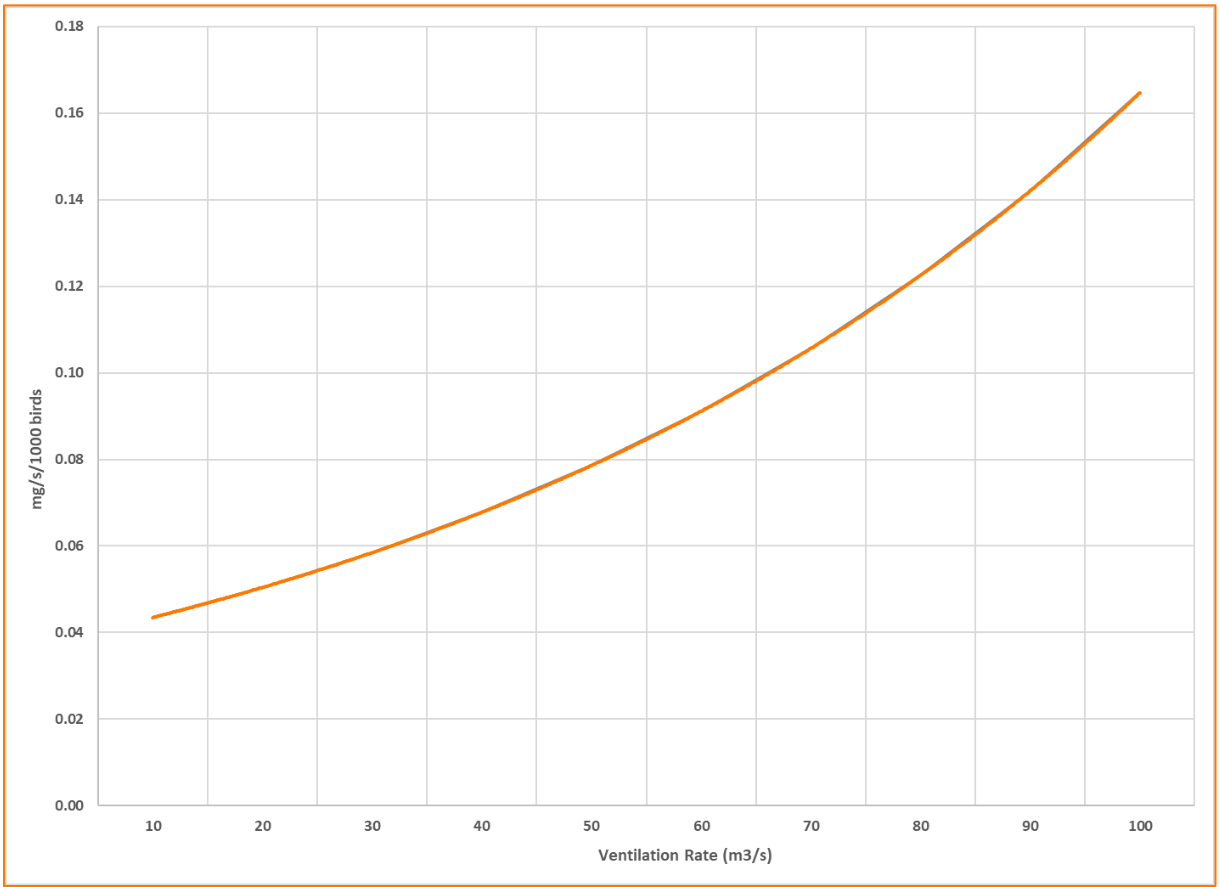


Figure 3-3 PM_{10} Emission Rate Relationship for Layers (Equation 3)

3.6 Sensitive Receptors

Several sensitive receptors across the area were identified during the modelling process. The location of the receptors as identified by spatial imagery are detailed below in Table 3-2. The receptors are shown in the figures in Sections 5 and 6 below.

Table 3-2: Identified Receptors (UTM m WGS84)

Number	Easting	Northing	Comments
SR1	266,836	6,505,647	
SR2	267,270	6,507,949	
SR3	269,248	6,507,453	
SR4	270,023	6,507,276	
SR5	270,172	6,506,560	
SR6	272,057	6,505,420	
SR7	271,000	6,504,783	
SR8	271,224	6,504,342	
SR9	272,079	6,503,039	
SR10	276,343	6,501,413	
SR11	277,737	6,500,880	
SR12	272,964	6,498,730	
SR13	273,419	6,495,632	
SR14	272,118	6,495,653	
SR15	269,836	6,497,477	
SR16	269,961	6,496,955	
SR17	270,005	6,496,344	
SR18	268,457	6,496,259	
SR19	264,124	6,497,489	
SR20	263,175	6,498,447	
SR21	266,821	6,501,972	
SR22	267,086	6,501,914	
SR23	267,412	6,501,993	
SR24	260,943	6,502,411	
SR25	266,500	6,503,704	Owned by Pace – Not sensitive
SR26	261,210	6,505,213	
SR27	261,709	6,505,129	
SR28	261,684	6,505,732	
SR29	261,843	6,507,371	
SR30	262,386	6,508,616	
SR31	261,478	6,509,034	
SR32	258,780	6,512,324	
SR33	263,327	6,512,117	
SR34	265,970	6,507,106	

3.7 On site Weather Station

Pace Farm commissioned Measurement Engineering Australia (MEA) to install and manage an onsite weather station. A summary of the details that have been provided to Astute are as follows;

- Station went live on the 15 December 2020 collecting valid data;
- Sensor is installed on a 9 m mast;

- A Gill 2D ultrasonic wind speed and direction sensor are positioned at 10 m from ground level;
- Air temperature and humidity sensor in sensor shelter located near ground level;
- Tipping bucket rain gauge on raised mount located adjacent to the weather station;
- Data is logged on a 15 minute period;
- A logger with remote telemetry with data uploading to MEA's Green Brain server;
- Wind speed and direction averaging is performed using vector averaging methods; and
- No specific information regarding the averaging techniques or calibration standards have been provided it is assumed these comply with relevant standards.

4 EXISTING ENVIRONMENT

The principal meteorological parameters that influence plume dispersion are wind direction, wind speed, atmospheric stability (turbulence) and atmospheric mixing height (height of turbulent layer). This section presents a summary of the key meteorological features

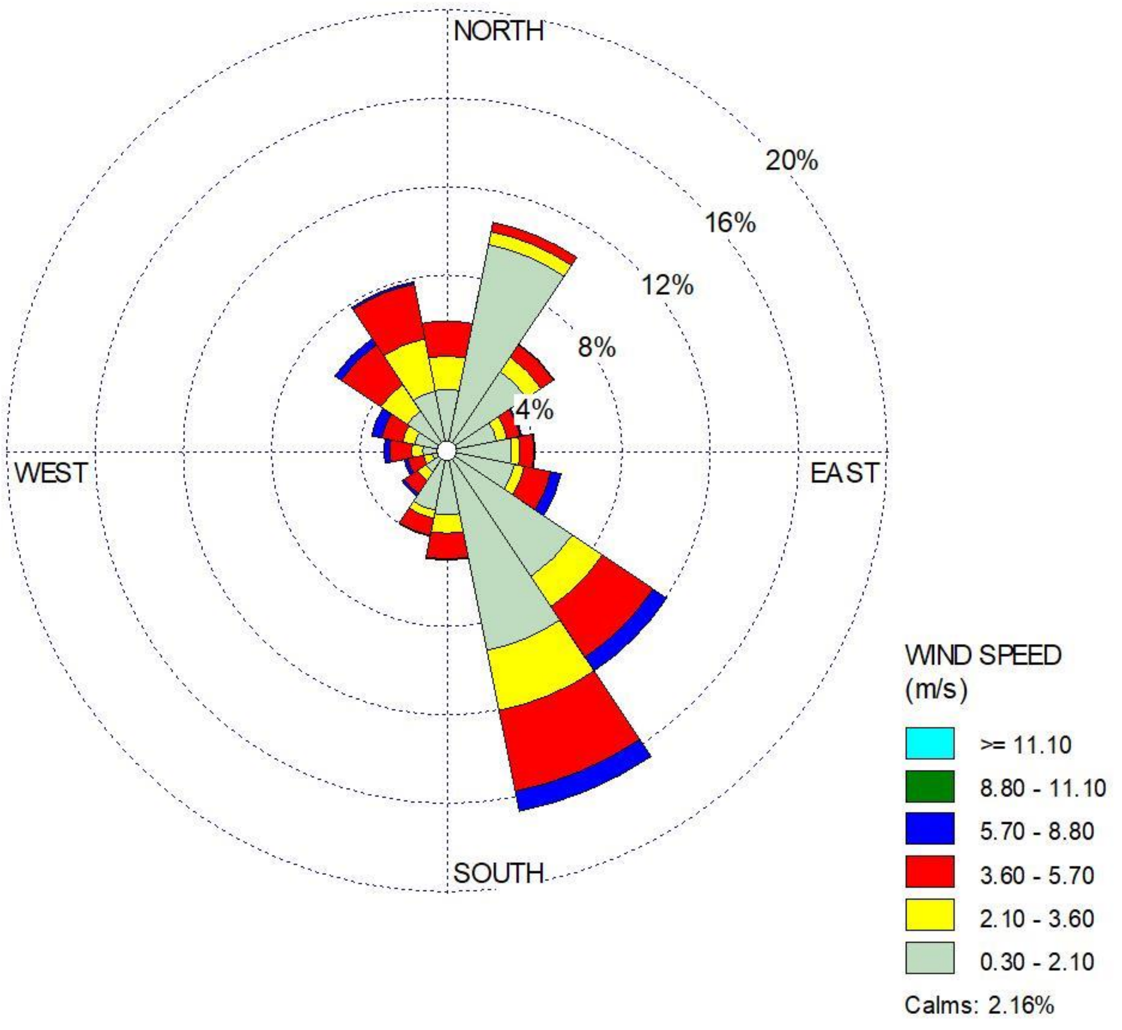
4.1 Metrological Data

4.1.1 Wind Speed and Direction

Wind roses are used to show the frequency of winds by direction and strength. The bars show the compass points (north, north-north-east, north-east etc) from which wind could blow. The length of each bar shows the frequency of winds from that direction and the different coloured sections within each bar show the wind speed categories and frequency of winds in those categories. In summary, wind roses are used to visually show winds over a defined period of time.

