VINEYARD PRECINCT STAGE 1

Noise and Odour Assessment

8 November 2016

NSW Department of Planning and Environment

TG584-01F03 (r4) Vineyard - Noise and Odour

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1 Introduction

Renzo Tonin & Associates and Todoroski Air Sciences have been commissioned by the New South Wales (NSW) Department of Planning and Environment (DP&E) to respectively undertake a noise and Level 2/3 odour study for the proposed Stage 1 development of the Vineyard Precinct as a part of the North West Priority Growth Areas (hereafter referred to as the Precinct).

The noise and odour study aims to identify any potential constraints on future development resulting from existing land uses within and surrounding the Precinct, as well as provide recommendations and controls for future development. The outcomes and findings of this study are to assist in developing strategies to aid the redevelopment of the site while identifying any risks or issues during the interim stages of development or at completion.

The noise assessment has been carried out in accordance with relevant NSW Environment Protection Authority (EPA) policies and referenced standards including consideration of vibration. At this stage, existing noise and vibration sources have been identified and assessed with regard to both existing and potential future land uses. Where relevant, guidance is provided with regard to necessary controls including buffer distances, physical mitigation measures or suitable adjacent land uses.

The Stage 2 odour assessment investigates the nature and extent of odour sources in the vicinity of the Precinct as identified in the previously completed Stage 1 odour assessment (Appendix E). A Level 2/3 Odour Impact Assessment as described in the '*Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW*' [1] has been conducted to characterise the extent of impacts from these sources.

2 Project background

The following section sets the context of the project and presents a description of the subject site and outlines the scope of the noise and odour study.

2.1 Sydney's North West Priority Growth Area

Sydney's North West Priority Growth Area is located approximately 34 kilometres (km) northwest of the Sydney CBD and is within the local government areas (LGA) of Baulkham Hills, Blacktown and Hawkesbury.

The North West Priority Growth Area covers approximately 10,000 hectares (ha) and is made up of 16 separate Precincts which will be progressively developed and released over time to provide approximately 70,000 new dwellings for 200,000 people.

2.2 Project description and setting

The Vineyard Precinct is located in the northern portion of the North West Priority Growth Area (Figure 2-1). The Precinct is bound by Bandon Road and Windsor Road to the south, Menin Road and Commercial Road to the northeast, and Boundary Road to the southeast. The western boundary traverses the properties between Eastern Creek and the Blacktown-Richmond rail line.

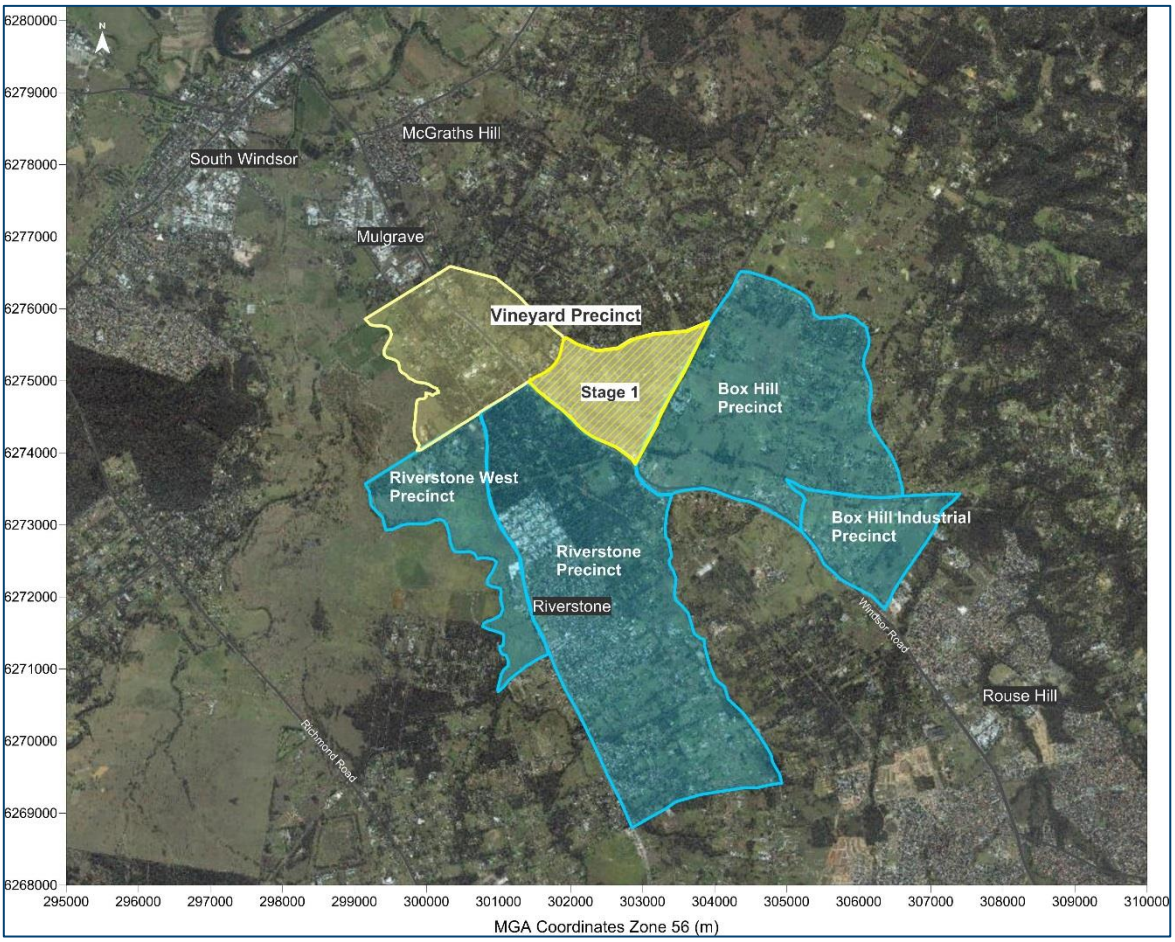
The Precinct is generally a semi-rural area that consists of a mix of low density residential and small agricultural operations such as market gardens and animal husbandry operations. The Precinct covers an area of approximately 590 ha and is defined into eastern and western development areas, identified as Stages 1 and 2, respectively. The Stage 1 development area is the focus of this assessment for the Precinct and is estimated to accommodate up to 2,400 homes for 7,400 residents.

In regard to future setting, the Precinct is bound by the North West Priority Growth Areas of Box Hill to the east, Riverstone to the south and Riverstone West to the west. The Box Hill Precinct has been rezoned for urban development and provides for new dwellings, retail and commercial development and associated infrastructure. The Riverstone Precinct has been rezoned for urban development, including large open space and conservation reserves, new schools, rail duplication and other associated infrastructure. The Riverstone West Precinct has been rezoned for predominantly industrial development.

To the north and west of the Precinct are the localities of Windsor, South Windsor and McGraths Hill. These areas comprise of developed urban areas surrounded by rural land uses. North of the Precinct also lies the Mulgrave industrial area.

Figure 2-2 presents the terrain features surrounding the Precinct. The Precinct is surrounded predominantly by flat terrain, with an area of rolling rural terrain to the northeast.

Figure 2-1: Vineyard Precinct location



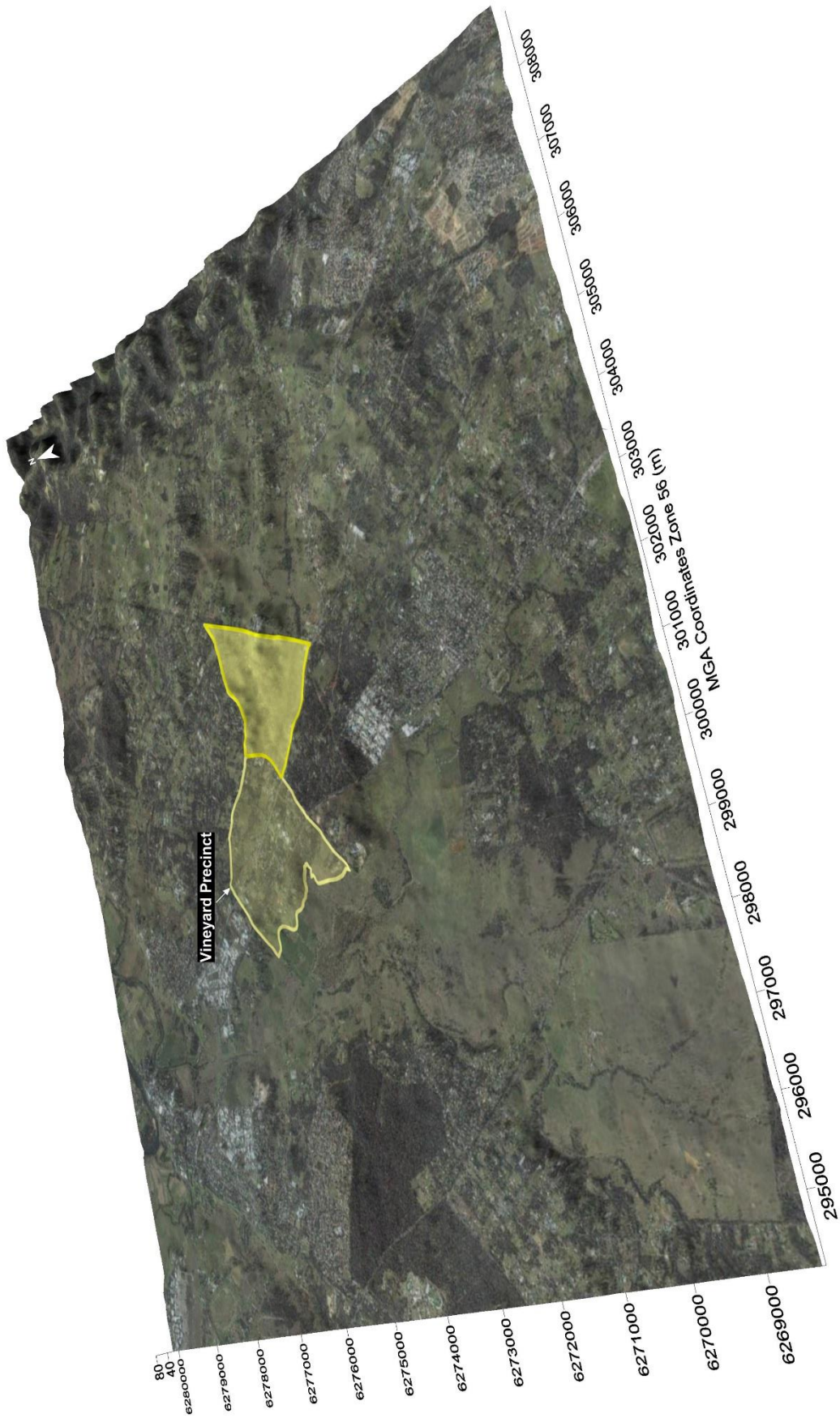


Figure 2-2: Representative visualisation of topography in the area surrounding the Vineyard Precinct

Figure 2-3: Vineyard precinct

2.3 Study objectives

The objectives of the noise and odour study include:

- Investigate and identify the key sources of noise and odour on or in the vicinity of the Precinct, including from agricultural or other economic/employment related activities
- Investigate the implications of any existing noise and odours for the staging of the development of the Precinct
- Recommend management strategies to maximise development opportunities both under the existing situation and under future scenarios, and
- Make recommendations for controlling impacts from noise and odour generating activities in proposed residential areas and other sensitive land uses.

2.4 Scope of work

2.4.1 Noise

Environmental noise and vibration has been recognised as a major cause of disturbance to living and working environments and therefore a key determinant of urban amenity. This report aims to identify and investigate existing and potential future noise and vibration conflicts within the Stage 1 development area of the Precinct to assist in the planning process.