The wind roses below were created from data extracted from CALMET and are presented in Figure 4-1 and Figure 4-2. The annual wind rose (Figure 4-1) shows that the site is dominated by south easterly winds with a north west to north east component. There are few winds from the east or west at the extract location.

The time of day wind roses (Figure 4-2) show a low proportion of calm winds (average of around 2%) with light winds over the year (up to 3 m/s) occurring ~70% of the time. The wind speed frequencies are summarised graphically in Figure 4-3.

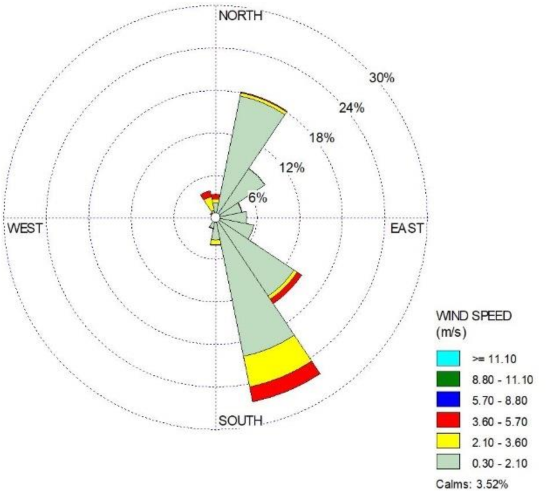


Location: Centre of domain	*Year:* 2021	*Data Source:* CALMET extract
Calm winds: 2.16 %	*Average wind speed:* 2.39 m/s	*Creator:* W. Shillito

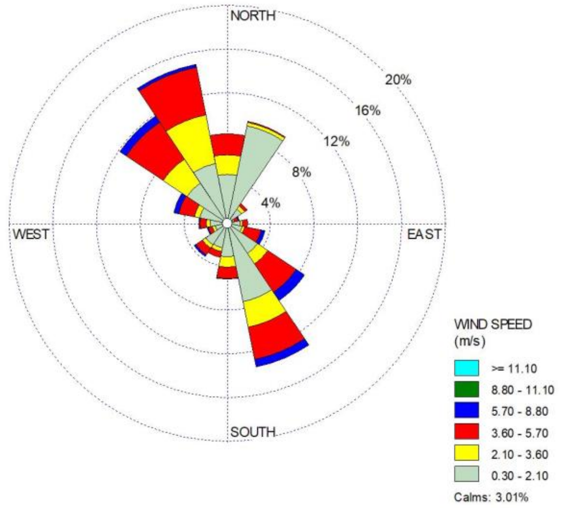
Figure 4-1: Annual Wind Rose for Centre of Domain[4]

[4] Approximately 2 km east of weather station location

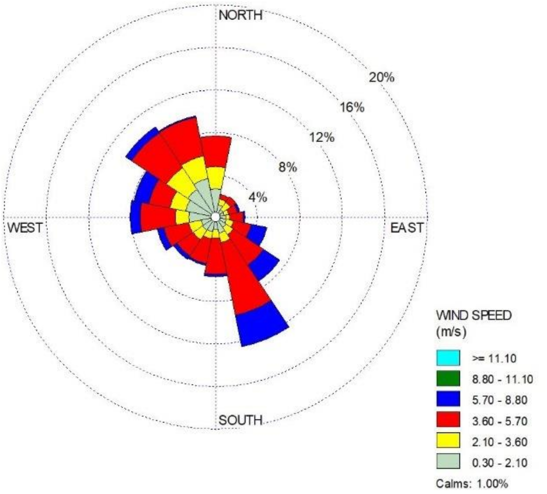
1 AM to 6 AM



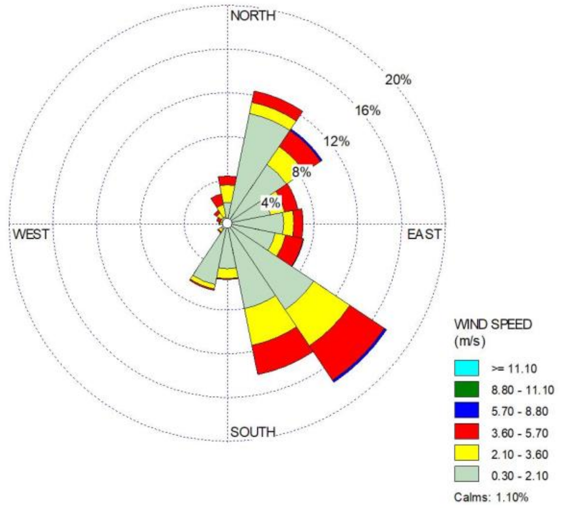
7 AM to 12 PM



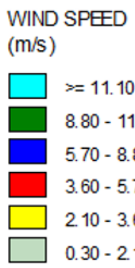
1 PM to 6 PM



7 PM to 12 AM



Period	*Average wind speed (m/s)*	*Calm winds %*
1 AM to 6 AM	1.48	3.52
7 AM to 12 PM	2.42	3.01
1 PM to 6 PM	3.52	1.00
7 PM to 12 AM	2.16	1.10



Location:	*Year:*	*Data Source:*	*Creator:*
Centre of domain	2021	CALMET extract	W. Shillito

Figure 4-2: Time of Day Wind Rose for the site

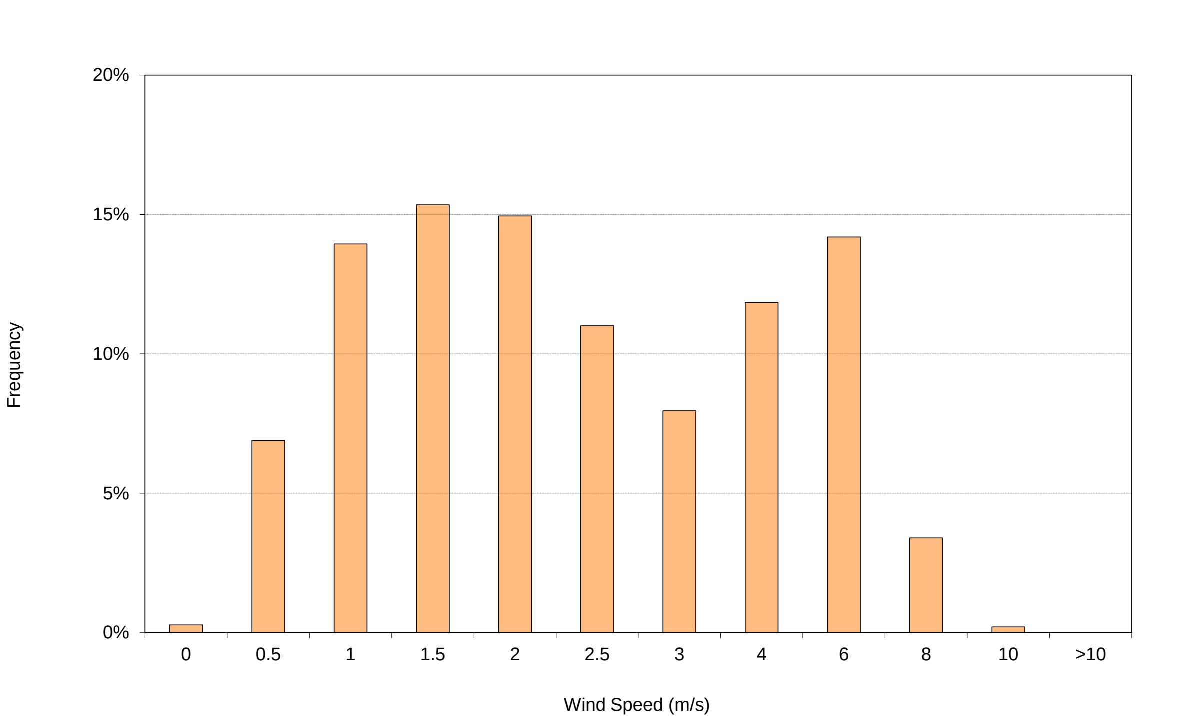


Figure 4-3 Wind Speed Frequency from CALMET

4.1.2 Atmospheric Stability

Atmospheric stability is a key factor in dispersion modelling and is used to describe turbulence in the atmosphere. Turbulence is an important factor in plume dispersion. Turbulence increases the width of a plume due to random motion within the plume. This changes the plume cross-sectional area (width and height of the plume), thus diluting or spreading the plume. As turbulence increases, the rate at which this occurs also increases. Limited or weak turbulence, therefore, does not dilute or diffuse the plume as much as strong turbulence, and leads to high downwind concentrations. This is often associated with low wind speeds (<0.3 m/s).

The Pasquill-Gifford stability scheme has been in use for many years to define turbulence in the atmosphere. The scheme uses stability classes from A to F[5]. Class A is highly unstable and at the other end of the scheme are class F conditions, which are very stable conditions that commonly occur at night and in the early morning. As noted above, under stable conditions, plumes do not disperse as well as during the day (unstable conditions) and these conditions can lead to impacts, especially for ground level sources.

Between Class A and Class F are stability classes which range from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are most often associated with clear skies, class D is linked to sunset and sunrise, or cloudy and/or windy daytime conditions. Unstable conditions most often occur during the daytime and stable conditions are most common at night.

[5] Note that CALPUFF uses a more accurate micrometeorological scheme for turbulence.

The stability classes predicted by CALMET for the Development Site are summarised in Figure 4-4. The data shows that E and F class stability occurs ~41% of the time. The frequency of D class stability (32%) is commonly seen in areas with winds above 2.5 m/s at night or site with a high frequency of cloudy days.

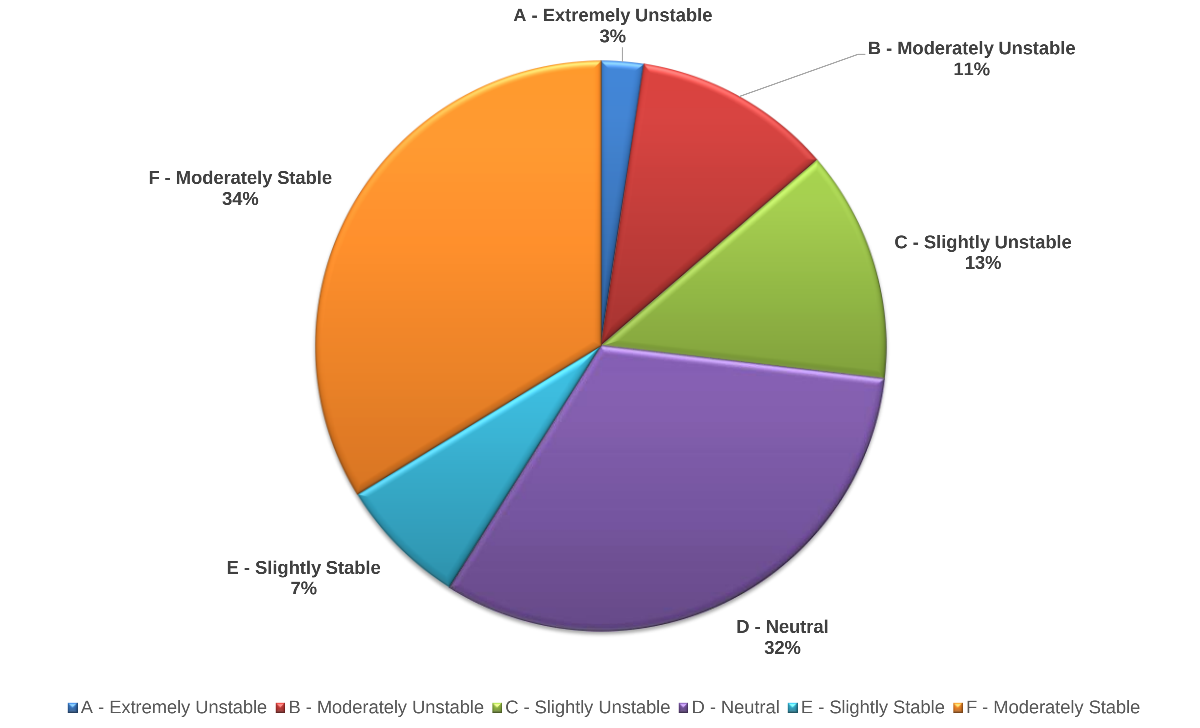


Figure 4-4: Atmospheric Stability

4.1.3 Atmospheric Mixing Height

The mixing height is the height of vertical mixing of air and suspended gases or particles above the ground. This height can be measured by the observation of the atmospheric temperature profile. A parcel of air rising from the surface of the Earth will rise at a given rate (called the dry-adiabatic lapse rate). As long as the parcel of air is warmer than the ambient temperature, it will continue to rise. However, once it becomes colder than the temperature of the environment, it will slow down and eventually stop (University of Michigan , 2004).

The mixing height is commonly referred to as an inversion layer. It is an important parameter when assessing air emissions as it defines the vertical mixing of a plume. This is because the air below the layer has restricted dispersion vertically and therefore the higher the mixing height, the more potential for dispersion.

The estimated variation of mixing height over time predicted at the site by CALMET is shown in Figure 4-5. The diurnal cycle is clear in this figure whereby at night the mixing height is normally relatively low and after sunrise, it increases as a result of heat associated with the sun on the Earth's surface. Overall, the estimated mixing height shown below is as expected with the exception that the overnight (midnight to 5 am) are quite low, which would lead to a conservative estimate of impacts.

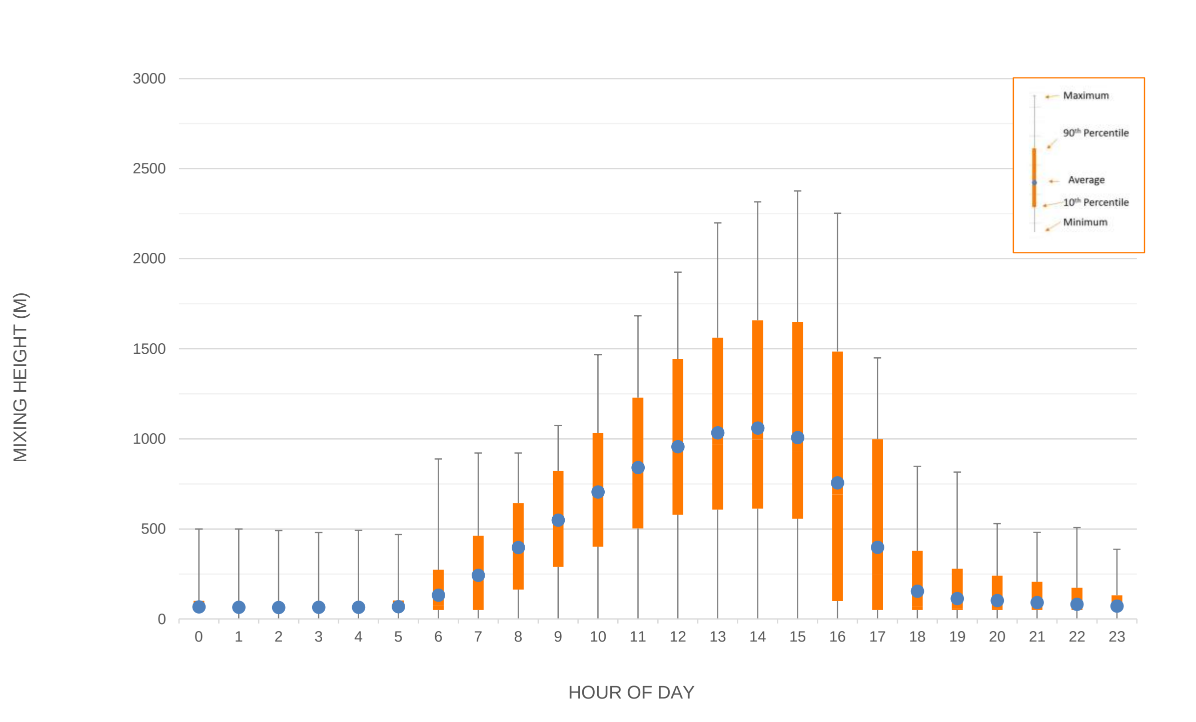


Figure 4-5: CALMET Extract – Predicted Mixing Heights

4.2 Background Air Quality Data

Existing air quality in the region is influenced by the following sources:

- Dust from agricultural activities (ploughing, harvesting, bailing);
- Wind erosion from exposed areas; and
- Wheel generated dust from unsealed rural roads.

The Office of Environment and Heritage (OEH) operates several monitoring stations throughout New South Wales. The closest monitoring station, being within the township of Tamworth, has been selected as the source of background data for the assessment. As there are numerous combustion sources within Tamworth including heavy vehicle traffic the measured concentrations would be higher than that typically expected at Warrah Ridge which is a rural area.