From our site investigations and review of available relevant planning documentation for the site and surrounds, the major sources of noise and vibration currently and potentially in the future affecting the Precinct are presented in Table 2-1. Additionally, Table 2-1 outlines the relevant policies and guidelines to each noise source assessment.

Table 2-1: Noise and vibration considerations

Consideration	Policy or Guideline
Noise generated by various industrial and commercial uses/facilities within and surrounding the Precinct	• NSW Industrial Noise Policy [2]
Road traffic noise associated with existing and future roads	• State Environmental Planning Policy - Infrastructure 2007 • Development Near Rail Corridors and Busy Road-Interim Guideline [3] • NSW Road Noise Policy [4]
Rail noise associated with the Richmond Line	• State Environmental Planning Policy - Infrastructure 2007 [5] • Development Near Rail Corridors and Busy Road-Interim Guideline [3]
Aircraft noise associated with the RAAF Base Richmond	• Australian Standard 2021-2000 [6]

2.4.2 Odour

The scope of work required for Stage 2 of the odour study includes:

- Undertake a Level 2 or 3 Odour Assessment as outlined by NSW EPA's "*Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW*" [1] and its Technical Notes [7]. Unless a superior alternative method can be suggested, this assessment should utilise the AUSPLUME model as preferred by the guidelines.[1] If another model is preferred this must be discussed with the EPA prior to modelling commencing. This task will include liaison and meetings with the relevant Council, the principal contractor, government authorities and land owners as appropriate;
- Prepare a report which:
  - Incorporates the results of the modelling and sets out any limitations to the data,
  - Highlights specific strategies for managing odour impacts (including any appropriate management or structural changes to the odour generating operation),
  - Predicts odour impacts on the future development of the Precinct in light of the management recommendations, and
  - Make specific recommendations for controlling odour impact from odour generating development on proposed residential development and associated land uses including open space. These recommendations shall be in the form of development control provisions suitable for inclusion in a development control plan and / or indicative layout plan.
- Modelling would incorporate suitable data representation over 1-year to account for seasonal variations in meteorological conditions.

[1] It is important to note that the 2005 Approved Methods for the Modelling and Assessment of Air Pollutants in NSW specify AUSPLUME as the default preferred model, however the current (2011) guidelines which originate from a NSW EPA workshop on odour modelling from poultry operations advise that CALPUFF should be used in preference to AUSPLUME. This is because CALPUFF can better deal with poultry odour under complex low wind speed conditions and temperature inversion conditions when odour and noise impacts are greatest.

Additionally, the CALMET meteorological component of the CALPUFF modelling suite would allow consideration of site specific temperature inversion conditions reliably in the noise assessment, making the odour and noise assessments more consistent and accurate for the purposes of good master planning.

We have discussed this with NSW EPA and can confirm their preference for the CALPUFF modelling suite.

3 Review of ILP

The Indicative Layout Plan (ILP) for the Vineyard Precinct, presented in Figure 3-1, has been developed with consideration of the potential noise and odour and impacts resulting from the proposed land use changes.

It is noted that the latest ILP has resulted in a reduction of potential land use conflicts, in particular through effective use of open space buffers and reduction of residential development interfacing with noise and odour sources. However not all land use conflicts can be addressed through buffer distances or alternate land use interfaces. Where conflicts cannot be overcome through reconfiguration of land uses, other noise mitigation measures may need to be considered during the detailed planning stages of the specific development, such as specific lot configurations, hours of operation and physical noise and odour controls. Discussion of the potential noise and odour issues is set out in subsequent sections of the report.

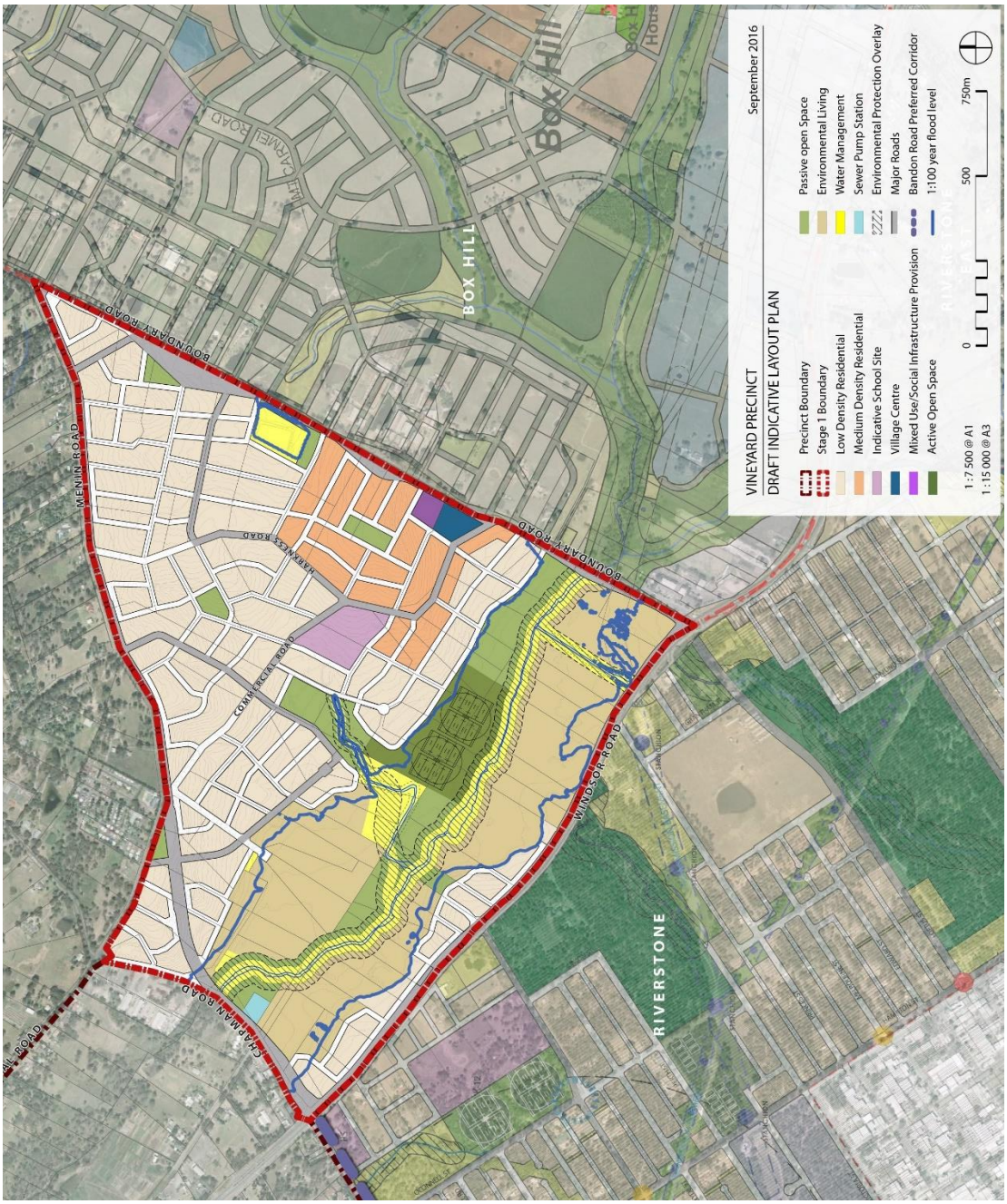


Figure 3-1: ILP

4 Existing environment

4.1 Local climate

Noise and particularly odour impacts on the Precinct will be influenced by local meteorological conditions. Influencing conditions such as wind speed, wind direction and atmospheric turbulence affect how odours disperse from their source, how often a downwind receptor is impacted by odours and how well odours disperse in the atmosphere.

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Richmond RAAF (Site No. 067105) have been used to characterise the local climate in the proximity of the Precinct. The Richmond RAAF station is located approximately 6.8km northwest of the Precinct.

Table 4-1 and Figure 4-1 present a summary of data from Richmond RAAF collected over an approximate 16 to 21-year period for the various meteorological parameters.

The data indicates that January is the hottest month with a mean maximum temperature of 30.0ºC and July is the coldest month with a mean minimum temperature of 3.6ºC.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 58% in October to 83% in June. Mean 3pm humidity levels vary from 39% in the months of August and September to 53% in May and June.

Rainfall peaks during the summer months and declines during winter. The data indicates that February is the wettest month with an average rainfall of 122.9mm over 8.4 days. July is the driest month with an average rainfall of 28.5mm over 3.9 days.

Wind speeds during the warmer months have a similar spread between the 9am and 3pm conditions compared to the colder months, but have higher wind speeds. Mean 9am wind speeds range from 5.7km/h in May to 10.3km/h in October and mean 3pm wind speeds range from 12.6km/h in May to 19.4km/h in September.

Table 4-1: Monthly climate statistics summary - Richmond RAAF

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (°C)	30.0	29.0	26.8	23.9	20.7	17.9	17.6	19.8	22.9	25.1	26.7	28.5
Mean min. temperature (°C)	17.6	17.7	15.6	11.5	7.5	5.1	3.6	4.4	8.0	10.9	14.1	15.9
Rainfall												
Rainfall (mm)	75.7	122.9	75.8	48.6	48.9	47.5	28.5	29.5	48.4	50.6	82.7	59.8
Mean no. of rain days (≥1mm)	7.5	8.4	7.9	5.9	5.5	5.6	3.9	3.7	4.6	5.7	7.9	6.4
9am conditions												
Mean temperature (°C)	22.1	21.3	19.1	17.0	13.1	10.0	8.9	11.4	15.4	18.3	19.2	20.9
Mean relative humidity (%)	72	78	80	76	82	83	80	69	63	58	68	68

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean wind speed (km/h)	9.1	8.1	6.6	6.9	5.7	6.3	5.9	8.1	9.9	10.3	9.9	8.9
3pm conditions												
Mean temperature (°C)	28.5	27.4	25.8	23.0	19.7	17.0	16.5	18.7	21.5	23.5	25.2	27.5
Mean relative humidity (%)	47	52	52	49	53	53	48	39	39	40	46	44
Mean wind speed (km/h)	16.6	15.6	14.7	14.4	12.6	13.5	14.3	17.7	19.4	19.1	19.0	17.7

Source: [8]

Figure 4-1: Monthly climate statistics summary - Richmond RAAF

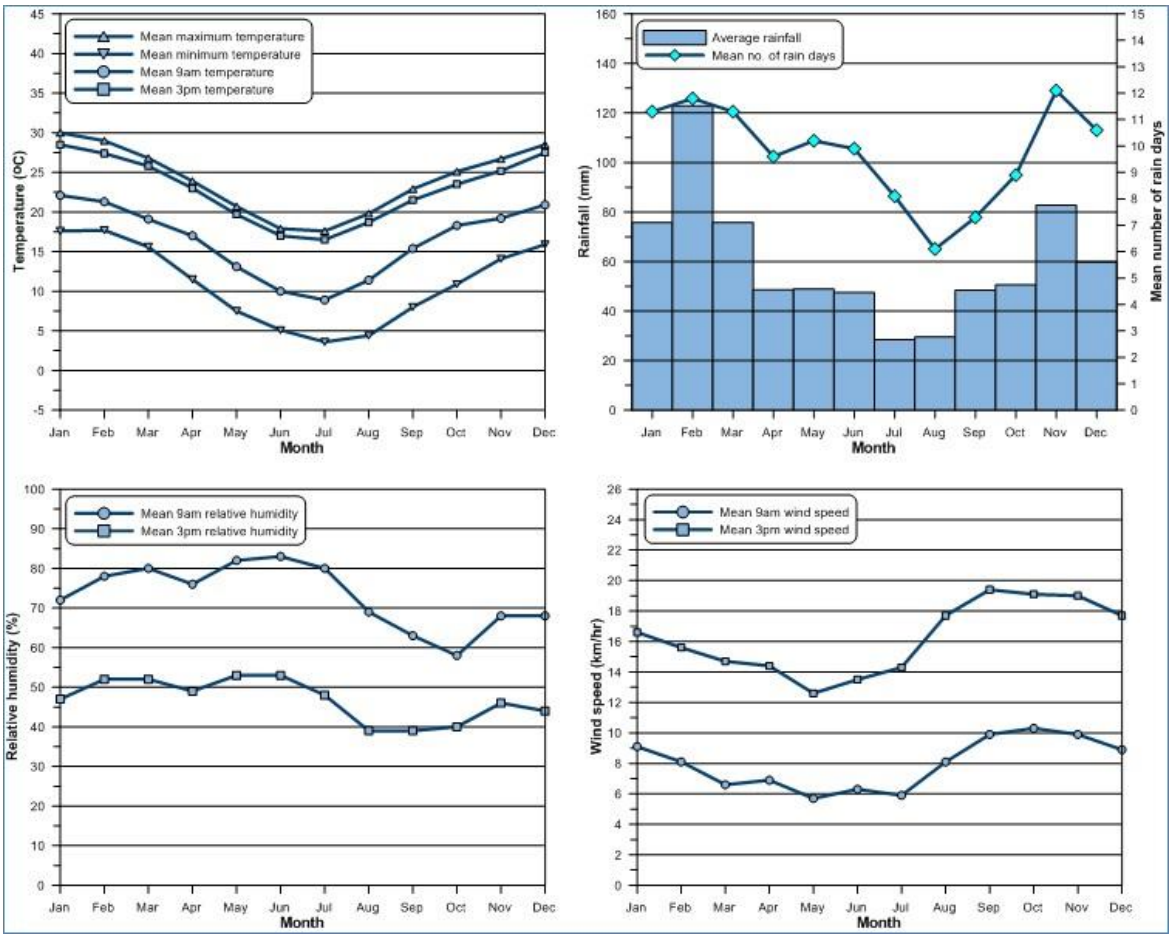
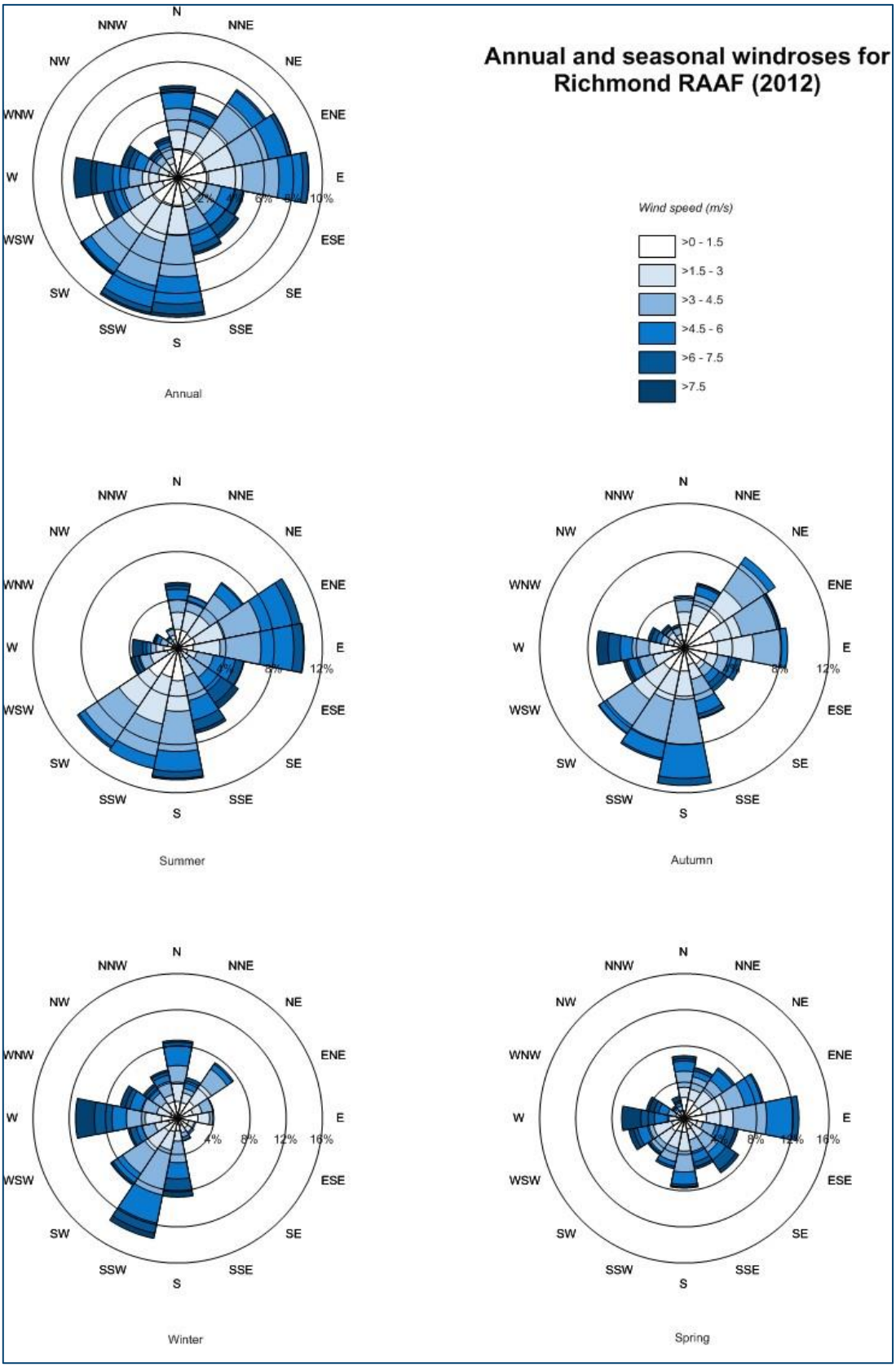


Figure 4-2 presents the annual and seasonal windroses for Richmond RAAF during the 2012 calendar period. On an annual basis, winds from the east, south and southwest are most frequent with a portion of strong winds originating from the west. In summer, winds from the east to northeast and south to southwest sectors are most dominant. During autumn, winds from the south are most frequent with other winds in a similar distribution to the summer windrose. The winter distribution is dominated by winds from the south-southwest and west. The spring distribution shows a high proportion of winds originating from the east and east-northeast with a spread of winds from other directions.

Figure 4-2: Annual and seasonal windroses - Richmond RAAF (2012)



4.2 Noise environment

Measurement of the existing noise environment has been carried out in order to assess existing noise generating development and infrastructure, such as roads. In addition, background noise level data is typically used for establishing noise criteria for noise generating development. However, it is noted that the future noise environment across much of the Precinct will vary considerably in the future, and therefore may only be applicable for assessment of impact upon existing noise sensitive development.

Appendix B of the NSW EPA *Industrial Noise Policy* (INP) outlines two methods for determining the background noise level of an area, being 'B1 - Long-term background noise method' and 'B2 - Short-term background noise method' [2]. The short-term method is recommended for use where specific assessment of noise generating development is required. The noise measurements have also been carried out to quantify noise from existing major roads. This assessment has used a combination of long-term and short-term noise monitoring.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. For example, in a suburban or urban area the noise environment is typically at its minimum at 3am in the morning and at its maximum during the morning and afternoon traffic peak hours.

The INP outlines the following standard time periods over which the background and ambient noise levels are to be determined:

- Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
- Evening: 18:00-22:00 Monday to Sunday & Public Holidays
- Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

Road and rail traffic noise is assessed across two periods:

- Day: 07:00-22:00
- Night: 22:00-07:00

4.3 Noise measurement locations

The long-term and short-term measurement locations are outlined in Table 4-2 and shown in Figure 4-3.

Table 4-2: Noise monitoring locations

ID	Address	Description
Long-term noise monitoring		
L1	372 Windsor Road, Vineyard	The monitor was located at the front boundary of the property, approximately 14m from the nearest carriageway of Windsor Road. The microphone of the monitor was positioned 1.5m above the ground level in the free-field.

ID	Address	Description
L2	170 Commercial Road, Vineyard	The monitor was located to the rear of the property approximately 12m from the southern boundary and 110m from the Commercial Road frontage. The microphone of the monitor was positioned 1.5m above the ground level in the free-field.
L3	47 Boundary Road, Box Hill	Front yard of property, 1.5m above the ground in the free-field, 70m from the edge of Boundary Road.
Short-term noise monitoring		
S1	Vineyard Hotel, Windsor Road, Vineyard	The sound level meter was located 1.5m above the ground, in the free-field in the car park along the Boundary Road frontage.

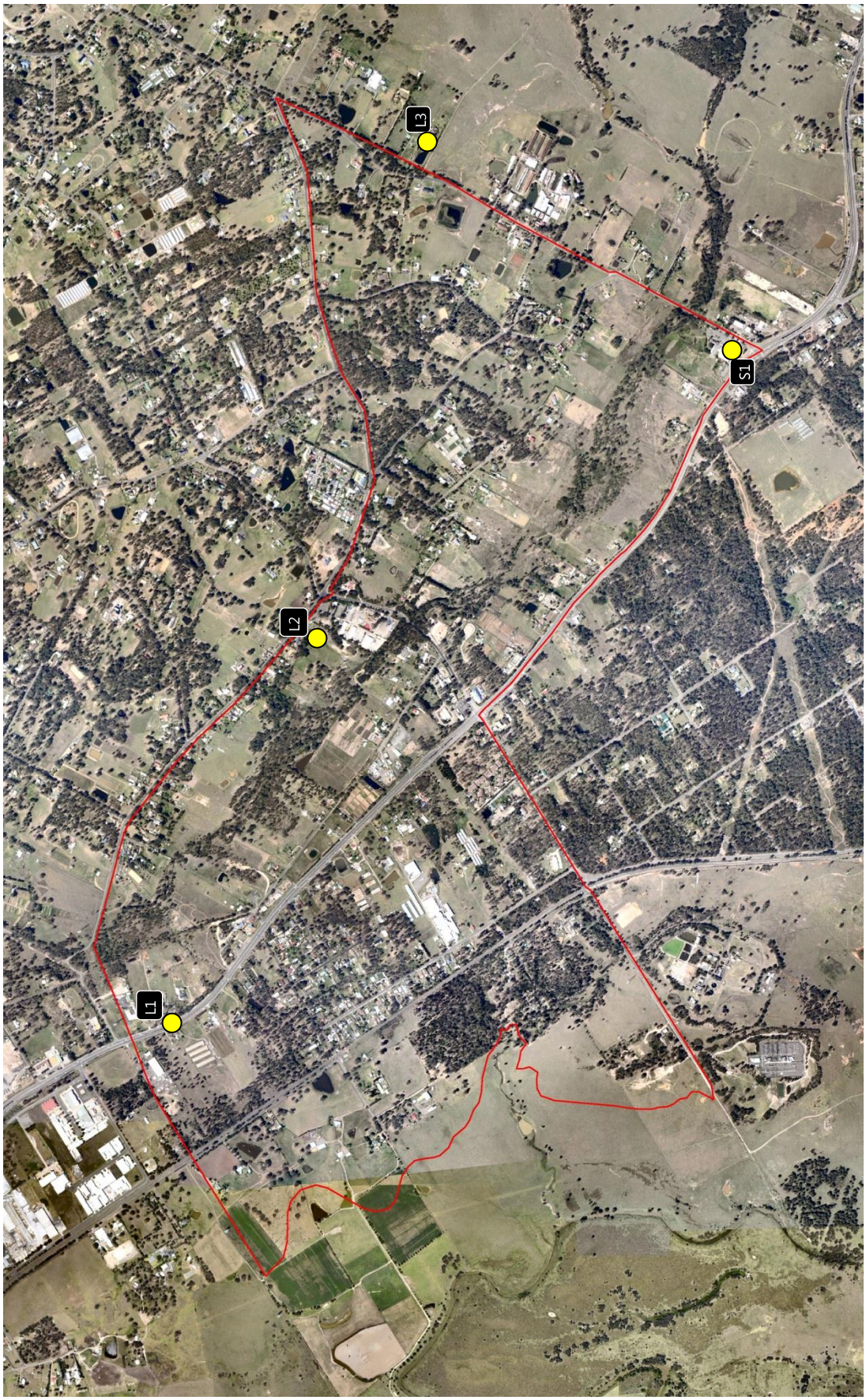


Figure 4-3: Site and noise monitoring locations

4.4 Long-term noise measurement results

Long-term noise monitoring at locations L1 and L2 was carried out from Tuesday, 4 to Friday, 14 March 2014. Long-term noise monitoring at location L3 was carried out from Wednesday, 4 to Tuesday, 10 August 2010 as part of the Box Hill Precinct planning. The long-term noise monitoring methodology is detailed in Appendix B, and noise level-vs-time graphs are included in Appendix C.