In accordance with the Approved Methods (NSW EPA, 2016), a level two assessment incorporating background data is as follows;

- Obtain ambient monitoring data that includes at least one year of continuous measurements and is contemporaneous with the meteorological data used in the dispersion modelling.
- At each receptor, add each individual dispersion model prediction to the corresponding measured background concentration (e.g., add the first hourly average dispersion model prediction to the first hourly average background concentration) to obtain hourly predictions of total impact.
- At each receptor, determine the 100th percentile (i.e. maximum) total impact for the relevant averaging period.

A statistical summary for the 2021 monitoring year (24 hour PM_{10}) is provided in Table 4-1 Table 4-1 below.

Table 4-1: Statistical summary of Tamworth PM_{10} Monitoring Data

Parameter	PM_{10} 24 – hour
Monitoring period	01/01/2021 – 31/12/2021
Averaging period	24 hours
Number of validated measurements	362
Data capture	100%
Average	12.7 µg/m^3
Standard deviation	4.7 µg/m^3
Percentiles and Concentrations (µg/m^3)	
25th	9.3
50th	12.1
70th	14.8
90th	18.9
99th	24.6
3rd highest	25.1
2nd highest	26.2
Maximum	36.4
Annual Average	12.7

5 RESULTS – FARM IN ISOLATION

5.1 Odour

Predicted odour concentrations associated with the proposed farm based on the modelling and emissions estimation methodologies detailed above are shown below as follows:

- Table 5-1: Predicted Receptor Concentrations ; and
- Figure 5-1: Layer Farm 1095 Predicted 1 second 99^{th} Percentile Odour Concentrations .

The results show a low risk of odour impact from the farm.

As discussed in Section 2.1, the EPAs preferred method to determine the odour criterion is to count the existing houses within the 2 ou contour, calculate the total population based on recent census people per household data for that area, then determine the criterion to be used based on Equation 7.2 in the Approved Methods.

Figure 5-1 indicates that no existing houses are within the 2 ou contour, which means that under the EPA method an odour criterion of $C_{99\ 1sec}$ = 7 ou would apply. However, we note that EPA typically apply a minimum criterion of 5 ou rather that 6 or 7 ou.

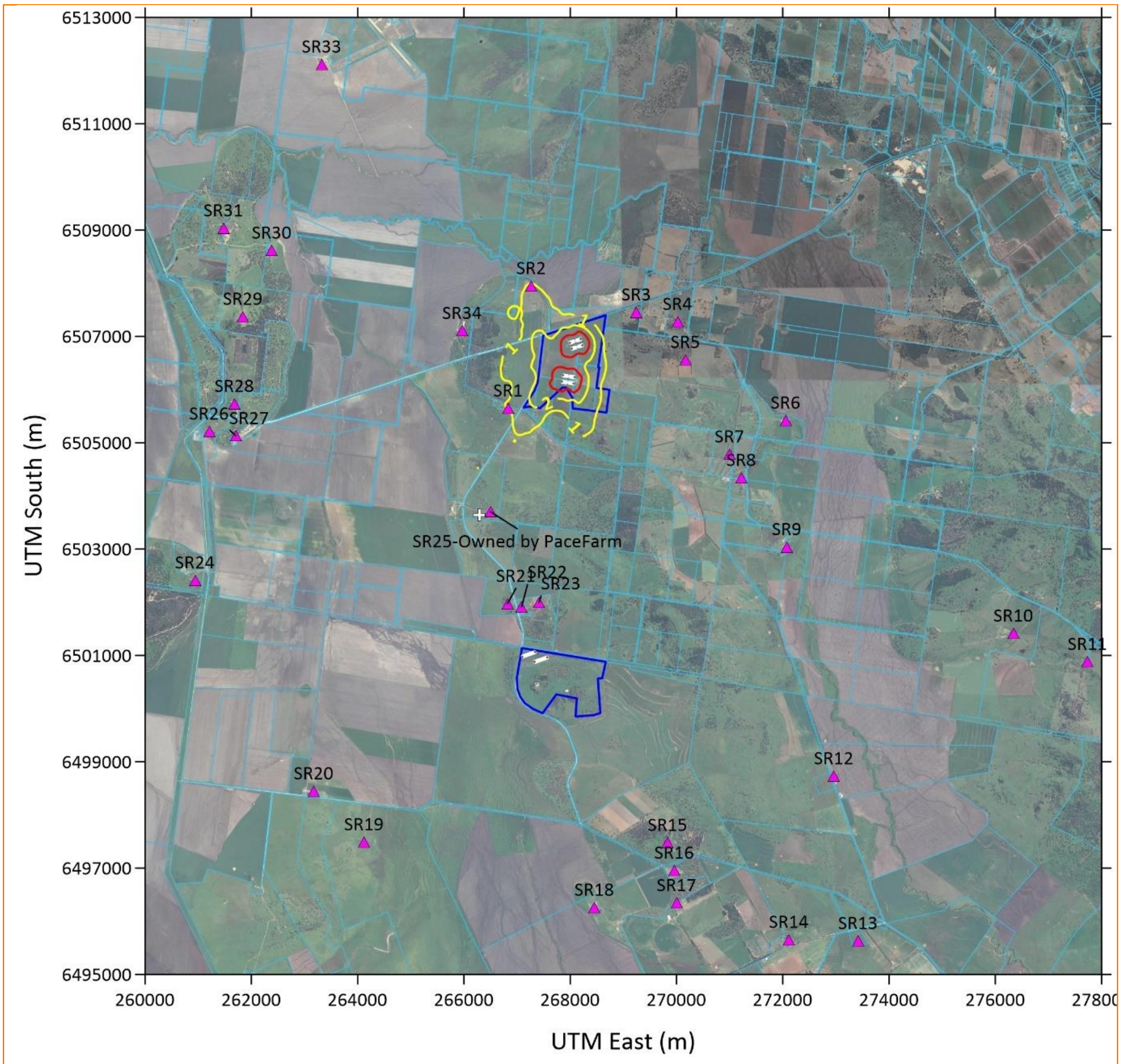
The highest predicted concentration is 1.1 ou at sensitive Receptor 2 which is located to the northwest of the site.

Although the farm in isolation complies, the farm needs to be considered cumulatively with Pace's Approved Rearing Farm 687 located to the south of the site. An assessment that considers potential cumulative impacts of this proposal with Farm 687 is provided in Section 6 below.

Table 5-1: Predicted Receptor Concentrations ($C_{99\ 1sec}$)

Receptor Number	Odour concentration
SR 1	1.0
SR 2	1.1
SR 3	0.3
SR 4	0.2
SR 5	0.1
SR 6	0.1
SR 7	0.2
SR 8	0.1
SR 9	0.1
SR 10	0.0
SR 11	0.0
SR 12	0.1
SR 13	0.0
SR 14	0.0
SR 15	0.1
SR 16	0.0
SR 17	0.0
SR 18	0.0
SR 19	0.1
SR 20	0.1
SR 21	0.2
SR 22	0.1
SR 23	0.1
SR 24	0.1
SR 25	0.7
SR 26	0.1
SR 27	0.1
SR 28	0.1
SR 29	0.1
SR 30	0.1
SR 31	0.1
SR 32	0.0
SR 33	0.1
SR 34	0.2

Note: Grey highlighted receptors are owned by Pace Farm.



Species: Odour	**Site:** Layer Farm 1095	**Scenario:** Proposed in isolation	**Averaging Period**: 1 sec	**Percentile:** 99th
Criterion: 5 ou (red)	**Units:** ou	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 5-1: Layer Farm 1095 Predicted 1 second 99th Percentile Odour Concentrations

5.2 Particulate Matter

Predicted particulate matter concentrations associated with the proposed site based on the modelling and emissions estimation methodologies detailed above are provided below.

The results are shown as follows:

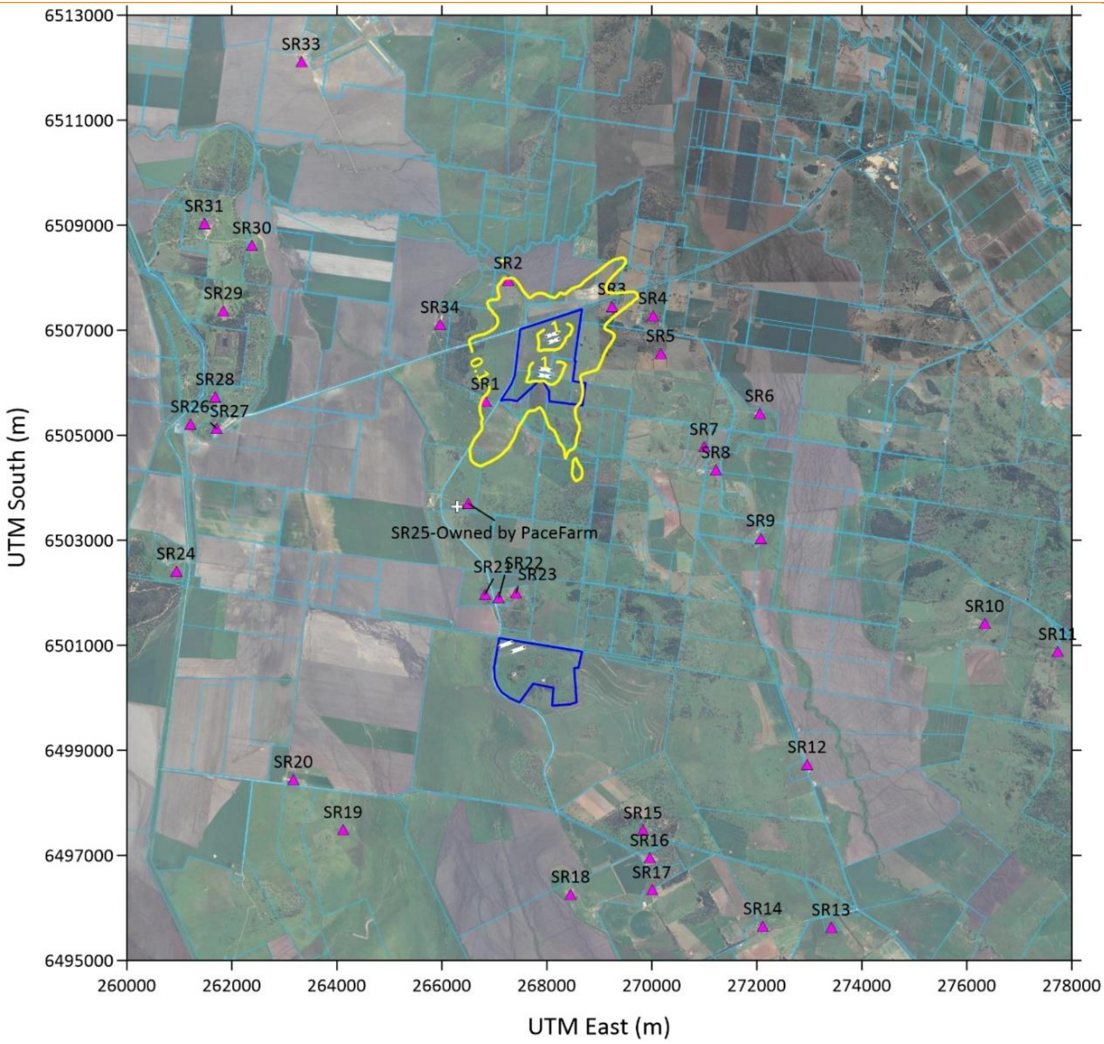
- Table 5-2: Predicted PM_{10} Concentrations for Sensitive Receptors in isolation;
- Figure 5-2: Predicted 24 hour maximum PM_{10} Concentrations –without background;
- Figure 5-3: Predicted 24 hour maximum PM_{10} Concentrations –with background; and
- Figure 5-4: Predicted Annual Average PM_{10} Concentrations – with background.

The maximum predicted ground level concentrations of particulate matter (PM_{10}) including maximum background data from Tamworth complies with the air quality impact criteria.

Table 5-2: Predicted PM_{10} Concentrations for Sensitive Receptors in isolation

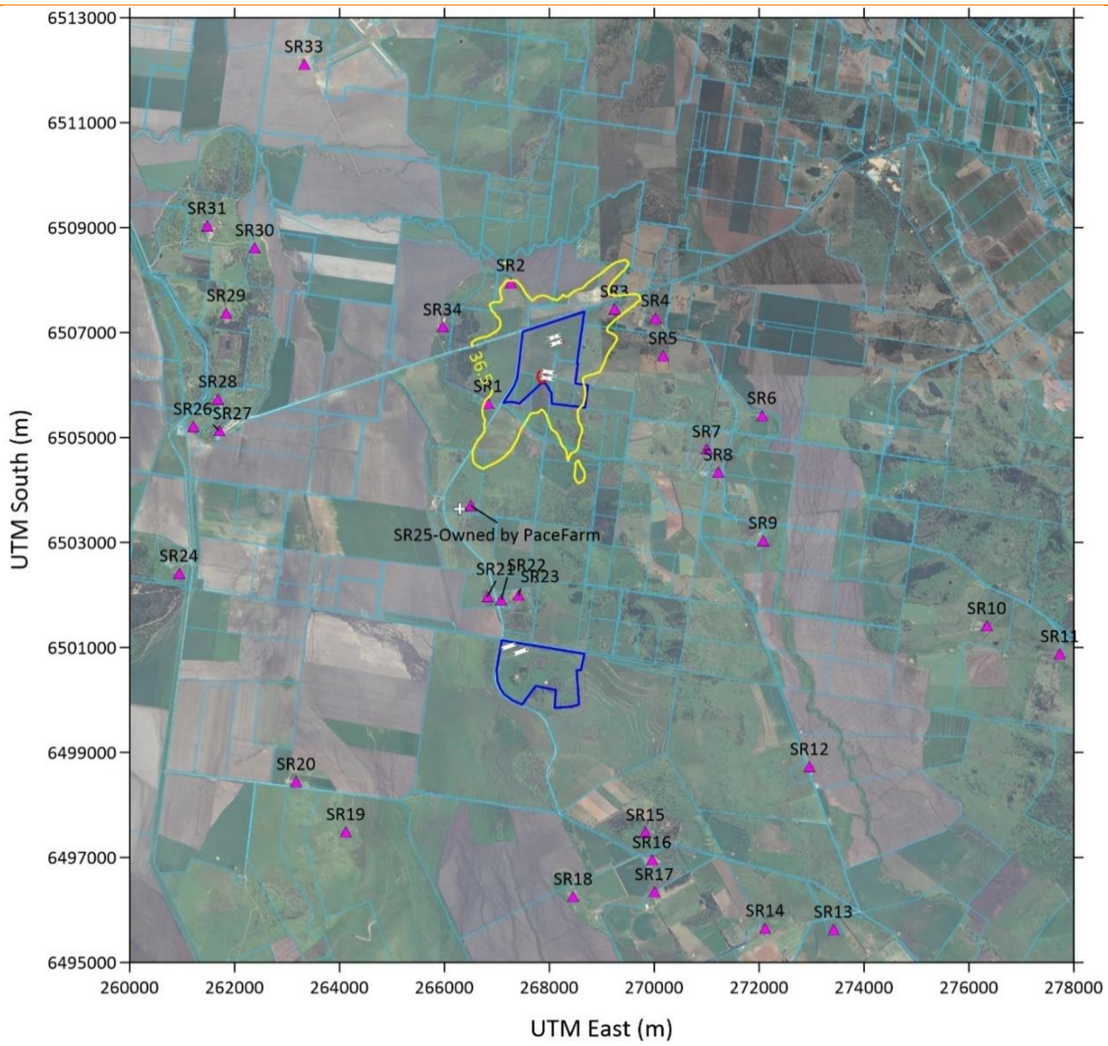
Receptor Number	Maximum PM_{10} 24 hour concentration in isolation (µg/m³)	Maximum PM_{10} 24 hour concentration with background (µg/m³)	PM_{10} Annual Average concentration in isolation (µg/m³)	PM_{10} Annual Average concentration with background (µg/m³)
SR 1	0.11	36.5	0.008	12.7
SR 2	0.10	36.5	0.012	12.7
SR 3	0.16	36.6	0.003	12.7
SR 4	0.06	36.5	0.002	12.7
SR 5	0.02	36.4	0.002	12.7
SR 6	0.02	36.4	0.001	12.7
SR 7	0.03	36.4	0.002	12.7
SR 8	0.02	36.4	0.001	12.7
SR 9	0.01	36.4	0.001	12.7
SR 10	0.01	36.4	0.000	12.7
SR 11	0.00	36.4	0.000	12.7
SR 12	0.02	36.4	0.001	12.7
SR 13	0.02	36.4	0.000	12.7
SR 14	0.01	36.4	0.000	12.7
SR 15	0.01	36.4	0.000	12.7
SR 16	0.01	36.4	0.000	12.7
SR 17	0.01	36.4	0.000	12.7
SR 18	0.01	36.4	0.000	12.7
SR 19	0.01	36.4	0.001	12.7
SR 20	0.02	36.4	0.001	12.7
SR 21	0.03	36.4	0.002	12.7
SR 22	0.02	36.4	0.001	12.7
SR 23	0.02	36.4	0.001	12.7
SR 24	0.01	36.4	0.000	12.7
SR 25	0.07	36.5	0.005	12.7
SR 26	0.02	36.4	0.001	12.7
SR 27	0.02	36.4	0.001	12.7
SR 28	0.03	36.4	0.001	12.7
SR 29	0.02	36.4	0.001	12.7
SR 30	0.02	36.4	0.001	12.7
SR 31	0.01	36.4	0.001	12.7
SR 32	0.01	36.4	0.000	12.7
SR 33	0.02	36.4	0.001	12.7
SR 34	0.03	36.4	0.001	12.7

Note: Grey highlighted receptors are owned by Pace Farm. The predicted concentration are maximum predicted at the receptor plus maximum or average background for 24 hour and annual respectively. See Section 6 below for a cumulative analysis.