Table 4-3 presents the Rating Background Levels (RBL) and representative ambient L_{eq} noise levels along with the octave band spectrums for each assessment period, determined in accordance with the INP. The octave band noise levels highlight increased noise levels above 2kHz at some locations, being attributed to insect noise. This noise will have influenced the overall noise levels and therefore the data is not directly assessable for industrial or traffic related noise. Further analysis has been carried out for the assessment in order to establish representative levels without the influence of insects.

Table 4-3: Long-term noise monitoring results

Noise descriptor	Period	Overall, dB(A)		Octave band centre frequency (Hz), dB(Z)								
		Measured	No insects^	31.5	63	125	250	500	1k	2k	4k	8k
L1 - 372 Windsor Road, Vineyard												
L_{eq}	Day	69	-	64	73	69	63	62	67	62	53	48
	7am - 10pm*	69	-	64	72	68	62	61	66	61	53	47
	Evening	67	-	60	69	66	59	59	64	60	51	41
	Night	63	-	58	68	64	57	56	61	56	48	38
L_{90}	Day	57	-	55	60	55	49	48	53	49	39	27
	Evening	52	-	47	51	47	40	40	48	44	36	23
	Night	40	37	39	41	38	30	28	30	29	34	20
L2 - 170 Commercial Road, Vineyard												
L_{eq}	Day	50	49	58	59	55	47	43	42	41	45	31
	7am - 10pm*	50	49	57	58	54	46	42	42	41	45	31
	Evening	49	47	53	54	52	44	40	40	40	45	31
	Night	52	47	51	53	47	41	40	44	41	49	29
L_{90}	Day	39	38	49	49	40	31	28	31	29	28	17
	Evening	39	35	41	42	34	25	26	29	27	33	19
	Night	43	30	36	39	33	27	24	23	18	38	19
L3 - 47 Boundary Road, Box Hill												
L_{eq}	Day	53	-	57	61	58	49	46	50	46	41	30
	7am - 10pm*	53	-	56	60	57	48	46	50	47	42	29
	Evening	54	-	53	58	56	46	46	50	49	44	21
	Night	51	-	52	57	53	43	42	47	45	41	23
L_{90}	Day	39	-	47	49	45	33	31	33	30	22	12
	Evening	45	39	44	47	42	33	33	33	38	31	11

Noise descriptor	Period	Overall, dB(A)		Octave band centre frequency (Hz), dB(Z)								
		Measured	No insects^	31.5	63	125	250	500	1k	2k	4k	8k
	Night	39	34	41	43	39	29	27	26	31	25	11

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

As required by the INP, the external ambient noise levels presented are free-field noise levels, ie. no facade reflection.

* Day time (L_{Aeq} 15hr) traffic noise period

^ where overall noise levels identified as affected by insects, frogs, etc., overall noise level estimated after excluding affected octave bands.

4.5 Short-term noise measurement results

Short-term noise measurement at location S1 was undertaken on Thursday, 13 March 2014. The measurement was undertaken in order to supplement the long-term noise monitoring and provide greater detail of the surrounding noise environment.

A summary of the short-term measurement results is presented in Table 4-4.

Table 4-4: Short-term noise monitoring results

Location	Time / Date	Measured noise level, dB(A)		Comments on measured noise levels
		L_{Aeq}	L_{A90}	
S1 - Vineyard Hotel, rear carpark along Boundary Road	00:05-00:10 13-03-2014	45	43	The background L_{A90} and ambient L_{Aeq} was determined by mechanical plant and equipment associated with the Vineyard Hotel.

Notes: The equipment used for noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having accuracy suitable for field and laboratory use. The instrument was calibrated prior and subsequent to measurements using a Brüel & Kjær Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with AS IEC 61672.1 2004 'Electroacoustics - Sound Level Meters' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

5 Air quality criteria

5.1 Introduction

Odour in a regulatory context needs to be considered in two similar, but different ways depending on the situation.

NSW legislation prohibits emissions that cause offensive odour to occur at any off-site receptor. Offensive odour is evaluated in the field by authorised officers, who are obliged to consider the odour in the context of its receiving environment, frequency, duration, character and so on and to determine whether the odour would interfere with the comfort and repose of the normal person unreasonably. In this context, the concept of offensive odour is applied to operational facilities and relates to actual emissions in the air.

However, in the approval and planning process for proposed new operations or modifications to existing projects, no actual odour exists and it is necessary to consider hypothetical odour. In this context, odour concentrations are used and are defined in odour units. The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose. Thus by definition, odour less than odour unit (1 OU), would not be detectable to most people.

The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The NSW Odour Policy [1] sets out a framework specifically to deal with such issues.

It needs to be noted that the term odour refers to complex mixtures of odours, and not 'pure' odour arising from a single chemical. Odour from a single, known chemical very rarely occurs (when it does, it is best to consider that specific chemical in terms of its concentration in the air). In most situations odour will be comprised of a cocktail of many substances that is referred to as a complex mixture of odour, or more simply odour.

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point that such odour reaches surrounding receptors. This approach allows the air dispersion model to produce results in terms of odour units.

The NSW criteria for acceptable levels of odour range from 2 to 7 OU, with the more stringent 2 OU criteria applicable to densely populated urban areas and the 7 OU criteria applicable to sparsely populated rural areas, as outlined below.

5.2 Complex mixtures of odorous air pollutants

Table 5-1 presents the assessment criteria as outlined in the NSW EPA document '*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*' [9]. This criterion has been refined to take into account population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 5-1: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria 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

NOTES: Source: NSW DEC, 2005 [9]

The NSW odour goals are based on the risk of odour impact within the general population of a given area. In sparsely populated areas the criteria assume there is a lower risk that some individuals within the community would find the odour unacceptable, hence higher criteria apply.

Peak-to-mean factors are applied to account for any odour fluctuation above and below the mean odour level of the 1-hour averaging time. The criteria in Table 5-1 are compared with modelled results that include peaking factors to account for the time-averaging limitations of air dispersion models. The peak-to-mean factors developed by Katestone Scientific Pty Ltd [10] [11] for NSW EPA are applied to convert the modelled (1-hour) averaging time to 1-second peak concentrations which are appropriate.

A summary of the peak-to-mean values is provided in APPENDIX D.

6 Noise criteria

6.1 Industrial criteria

6.1.1 Relevant noise generating development

The EPA INP [2] is the primary noise policy for industrial type noise sources, for which the policy states, includes:

- *facilities (encompassing all the activities taking place within the property boundary of the facility) usually comprising many sources of sound, including*
  - *industrial premises*
  - *extractive industries*
  - *commercial premises*
  - *warehousing facilities*
- *maintenance and repair facilities*
- *individual industrial sources, such as*
  - *heating, ventilating and air conditioning (HVAC) equipment*
  - *rotating machinery*
  - *impacting mechanical sources*
  - *other mechanical equipment and machinery*
  - *such as conveyors*
  - *mobile sources confined to a particular location, such as draglines and haul trucks.*

6.1.2 Criteria overview

The NSW INP policy has two primary components:

- controlling intrusive noise impacts in the short term for residences, and
- maintaining noise level amenity for particular land uses for residences and other land uses.

Noise intrusiveness ensures that industrial noise does not exceed the existing background noise level by an excessive margin. This is commonly referred to as the 'background plus 5' criterion, that is, that the noise level from the new industrial development should not exceed the existing background noise level (measured in the absence of that development) by more than 5dB(A).

Noise amenity ensures that industrial noise levels do not increase without limit, for if a number of industrial noise sources are permitted to increase the background noise level by 5dB(A), in turn there would be a point where the ultimate noise level is unacceptable. A limit on the ultimate acceptable noise level is therefore included in the INP as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is referred to as the amenity goal. The appropriate limit in any circumstance relates to the land use category, for example, there are different limits for rural, suburban and urban areas.

Table 2.1 of the INP (replicated in Table 6-1) sets appropriate noise amenity limits for different receptor land uses for day, evening and night-time periods.

Table 6-1: Recommended L_{Aeq} noise levels from industrial noise sources

Type of receiver	Indicative noise amenity area	Time of day	Recommended L_{Aeq} noise level	
			Acceptable	Recommended maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface – for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1-hr period when in use	35	40
Hospital ward - internal - external	All	Noisiest 1-hr period	 35 50	 40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg. National Park)	All	When in use	50	55
Active recreation area (eg. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Notes: Daytime 7:00am to 6:00pm or 8:00am to 6:00pm Sundays and Public Holidays;
Evening 6:00pm to 10:00pm;
Night-time 10:00pm to 7:00am or 10:00pm to 8.00am Sundays and Public Holidays.

6.1.3 Encroachment of existing industrial sites

Regarding changes of land use, such as residential subdivisions encroaching upon pre-existing industrial development the concept of there being a background noise level absent of industrial noise is likely to be non-existent. Residents would therefore come to an area with prevalent industrial noise and the question therefore becomes whether or not that industrial noise is an acceptable noise for the land use category contemplated by the subdivision instrument. This issue is discussed in the INP:

> *Land uses can change—sometimes dramatically— with an increase in industrial activities, construction of new freeways, or the development of new residential suburbs. A consequence of this is that the land-use designation of an area may change. Changes in designation occur as a result of urban type residential subdivisions in a village or rural area with few residences, or the encroachment of industrial developments near residential areas and vice versa.*
>
> *In such cases, the primary decision by planning authorities to cause or allow the development would take account of the many consequent implications. As developments introduce increased activities, they also increase environmental noise levels. Therefore, previously low ambient noise levels will not be maintained, and assessments of noise sources for control purposes should be made against the acceptable noise level relevant to the modified land use.*

In the circumstances of the subject development, the encroachment of residential development near an industrial development is contemplated in the INP as one in which the previously low ambient noise levels will not be maintained and therefore assessment of the acceptability of the development should be made against the acceptable noise level relevant to the modified land use.

The acceptability or otherwise of approving residential development on the subject land in close proximity to an existing industrial should have regard to whether or not the existing industrial noise levels comply within the range of the *Acceptable and Recommended Maximum* noise levels indicated in Table 6-1 above.

As stated in the Section 2.2 of the INP:

> *Meeting the acceptable noise levels in* [Table 6-1*] will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance. These levels represent current best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia.*
>
> [Table 6-1] *also includes recommended maximum noise levels for different land uses. These recommended maximum values provide guidance on an upper limit to the level of noise from industry. In all cases it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced.*

> *In some instances it may not be possible to achieve even the recommended maximum noise level, even after all feasible and reasonable noise mitigation has been applied. Such cases are expected to have a large adverse noise impact. Where a proposed development exceeds the recommended maximum noise levels in* [Table 6-1*], substantial benefits in other areas, including a high degree of social worth, would need to be demonstrated.*

While it is therefore acceptable for ambient industrial noise levels on the site to extend to the *Recommended Maximum* noise level provided that all feasible and reasonable mitigation measures have been applied, this planning assessment has considered the acceptable goals only.

6.1.4 Noise amenity area determination

The classification of the site in terms of the 'Indicative Noise Amenity Area' categories used in Table 6-1 also needs to be established. The appropriate classification would normally follow the proposed zoning for the land and character of the surrounding environment, excluding consideration of the 'existing industrial interface' classification.

The classification should also consider the predominant manner of development and the prevailing noise climate. Guidance is provided in the INP as follows:

> *The primary means for identifying the type of receiver is how the receiver area is zoned in the relevant planning instrument. The standard terminology used in planning instruments is usually limited to rural, rural/residential and residential in respect of areas where dwellings would normally be located. These terms do not differentiate suburban and urban residential uses, and this is discussed in the next point.*
>
> *In deciding whether a receiver area should be allocated to the suburban or urban categories, it may be necessary to examine the predominant manner of development in the area and the prevailing noise climate. The definitions of suburban and urban provide guidance on this. For example, small communities such as villages or towns are likely to be closer in noise climate to a suburban category. Urban receivers are usually those located in densely populated areas where multi-dwelling developments such as townhouses, units, flats and apartments are the norm. Areas near noise generators (for example, roads, railways and industry) would normally be considered to be urban-receiver type for the purpose of the amenity criteria. The rural category is more representative of more isolated single dwellings on large lots (for example, 2 hectares). The population density for an area may provide a guide as to which of the residential receiver categories apply.*
>
> ...
>
> *Other features of a locality that should also be considered include:*
>
> - *predominant land use, including the proportion of the different land uses within the potentially noise-affected zone*
> - *strategic planning objectives or plans to rezone (for example, as included in REPs, SEPs, Urban Development Program)*

- *proximity of land-use to neighbouring industries and busy roads*
- *any permanent existing shielding provided by natural topography or otherwise between existing noise sources and sensitive receivers*
- *existing ambient noise levels in the area.*

For the Precinct, while existing residents may be deemed 'rural', the future residential land uses are expected to be either 'suburban' or 'urban'. For the initial screening assessment of existing industrial premises, the Suburban category has been assumed.

As previously stated, these criteria apply to industrial noise only. Consideration must however be given to the modifying factors outlined in the INP for annoying characteristics such as prominent tonal components, impulsiveness, intermittency, irregularity or dominant low-frequency content. The 'noise' to be assessed for the purpose of determining these characteristics is the total ambient noise level including both industrial and other sources.

6.1.5 Modifying factor adjustments

The correction factors referred to in Section 4 of the NSW INP apply to the noise if it is tonal, low frequency, impulsive or intermittent. Specific tests for these characteristics are outlined in Section 4 of the INP, reproduced in Table 6-2 below. If any of these characteristics are identified, a correction of 5dB is to be added to the $L_{Aeq(15minute)}$ noise level for each characteristic, up to a maximum correction of 10dB.

Table 6-2: Modifying factor corrections (Table 4.1 NSW INP)

Factor	Assessment/ measurement	When to apply	Correction [1]	Comments
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: - 5dB or more if the centre frequency of the band containing the tone is above 400Hz - 8dB or more if the centre frequency of the band containing the tone is 160 to 400Hz inclusive - 15dB or more if the centre frequency of the band containing the tone is below 160Hz	5dB [2]	Narrow-band frequency analysis may be required to precisely detect occurrence
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C- and A- weighted levels over same time period. Correction to be applied if the difference between the two levels is 15dB or more	5dB [2]	C-weighting is designed to be more responsive to low-frequency noise
Impulsive noise	A-weighted fast response and impulse response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5s
Intermittent noise	Subjectively assessed	Level varies by more than 5dB	5dB	Adjustment to be applied for nighttime only.

Factor	Assessment/ measurement	When to apply	Correction [1]	Comments
Duration	Single-event noise duration may range from 1.5min to 2.5hr	One event in any 24-hour period	0 to –20dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise. (See Table 4.2)
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A) [2] (excluding duration correction)	

Notes:
1. Corrections to be added to the measured or predicted levels.
2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range.

See definitions in Section 4.2 NSW INP [2]

6.1.6 Sleep disturbance

Noise emanating from industrial development during the night time period (10pm to 7am) may also be assessed for its potential to disturb sleep. The NSW EPA (formerly DEC) has made the following policy statement with respect to sleep disturbance:

> *"Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *DEC reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, DEC recognised that current sleep disturbance criterion of an $L_{A1,\ (1\ minute)}$ not exceeding the $L_{A90,\ (15\ minute)}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DEC will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or $L_{A1,\ (1\ minute)}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> – *how often high noise events will occur;*
> – *time of day (normally between 10pm and 7am); and*

- *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The $L_{A1, (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. DEC will accept analysis based on either $L_{A1, (1\ minute)}$ or $L_{A, (Max)}$."

The NSW EPA confirm that a sleep disturbance criterion of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$, should only be used as a first step guide and where the criteria is not met, more detailed analysis is required. The Application Notes of the NSW Industrial Noise Policy (2010) note the detailed analysis should include:

- the extent to which the maximum noise level exceeds the background level
- the number of times this happens during the night-time period, and
- the time of day (normally between 10pm and 7am).

In addition, reference is made to Appendix B of the NSW ECRTN, which summarises the findings of international research undertaken on sleep disturbance from noise (up until 2009) and concludes:

"Considering all of the foregoing information the following conclusions can be drawn:

- *Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.*
- *One or two noise events per night, with maximum internal noise levels of 65-70dB(A), are not likely to affect health and wellbeing significantly."*

In regard to external noise levels, the maximum internal noise level 55dB(A) referenced in the ECRTN is equivalent to 65dB(A) outside an open window. It is noted that a 10dB(A) reduction from outside to inside is common and typical noise reduction via an open window. The 65dB(A) external noise limit is consistent with the findings of Griefahn [*Acoustics Australia Vol 20 No 2 August 1992 pp 43-47*].

In summary, the sleep disturbance criteria of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$ is to be used for initial assessment, however consideration is also given to the 'upper' limit criteria of 65dB(A) in accordance with the ECRTN. It is noted that the background $L_{A90(15minute)}$ noise level used for establishing the sleep disturbance criteria does not need to exclude other noise from the subject premise.

6.2 Road traffic noise exposure on sensitive land uses

6.2.1 NSW Road Noise Policy (RNP)

The NSW *Road Noise Policy* (RNP) [4] was introduced in July 2011 and replaced the NSW *Environmental Criteria for Road Traffic Noise* (ECTRN). Table 3 of the RNP outlines criteria to be applied to particular types of road development and land use. The criteria apply when assessing noise impact and determining mitigation measures for existing developments that are potentially affected by road traffic noise, with the aim of preserving the amenity appropriate to the land use.

Unlike the ECTRN, the RNP no longer stipulates noise criteria for new land use developments potentially impacted by road traffic noise. Criteria for new developments affected by existing roads are now addressed through the State Environmental Planning Policy (Infrastructure) 2007 ('ISEPP') and the associated NSW Department of Planning *'Development Near Rail Corridors and Busy Roads – Interim Guideline*' [3].

6.2.2 State Environmental Planning Policy (Infrastructure) 2007 (ISEPP)

The NSW State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the ISEPP includes the following clauses:

> *102 Impact of road noise or vibration on non-road development*
>
> *1. This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*
>
> *a. a building for residential use,*
>
> *b. a place of public worship,*
>
> *c. a hospital,*
>
> *d. an educational establishment or child care centre.*
>
> *2. Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
>
> *3. If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
>
> *a. in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,*
>
> *b. anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.*
>
> *4. In this clause, "freeway", "tollway" and "transitway" have the same meanings as they have in the Roads Act 1993*

6.2.2.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

To support the Infrastructure SEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline*, in December 2008 [3]. The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. While the ISEPP applies only to roads with an AADT greater than 40,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

6.2.2.2 Clarification of ISEPP noise limits

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

- Daytime 7:00am - 10:00pm $L_{Aeq(15hr)}$
- Night-time 10:00pm - 7:00am $L_{Aeq(9hr)}$

The noise criteria nominated in the ISEPP apply to internal noise levels with windows and doors closed. However, as the preliminary noise assessment is based on measurement and/or prediction at external locations, equivalent external noise criteria have been established as a screening test. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment in order to meet the internal noise requirements of the ISEPP. The equivalent external goals have been determined on the following basis:

- The ISEPP states: "*If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia*." The internal criteria with windows open is therefore 10dB(A) above the criteria explicitly outlined in the ISEPP.
- The generally accepted noise reduction through an open window from a free-field external position is 10dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the Building Code of Australia (BCA) ventilation requirements.

Table 6-3 presents the ISEPP internal noise criteria along with the equivalent external noise criteria for residential premises.

Table 6-3: ISEPP noise criteria for new residential development

Room	Location	$L_{Aeq, 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
Living rooms*	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)^	60	60
Bedrooms*	Internal, windows closed	40	35
	Internal, windows open	50	45
	External free-field (allowing windows to remain open)^	60	55

Notes: * Requisite for 40,000AADT Roads only under ISEPP 2007.

^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2016 requirements.

Table 6-4: ISEPP noise criteria for other sensitive development

Occupancy		$L_{Aeq, 15hr}$ Day or $L_{Aeq\ 9hr}$ Night (when in use)
Educational institutions including childcare centres		40
Places of worship		40
Hospitals	Wards	35
	Other sensitive areas	45

Note: * Requisite for 40,000 AADT roads only under ISEPP 2007.

6.3 Rail noise exposure on sensitive land uses

Relevant references and requirements of the ISEPP for road traffic noise have already been presented in Section 6.2.2. Note is made that the requirements for assessing the impact of rail noise are the same as those for road traffic. However, additional references and requirements specifically for rail noise contained within the ISEPP are reproduced below.

87 Impact of rail noise or vibration on non-rail development

5. This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:

a. a building for residential use,

b. a place of public worship,

c. a hospital,

d. an educational establishment or child care centre.

6.4 Aircraft noise criteria

6.4.1 AS2021-2000 - aircraft noise intrusion

Aircraft noise intrusion from take-off, landing and circuit training operations at civil aerodromes or military airfields is assessed using Australian Standard A2021-2000 - '*Acoustics – Aircraft Noise Intrusion – Building Siting and Construction*' ('AS2012') [6]. This section of the report outlines the application of AS2021.

The scope of AS2021-2000 is stated as:

> *This standard, together with the relevant Australian Noise Exposure Forecast (ANEF) chart provides guidelines for determining-*
>
> *a. whether the extent of aircraft noise intrusion makes building sites 'acceptable', 'unacceptable' or 'conditionally acceptable' for the types of activity to be, or being, undertaken;*
>
> *b. for 'conditionally acceptable' sites, the extent of noise reduction required to provide acceptable noise levels indoors for the types of activity to be, or being, undertaken; and*
>
> *c. the type of building construction necessary to provide a given noise reduction, provided that external windows and doors are closed.*

6.4.2 Building site acceptability

AS2021 contains advice on the acceptability of building sites based on Australian Noise Exposure Forecast (ANEF) zones. The ANEF chart provides a predicted cumulative exposure to aircraft flyover noise in communities near aerodromes. The chart presents zones represented by noise contours overlaid on a locality map specific to an airport. The ANEF system was developed as a land use planning tool aimed at controlling encroachment on airports by noise sensitive buildings.

Table 2.1 of AS2021 sets acceptability zones for different building types and land uses. The table categorises building sites as either 'Acceptable', 'Conditional' or 'Unacceptable' relative to different ANEF levels. Table 6-5 reproduces the sections of AS2021 Table 2.1 relevant to the subject site.