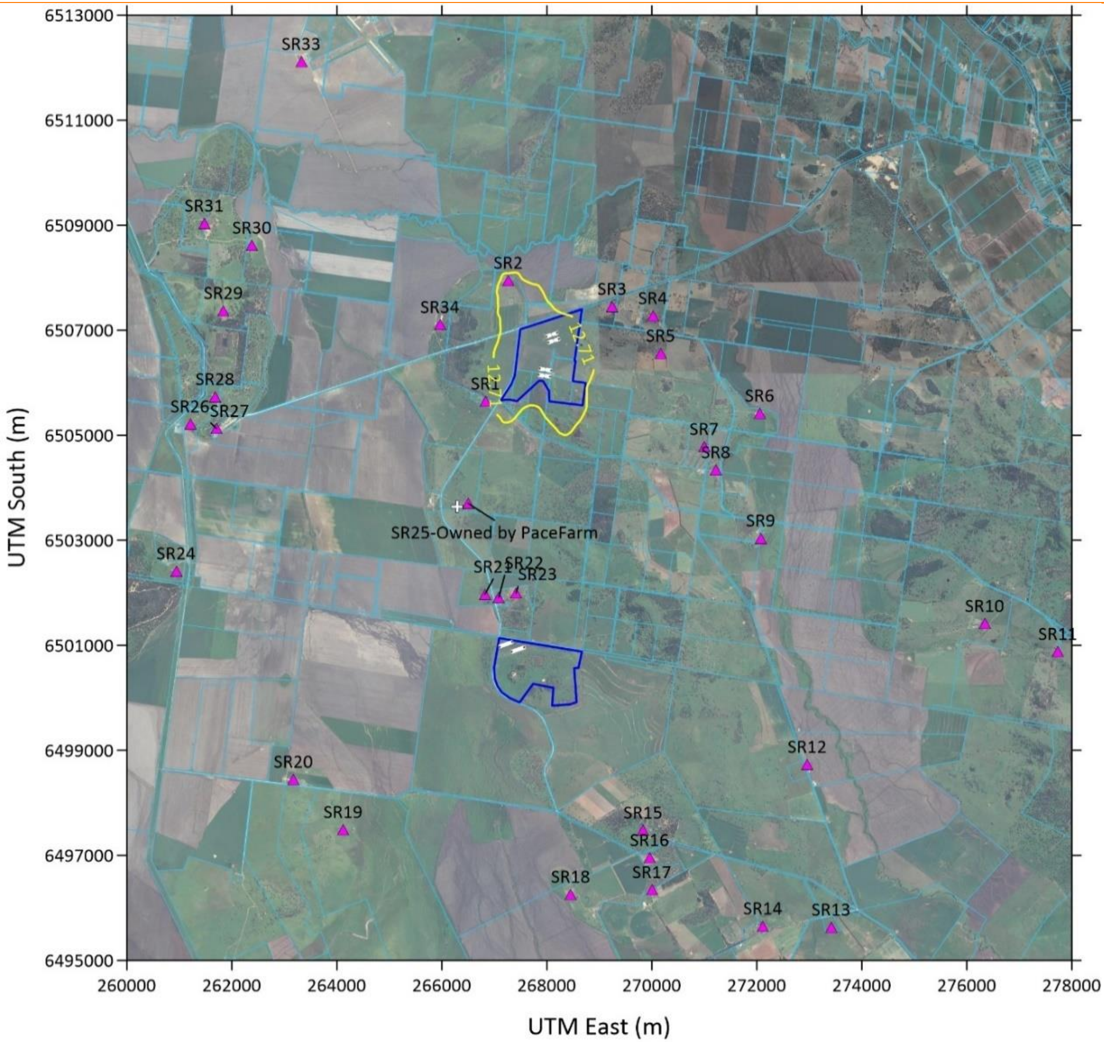
Species: PM10	**Site:** Layer Farm 1095	**Scenario:** Proposed	**Averaging Period:** 24 hour	**Percentile:** Maximum in isolation
Criterion: 50	**Units:** µg/m^3	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 5-2: Predicted 24 hour maximum PM_{10} Concentrations –without background



Species: PM10	Site: Layer Farm 1095	Scenario: Proposed	Averaging Period: 24 hour	Percentile: Maximum with background
Criterion: 50	Units: µg/m^3	Meteorology: 2021	Model: CALPUFF v 6.42	Author: W. Shillito

Figure 5-3: Predicted 24 hour maximum PM_{10} Concentrations –with background



Species: PM10	**Site:** Layer Farm 1095	**Scenario:** Proposed	**Averaging Period:** Annual Average	**Percentile:** Average with background
Criterion: 25	**Units:** µg/m³	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 5-4: Predicted Annual Average PM_{10} Concentrations – with background

6 RESULTS – CUMULATIVE

6.1 Odour

Predicted odour concentrations associated with Layer Farm 1095 including impacts from Farm 687 based on the modelling and emissions estimation methodologies detailed above are shown below as follows:

- Table 6-1: Predicted Cumulative Receptor Concentrations ($C_{99\ 1sec}$); and
- Figure 6-1: Predicted Cumulative Odour Concentrations .

Note that the K factor adopted for Farm 687 is K=2. For details on the K factor method see the Farm 687 report (Astute Environmental Consulting, 2021). We note that the modelling here uses on site meteorological data, i.e. Farm 687 has been remodelled for this report with the updated meteorological dataset.

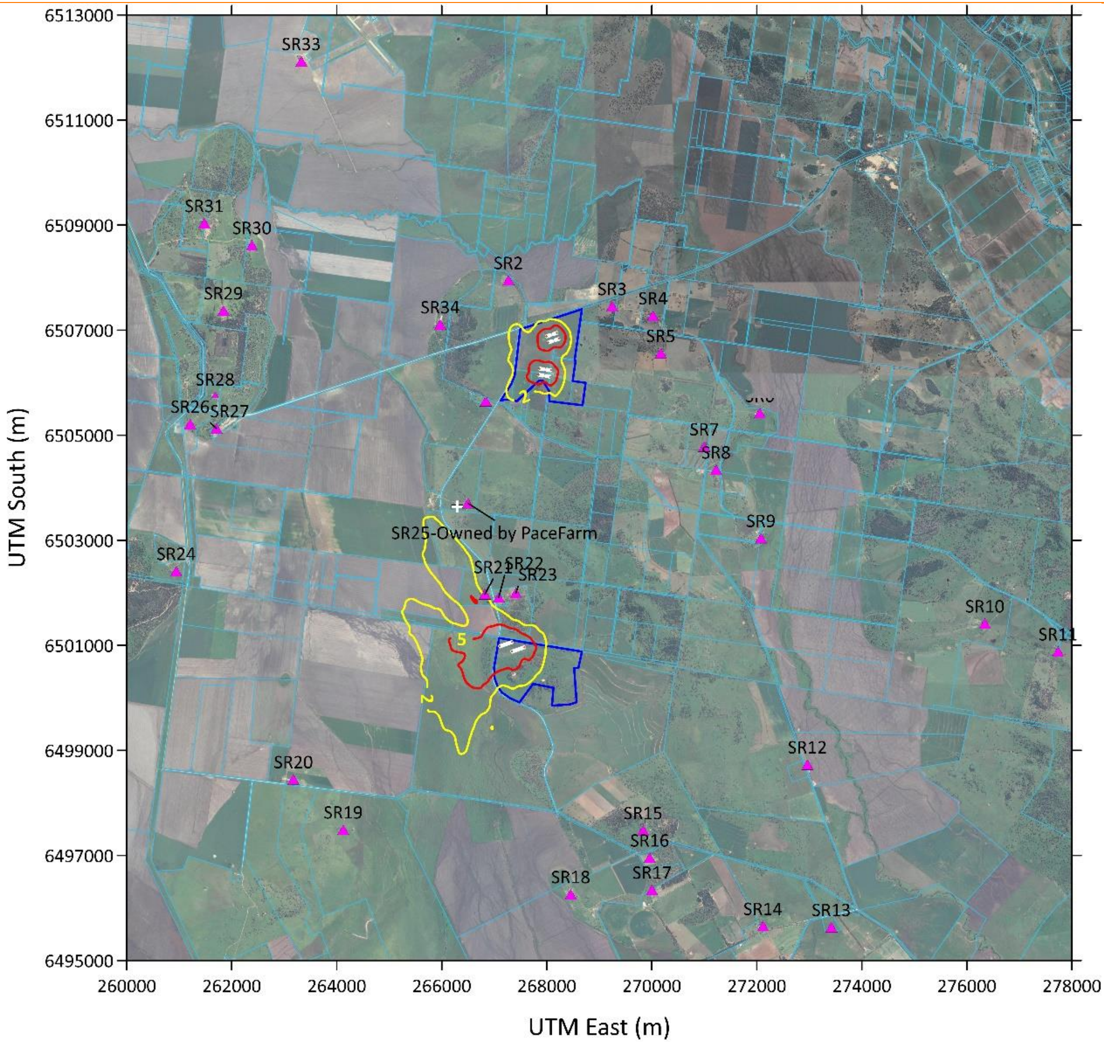
The predicted ground level 99th percentile 1 second concentrations for a K factor of 2 for Farm 687 and Layer Farm 1095 as modelled are predicted to comply with the 5 ou criterion.