Table 6-5: Building site acceptability based on ANEF zones (Table 2.1 of AS2021)

Building type	ANEF zone of site		
	Acceptable	Conditional	Unacceptable
House, home unit, flat, caravan park	Less than ANEF 20[1]	20 to 25 ANEF[2]	Greater than 25 ANEF
School, university	Less than ANEF 20[1]	20 to 25 ANEF[2]	Greater than 25 ANEF
Hospital, nursing home	Less than ANEF 20[1]	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than ANEF 20[1]	20 to 30 ANEF	Greater than 30 ANEF
Hotel, motel hostel	Less than ANEF 25	25 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than ANEF 25	25 to 35 ANEF	Greater than 35 ANEF

Building type	ANEF zone of site		
	Acceptable	Conditional	Unacceptable
Light industrial	Less than ANEF 30	30 to 40 ANEF	Greater than 40 ANEF
Heavy industrial	Acceptable in all ANEF zones		

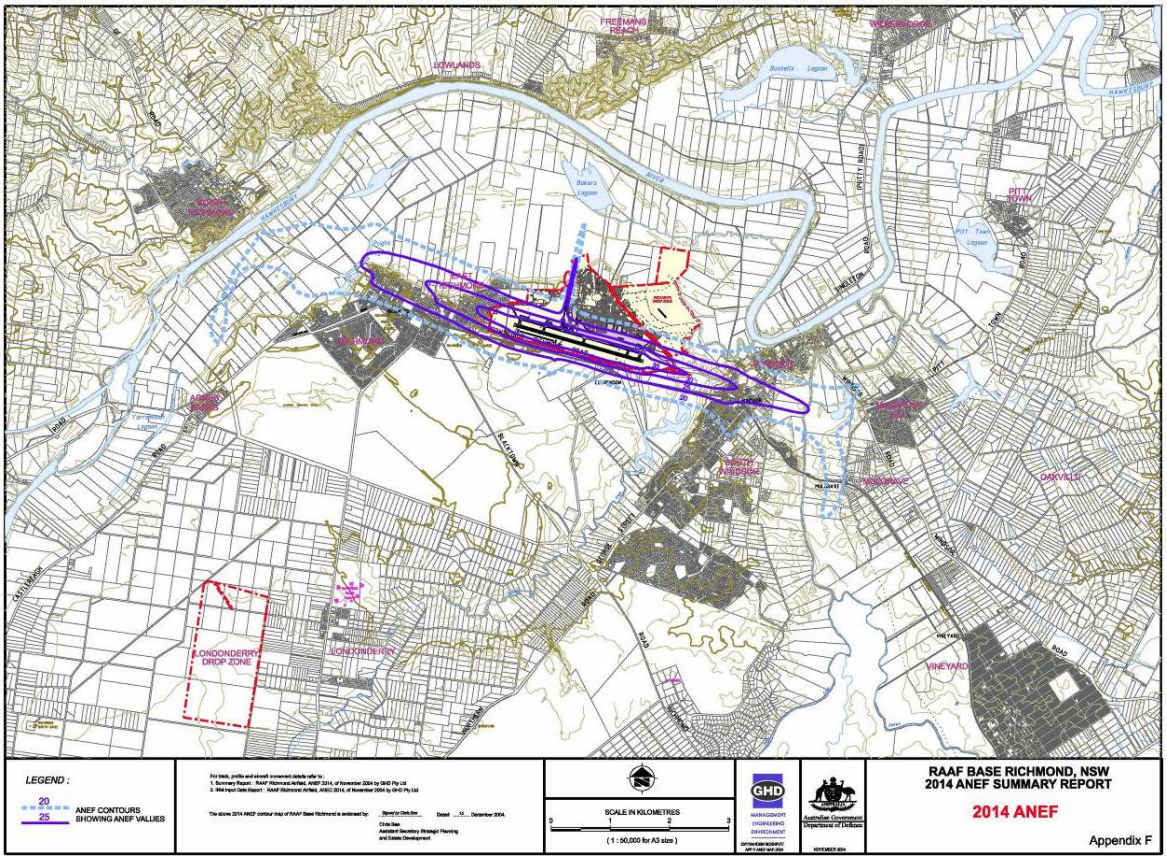
Notes:
1. The actual location of the ANEF 20 contour is difficult to define accurately, mainly because of variation in aircraft flight paths. Because of this, the procedure of Clause 2.3.2 may be followed for building sites outside or near the ANEF 20 contour.
2. Within ANEF 20 to ANEF 25, some people may find that the land is not compatible with residential or educational uses. Land use authorities may consider that the incorporation of noise control features in the construction of residences or schools is appropriate.
3. This Standard does not recommend development in unacceptable areas. However, where the relevant planning authority determines that any development may be necessary within existing built-up areas designated as unacceptable, it is recommended that such development should achieve the required ANR determined according to Clause 3.2. For residences, schools, etc., the effect of aircraft noise on outdoor areas associated with the buildings should be considered.

Table 6-6: Description of building site acceptability

Zone	Description
Acceptable	In Acceptable zones there is usually no need for the building construction to provide protection specifically against aircraft noise. However, it should not be inferred that aircraft noise will not be noticeable outside the ANEF20 contour.
Conditional	In Conditional zones the maximum aircraft noise levels for the relevant aircraft and the required noise reduction should be determined from the procedures of Clause 3.1 and 3.2 of AS2021-2000, and the aircraft noise attenuation to be expected from the proposed construction should be determined in accordance with Clause 3.3.
Unacceptable	In Unacceptable zones construction of the proposed development should not normally be considered. In no case should new development take place in 'greenfield' sites deemed unacceptable because such development may impact on airport operations.

The Vineyard Precinct is located approximately 5.4km south east from the eastern end of the RAAF Base Richmond Runway (10/28). The RAAF Richmond 2014 ANEF Map is presented in Figure 6-1.

Figure 6-1: RAAF Base Richmond 2014 ANEF Map



7 Noise assessment

The primary noise generating development identified within or surrounding the Precinct, as well as known future noise sources have been assessed and preliminary recommendations provided to assist in developing the ILP.

Table 7-1: Noise assessment summary

Assessment type and policy	Noise source	Detail of assessment	Findings and recommendations
Industrial, INP	172 Commercial Road, Vineyard	The site is identified as a hire business for construction equipment. Long-term noise measurements were carried out at L2 in proximity to the site.	Ambient noise levels recorded at L2 generally complied with the amenity noise goals for the day and evening period for suburban residential development. While noise levels at exceeded the night time criteria, observations at night did not identify the site to be operational and therefore measured noise levels are likely to be attributed to distant traffic or the natural environment. Further detail assessment of site operations is recommended if new residential dwellings are to be developed around the site.
	Vineyard Hotel	Detailed assessment of the operational noise form the Hotel has not been carried out however in-principle planning advice is provided.	While the Vineyard Hotel includes on site accommodation, if the site is to be retained in its current form or use, it is recommended that future rezoning immediately around the site be commercial in nature.
	Future surrounding development	The land use zoning of surrounding North West Priority Growth Area Precincts has been reviewed.	The land use zoning along the western boundary of the Box Hill Precinct and common boundary of Riverstone Precinct is predominantly residential and should not constrain further residential zoning within the Vineyard Precinct. However, any proposed noise generating development should be reviewed. With regard to Riverstone West, the impact of the proposed intermodal with its potential traffic access to Bandon Road requires further consideration. While the affected area of the Vineyard Precinct is unlikely to include residential development, further assessment may be required.
Road traffic, ISEPP	Windsor Road	Identified as a major road running through the centre of the Precinct. Preliminary assessment has been based upon long-term noise monitoring carried out at L1. Review and consideration of future road traffic volumes have also been made.	Noise monitoring at L1 was 14m from the southernmost carriage way of Windsor Road. The average weekday two-way traffic volumes counts on Windsor Road (between Perth & Otago Streets) between 11 to 17 March 2014 were 23,486 and 3,539 for the daytime and night time periods respectively. The recorded noise levels, revealed exceedance of the ISEPP equivalent external goals at locations up to 100m from the nearest carriageway. As it is not feasible to exclude noise sensitive development within 100m of the Windsor Road frontage throughout the Vineyard Precinct, noise mitigation measures will need to be implemented into the building design of noise sensitive developments such that the recommended internal noise criteria are met. Further detail is provided in Section 7.1.

Assessment type and policy	Noise source	Detail of assessment	Findings and recommendations
	Bandon Road	Currently a minor collector/sub arterial road. Forecast traffic volumes post-development have been reviewed, as outlined in Table 7-2. Noise measurements not carried out for Bandon Road and assessment will be based on noise modelling.	The average weekday two-way traffic volumes counts on Riverstone Parade (between Otago & Clyde Streets) are considered representative of existing Bandon Road traffic. Counts between 11 and 17 March 2014 were 5,347 and 874 for the daytime and night time periods respectively. Future traffic volumes for 2036 are forecast to be below 20,000AADT. Further discussion is provided in Section 7.1.
	Commercial Road	Currently a minor road. Forecast traffic volumes post-development have been reviewed, as outlined in Table 7-2. Noise measurements not carried out for Commercial Road traffic and assessment will be based on noise modelling.	The average weekday two-way traffic volumes counts on Commercial Road (between Broos & Glenidol Road) from 11 to 17 March 2014 were 1,126 and 165 for the daytime and night time periods respectively. Future traffic volumes for 2036 are forecast to be below 20,000AADT. Further discussion is provided in Section 7.1.
Rail noise, ISEPP	Richmond Line	The existing rail line is too far from the boundary of the Stage 1 development area of the Precinct to be considered for an assessment.	-
Aircraft, AS2021:2000	Richmond RAAF	The assessment has relieved upon review of the Aircraft Noise Exposure Forecast (ANEF) maps for the RAAF Base Richmond to determine the Building site acceptability	Review of the 2014 ANEF for RAAF Base Richmond in relation to the Vineyard Precinct site found that all areas of the site are outside the ANEF 20 contour, as shown in Figure 6-1. All land proposed to be rezoned for residential and other noise sensitive use (such as schools) is below the ANEF 20 contour and therefore permissible.

7.1 Future road traffic noise

7.1.1 Traffic volumes

Predictions of future traffic volumes for the main access roads servicing the area have been provided by Arup. The estimated annual average daily totals (AADT) have been extrapolated from the peak hour traffic volumes and are summarised in Table 7-2 for assessment against the ISEPP.

Table 7-2: Predicted future traffic volumes - 2036

Road	AM (Peak Hr)		PM (Peak Hr)		Estimated daily traffic volumes		
	N/E	S/W	N/E	S/W	AADT[1,2]	15hr[3]	9hr[4]
Windsor Rd (west of Boundary)	1434	1526	1484	1742	30930	26291	4640
Windsor Rd (west of Chapman)	1046	1128	932	1174	21400	18190	3210
Bandon Rd (near Windsor Rd)	579	563	579	563	11420	9707	1713
Commercial Road (near Boundary Rd)	692	515	371	845	12115	10298	1817
Commercial Rd (near Windsor Rd)	721	954	909	748	16660	14161	2499
Menin Road (near Boundary Rd)	552	623	526	620	11605	9864	1741

Notes:
1. Future traffic flows from data Arup Model Run Date 1/14 13:50, Model 36PMA6. Ver 2015 & Run Date 1/14 13:47, Model 36AMA6. Ver 2015.
2. Estimated AADT based on assumption that combined average AM/PM peak hour flows is 10% of the AADT.
3. 15hr day time assumed to be 85% of AADT 24hr.
4. 9hr night time assumed to be 15% of AADT 24hr.

The data indicates that the future traffic flows on all of roads are predicted to be below 40,000 AADT, and therefore would not trigger the requirement for detailed assessment in accordance with the ISEPP. The ISEPP guideline does however recommend that roads greater than 20,000 AADT are also assessed. Only Windsor Rd is predicted to have traffic flows greater than 20,000 AADT.

7.1.2 Policy recommendations

As outlined in Section 6.2, current NSW noise policy only requires acoustic assessment of new residential dwelling if they are built along roads having an AADT greater than 40,000. Current guidelines also recommend assessment for roads having an AADT between 20,000 and 40,000.

However, development along lower order roads can still be exposed to road traffic noise levels exceeding the recommended noise criteria in the relevant guidelines and standards. This is highlighted by review of the screening tests set out in the ISEPP guideline [3], reproduced 7.1.3. It is on this basis that some consent authorities require acoustic assessment of all noise sensitive development (typically at the subdivision stage) for developments fronting any road other than a local street.

In addition, the current requirements exclude consideration of the external area of residential premises. This may largely be in response to the difficulties in meeting the external noise criteria recommended in the superseded ECRTN, however the criteria applied at all facades of a building. By limiting assessment to an area of principle private open space, siting and orientation of buildings can reduce noise exposure and provide improved amenity for residential dwellings. Such controls or requirements are typically limited to low density residential development where rear yards can be acoustically shielded from roadways.

Requirement to assess lower order roads and/or areas of principle private open space would need to be defined by the consent authority.

7.1.3 Noise control recommendations

It is unlikely that land use zoning alone can reasonably address impacts from road traffic noise and therefore noise sensitive development that is considered in proximity to major roads will need to consider other methods to reduce noise impacts. As the ISEPP noise criteria apply within buildings, the building constructions need to be designed to minimise noise ingress. This design response is not uncommon and in-principle treatments for residential dwellings are presented in the ISEPP Guideline [3]. The extent of acoustic treatment will vary depending on a number of factors, including:

- Distance from the road
- Road traffic volumes, speed and percentage of heavy vehicles
- The type of building and specific occupancy (ie residential bedroom, or residential living room)
- Other obstructions to noise, ie boundaries fences or other buildings.

While it may be necessary to construct noise sensitive buildings in proximity to busy roads, the distances to these roads should be maximised wherever possible.

Furthermore, consideration should be given to how external amenity to areas of principle private open space may be provided for dwellings.

Urban design objectives generally seek to preclude the construction of noise barriers, however such controls should not be excluded from consideration as in some cases they may provide beneficial noise reduction, providing both improvements to external amenity and reduced building costs.

In-principle treatment for residential dwellings is provided in the ISEPP guideline, based on simple screening tests for habitable areas. The screening tests are presented below, along with the recommended category treatments in Table 7-3. The screening tests serve to provide general guidance as to expected acoustic treatment required, however as discussed above, the requirement for treatment is not strictly dependent on the traffic volumes. Detailed assessment should therefore be carried out for new subdivisions.

Figure 7-1: Screen tests for habitable areas of single/duel occupancy dwellings 60/70 km/h (Figure 3.3a of ISEPP Guideline)

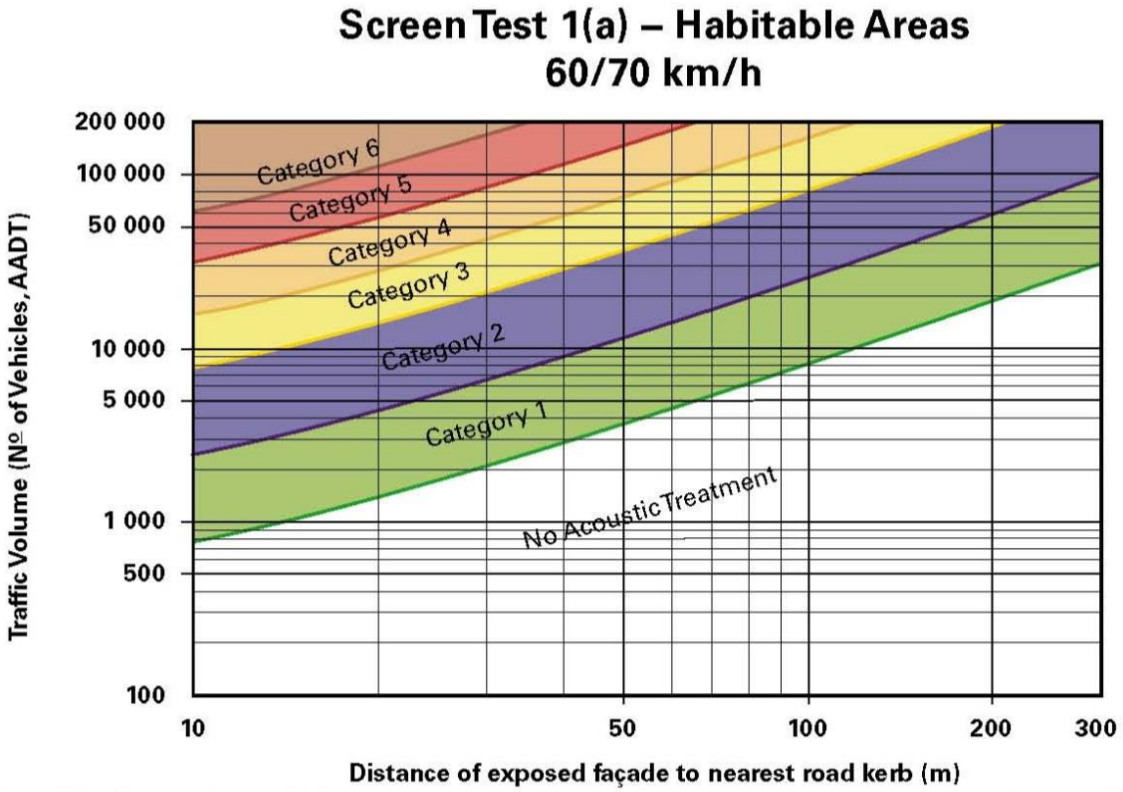


Figure 3.3(a): Screen tests for habitable areas of single/dual occupancy dwellings (if any exposed façade is direct line-of-sight)

Figure 7-2: Screen tests for habitable areas of multiple dwellings 60/70 km/h (Figure 3.4a of ISEPP Guideline)

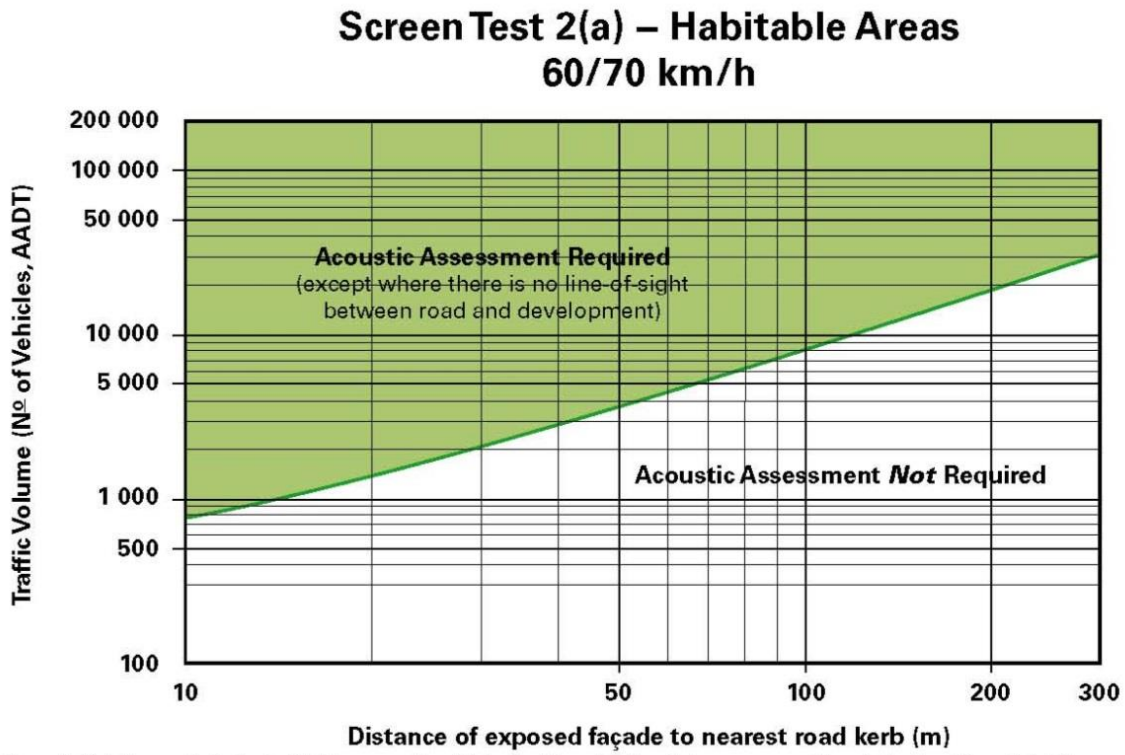


Figure 3.4(a): Screen tests for habitable areas of multiple dwellings (noting that any exposed façade is direct line-of-sight)

Table 7-3: Noise control treatment category and minimum building element performance (Appendix C of ISEPP Guideline)

Category of Noise Control Treatment	R_w of Building Elements (minimum assumed)				
	Windows/ Sliding Doors	Frontage Facade	Roof	Entry Door	Floor
Category 1	24	38	40	28	29
Category 2	27	45	43	30	29
Category 3	32	52	48	33	50
Category 4	35	55	52	33	50
Category 5	43	55	55	40	50

8 Odour impact assessment

8.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment.

The CALPUFF model is an advanced 'puff' model which can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three-dimensional, hourly varying time step.

CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document "*Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia*" [12].

8.2 Modelling methodology

Modelling was undertaken using a combination of the CALPUFF Modelling System and TAPM. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for three-dimensional simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three-dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects 'puffs' of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the three-dimensional meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

8.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three-dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 33deg 39.5min south and 150deg 52.5min east. The simulation involved four nesting grids of 30km, 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the three-dimensional wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domain. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative three-dimensional wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality, also the coarse scale wind flow fields give a better set of starting conditions with which to operate the finer grid run.

The CALMET initial domain was run on a 75 x 75km grid with a 1.5km grid resolution and refined for a second domain on a 40 x 40km grid with a 0.8km grid resolution and further refined for a final domain on a 10 x 10km grid with a 0.1km grid resolution.

The available meteorological data for January 2012 to December 2012 from nine surrounding meteorological monitoring sites were included in the simulation. The 2012 calendar year was chosen as a representative meteorological year based on a long-term meteorological analysis.

Table 8-1 outlines the parameters used from each station. Three-dimensional upper air data were sourced from TAPM output.