The highest predicted concentration is 1.9 ou at sensitive Receptor 21, located to the northwest of Farm 687 poultry sheds and south of the Layer Farm 1095 sheds. 1.9 ou (rounded to 2 ou) is below the 5 ou criterion.

Table 6-1: Predicted Cumulative Receptor Concentrations ($C_{99\ 1sec}$)

Receptor Number	Odour concentration
SR 1	1.0
SR 2	1.1
SR 3	0.3
SR 4	0.2
SR 5	0.2
SR 6	0.1
SR 7	0.2
SR 8	0.2
SR 9	0.2
SR 10	0.0
SR 11	0.0
SR 12	0.1
SR 13	0.1
SR 14	0.1
SR 15	0.2
SR 16	0.1
SR 17	0.1
SR 18	0.3
SR 19	0.5
SR 20	0.3
SR 21	1.9
SR 22	1.1
SR 23	0.6
SR 24	0.3
SR 25	1.0
SR 26	0.2
SR 27	0.3
SR 28	0.3
SR 29	0.3
SR 30	0.3
SR 31	0.2
SR 32	0.1
SR 33	0.2
SR 34	0.3

Note: Grey highlighted receptors are owned by Pace Farm.



Species: Odour	**Site:** Layer Farm 1095	**Scenario:** Proposed Layer Farm 1095 cumulative with Farm 687 (K=2)	**Averaging Period:** 1 sec	**Percentile:** 99th
Criterion: 5 ou	**Units:** ou	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 6-1: Predicted Cumulative Odour Concentrations

6.2 Particulate Matter

Predicted particulate matter concentrations associated with Layer Farm 1095 including emissions from Farm 687 based on the modelling and emissions estimation methodologies described above are provided below.

The results are shown as follows:

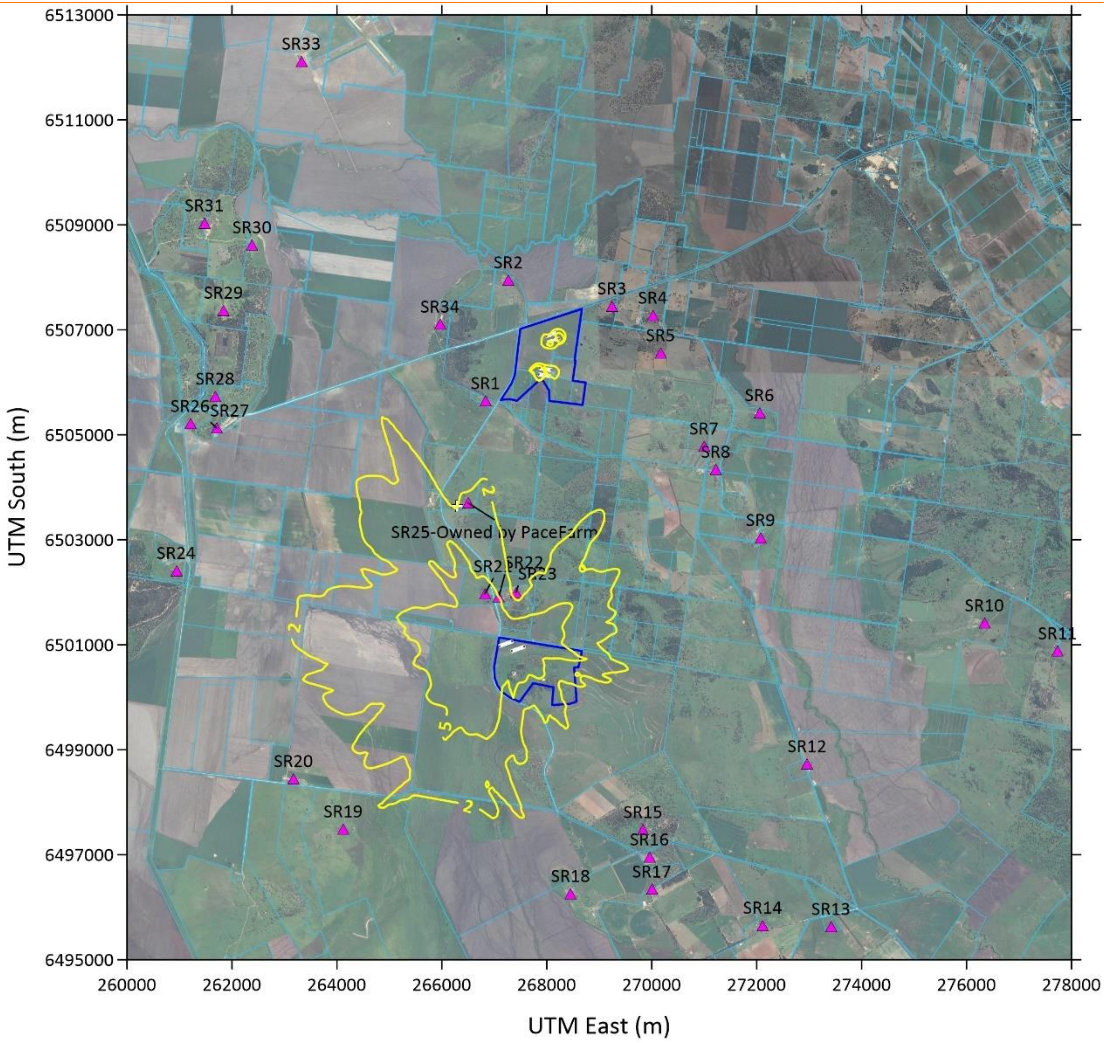
- Table 6-2 Predicted PM_{10} Concentrations for Sensitive Receptors Cumulative with Farm 687;
- Figure 6-2: Predicted Cumulative 24 hour maximum PM_{10} Concentrations –without background;
- Figure 6-3: Predicted Cumulative 24 hour maximum PM_{10} Concentrations –with background; and
- Figure 6-4: Predicted Cumulative Annual Average PM_{10} Concentrations – with background

Note that for all figures the red contour (if included in the figure) shows the regulatory criterion. Areas outside of this contour are compliant with the criterion.

Table 6-2 Predicted PM_{10} Concentrations for Sensitive Receptors Cumulative with Farm 687

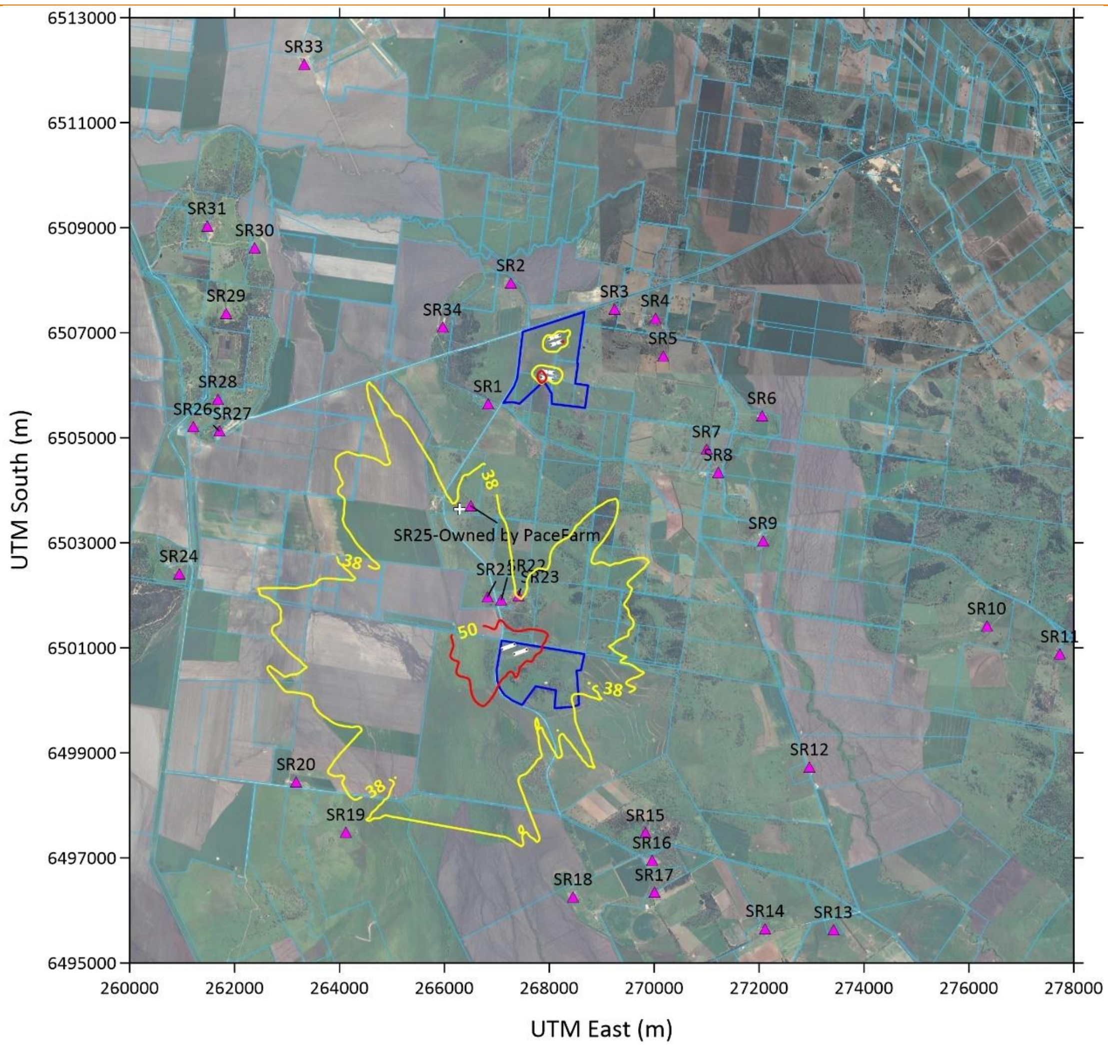
Receptor Number	Maximum PM_{10} 24 hour concentration in isolation (µg/m³)	Maximum PM_{10} 24 hour concentration with background (µg/m³)	PM_{10} Annual Average concentration in isolation (µg/m³)	PM_{10} Annual Average concentration with background (µg/m³)
SR 1	1.1	37.5	0.03	12.7
SR 2	0.3	36.7	0.02	12.7
SR 3	0.2	36.6	0.01	12.7
SR 4	0.2	36.6	0.01	12.7
SR 5	0.4	36.8	0.01	12.7
SR 6	0.4	36.8	0.01	12.7
SR 7	0.3	36.7	0.01	12.7
SR 8	0.5	36.9	0.01	12.7
SR 9	0.8	37.2	0.02	12.7
SR 10	0.2	36.6	0.00	12.7
SR 11	0.1	36.5	0.00	12.7
SR 12	0.3	36.7	0.01	12.7
SR 13	0.4	36.8	0.01	12.7
SR 14	0.3	36.7	0.01	12.7
SR 15	0.7	37.1	0.03	12.7
SR 16	0.5	36.9	0.02	12.7
SR 17	0.3	36.7	0.02	12.7
SR 18	0.8	37.2	0.05	12.7
SR 19	1.2	37.6	0.06	12.8
SR 20	1.1	37.5	0.04	12.7
SR 21	8.6	45.0	0.52	13.2
SR 22	4.5	40.9	0.26	13.0
SR 23	1.3	37.7	0.09	12.8
SR 24	1.0	37.4	0.03	12.7
SR 25	2.5	38.9	0.08	12.8
SR 26	0.6	37.0	0.03	12.7
SR 27	0.7	37.1	0.04	12.7
SR 28	0.8	37.2	0.04	12.7
SR 29	0.4	36.8	0.04	12.7
SR 30	0.5	36.9	0.05	12.7
SR 31	0.4	36.8	0.03	12.7
SR 32	0.1	36.5	0.01	12.7
SR 33	0.5	36.9	0.02	12.7
SR 34	0.6	37.0	0.02	12.7

Note: Grey highlighted receptors are owned by Pace Farm



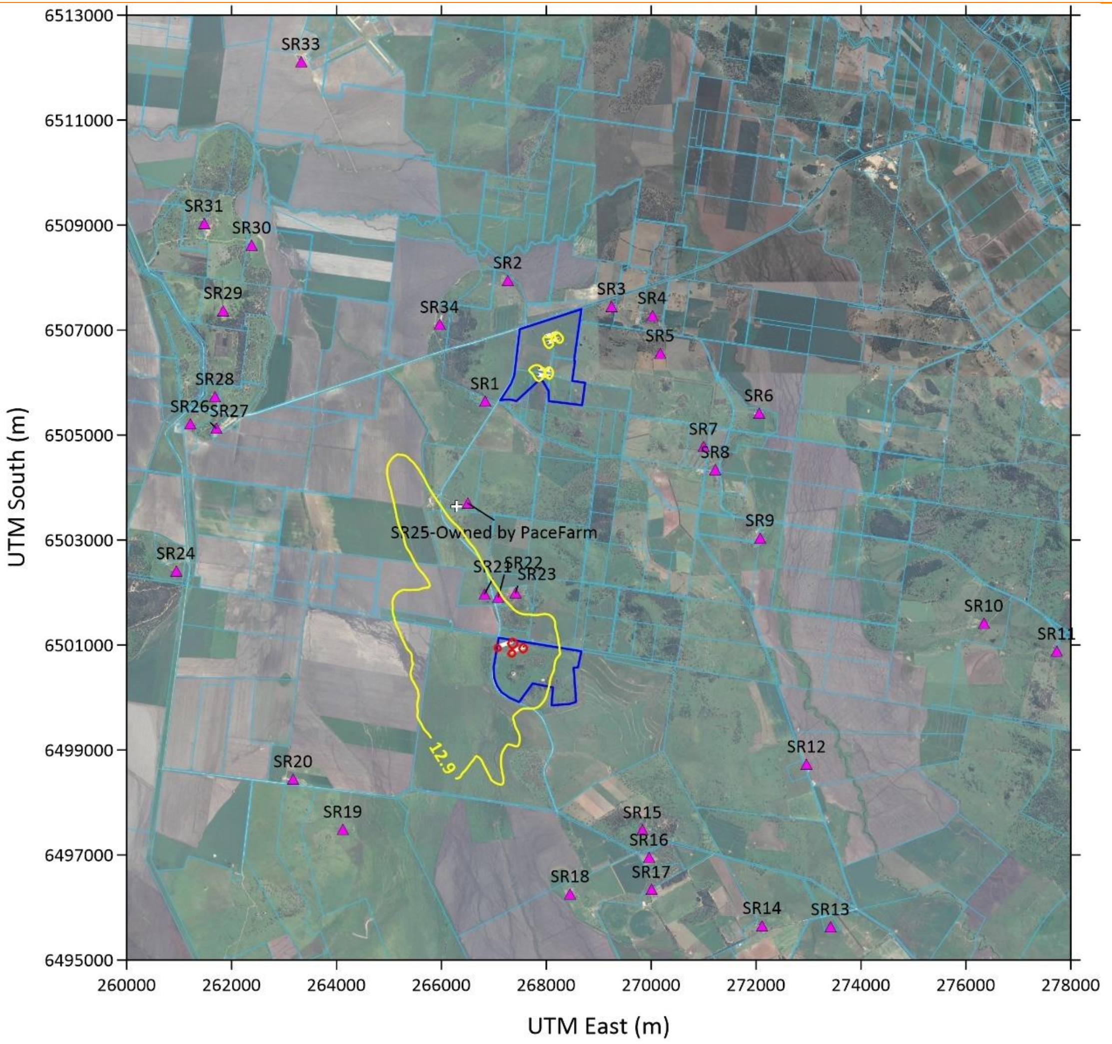
Species:	**Site:**	**Scenario:**	**Averaging Period:**	**Percentile:**
PM_{10}	Layer Farm 1095	Proposed Layer Farm 1095 cumulative with Farm 687	24 hour	Maximum in isolation
Criterion:	**Units:**	**Meteorology:**	**Model:**	**Author:**
50	$\mu g/m^3$	2021	CALPUFF v 6.42	W. Shillito

Figure 6-2: Predicted Cumulative 24 hour maximum PM_{10} Concentrations –without background



Species: PM10	Site: Layer Farm 1095	Scenario: Layer Farm 1095 cumulative with Farm 687	Averaging Period: 24 hour	Percentile: Maximum with background
Criterion: 50	**Units:** µg/m³	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 6-3: Predicted Cumulative 24 hour maximum PM_{10} Concentrations –with background



Species: PM10	**Site:** Layer Farm 1095	**Scenario:** Proposed Layer Farm 1095 cumulative with Farm 687	**Averaging Period:** Annual Average	**Percentile:** Average with background
Criterion: 25	**Units:** µg/m^3	**Meteorology:** 2021	**Model:** CALPUFF v 6.42	**Author:** W. Shillito

Figure 6-4: Predicted Cumulative Annual Average PM_{10} Concentrations – with background

7 CONCLUSION

The modelling presented in this report considers the proposed site and has been performed in accordance with the Approved Methods (NSW EPA, 2016). The assessment has used a standard odour emissions methodology (McGahan & Galvin, 2018) to determine odour emissions for the layer farm. The modelling using emissions based on layer farms elsewhere indicates that the proposed site would not lead to any exceedances of the odour criterion of 5 ou at the nearest sensitive locations either in isolation or when considered cumulatively with Farm 687. The modelling has also demonstrated that the risk associated with particulate matter is low as there will not be any exceedances at the receptors.

Therefore, based on the emission estimation methods used, the operation is unlikely to have impacts on the amenity and character of the locality provided the farms are managed in line with best practice and in a way to minimise odour emissions to ensure the farm is operated as modelled.

Based on our assessment we recommend the development be approved and operated in line with current industry best practice.

8 REFERENCES

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