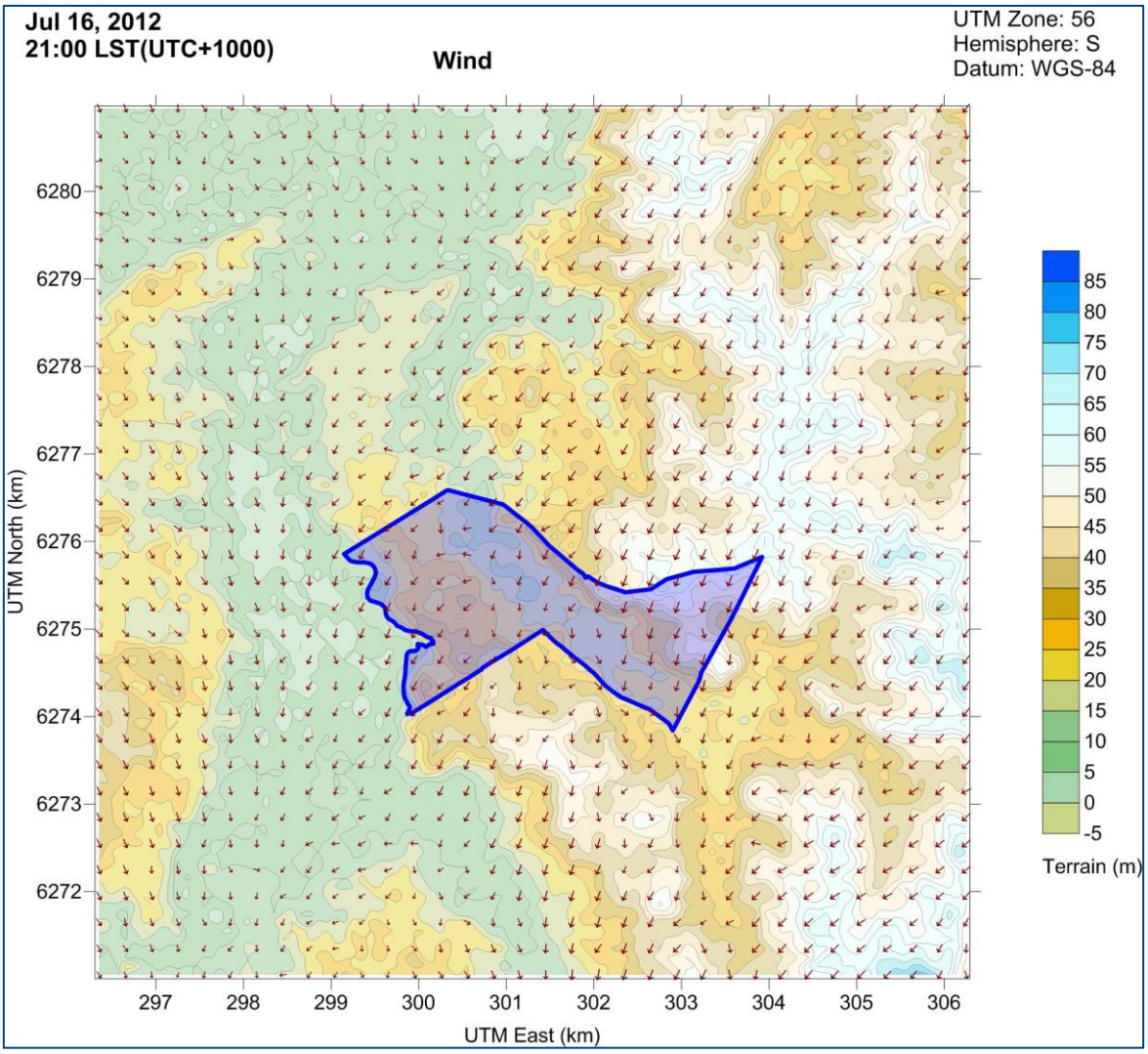
Table 8-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Terrey Hills AWS (BoM) (Station No. 066059)	□	□			□	□	
Sydney Airport AMO (BoM) (Station No. 066037)	□	□	□	□	□	□	□
Bankstown Airport AWS (BoM) (Station No. 066137)	□	□	□	□	□	□	□
Canterbury Racecourse AWS (BoM) (Station No. 066194)	□	□			□	□	□
Richmond RAAF (BoM) (Station No. 067105)	□	□	□	□	□	□	□
Badgerys Creek AWS (BoM) (Station No. 067108)	□	□			□	□	□
Penrith Lakes AWS (BoM) (Station No. 067113)	□	□			□	□	
Holsworthy Control Range (BoM) (Station No. 067117)	□	□			□	□	
Horsley Park Equestrian Centre AWS (BoM) (Station No. 067119)	□	□			□	□	

NOTES: WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = sea level pressure

Local land use and detailed topographical information was included to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in Figure 8-1.

Figure 8-1: Representative snapshot of wind field for the Precinct



CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in Figure 8-2 and Figure 8-3.

Figure 8-2 presents annual and seasonal windroses extracted from one point in the CALMET domain. On an annual basis, winds from the northeast, east-northeast and south-southwest were most frequent. During summer, winds from the east-northeast were most dominant with a spread of winds from the northeast and southeast quadrants. The autumn wind distribution is fairly similar to the annual wind distribution pattern, with a high proportion of winds from the northeast, east-northeast and south-southwest. The winter distribution is typically dominated by winds from the south-southwest and light winds from the northeast. In spring winds tend to occur from the northeast and east-northeast sectors with variable winds from the other directions.

Figure 8-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

Figure 8-2: Annual and seasonal windroses from CALMET (Cell ref 5144)

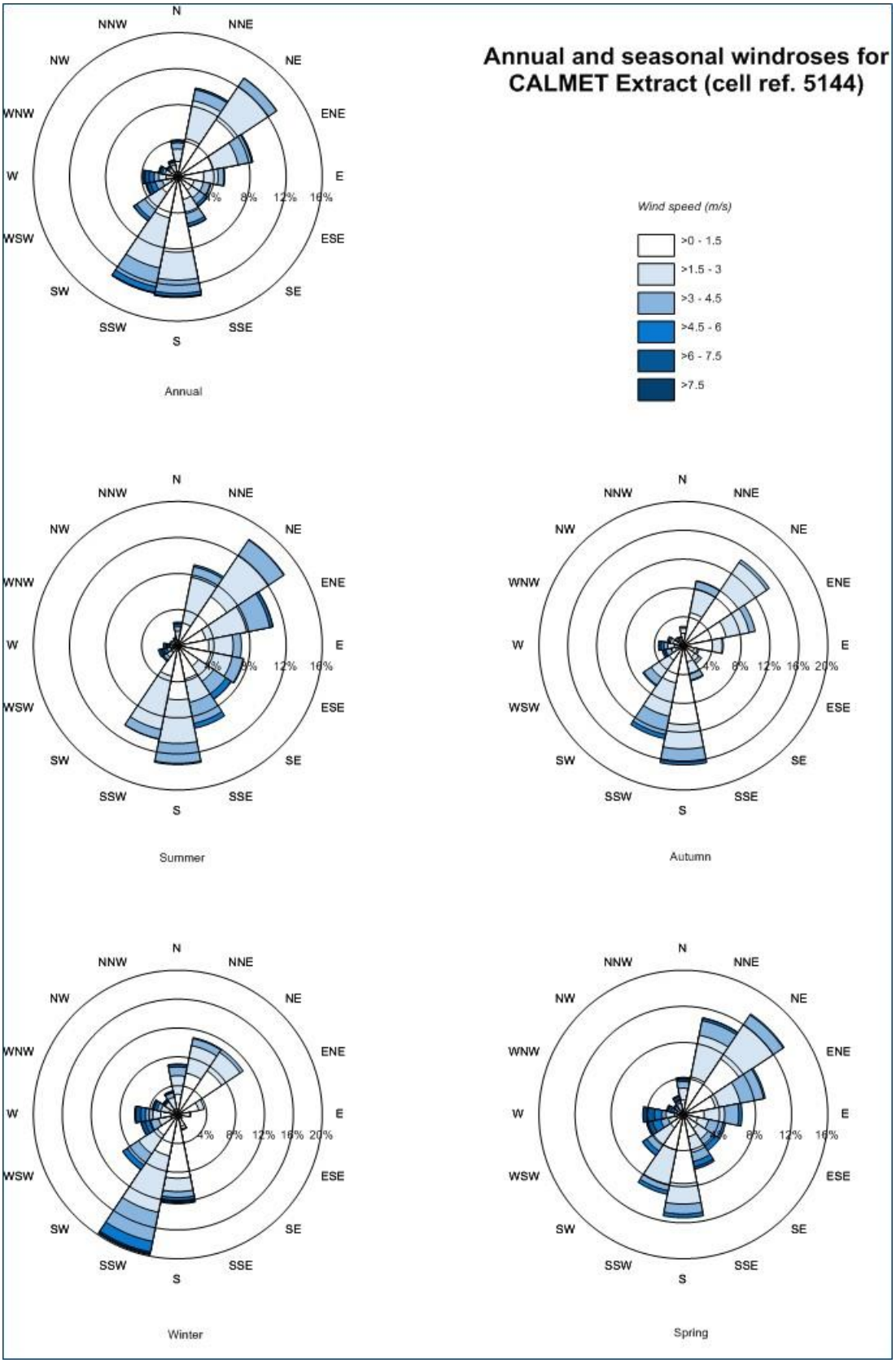
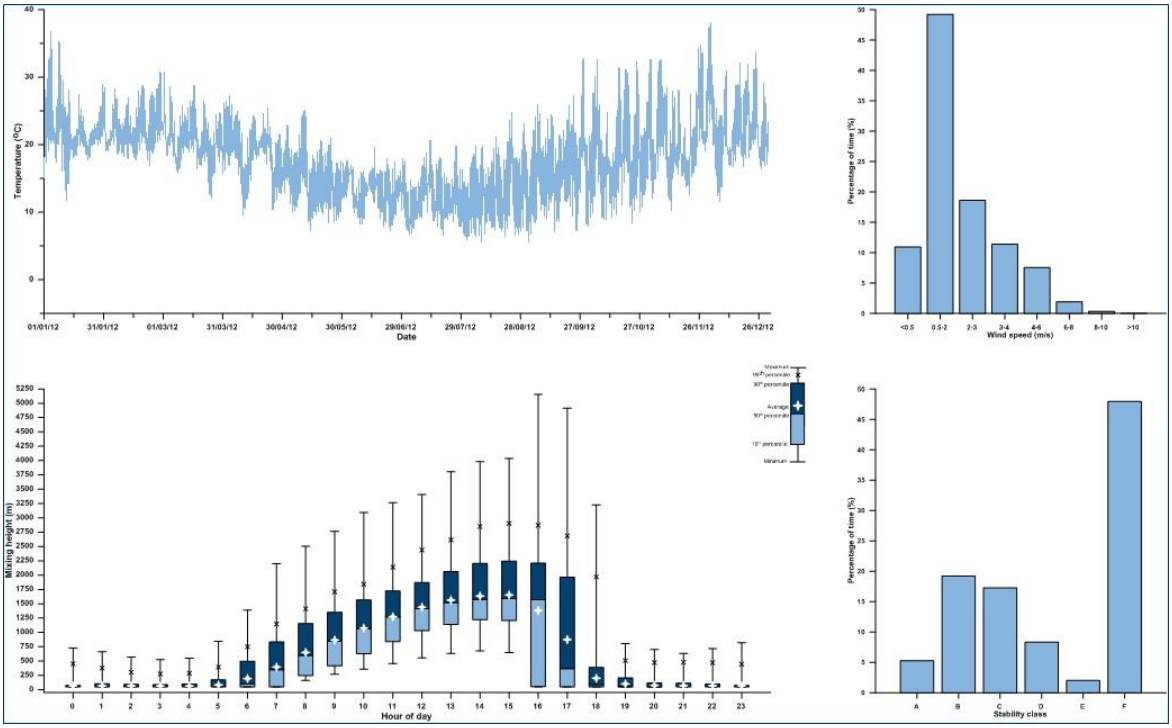


Figure 8-3: Meteorological analysis of CALMET (Cell Ref 5051)



8.3 Dispersion modelling

The CALPUFF air dispersion model has been used to predict the potential odour levels in the ambient air in the wider area around the Precinct.

Modelling of the key odour emission sources was conducted using the emissions rates and parameters outlined in the following section and utilising the meteorological data described in the previous section.

8.3.1 Odour Sources

Table 8-2 presents the potential odour sources examined in the Stage 1 odour study and includes poultry operations (broiler chickens, layer chickens and ducks), piggeries, a meat rendering plant, a mushroom production facility, and sewerage and wastewater treatment plants.

The conservative nature of the Level 1 assessment conducted for Stage 1 odour study produced results for operations that indicated an area of odour impact that essentially covered the majority of the Precinct area. This information did not provide adequate detail to reasonably inform planning decisions about the potentially odour affected areas within the Precinct. Therefore, a Level 2/3 odour impact assessment was conducted for these sources. The results of the Level 1 assessment are presented in APPENDIX E.

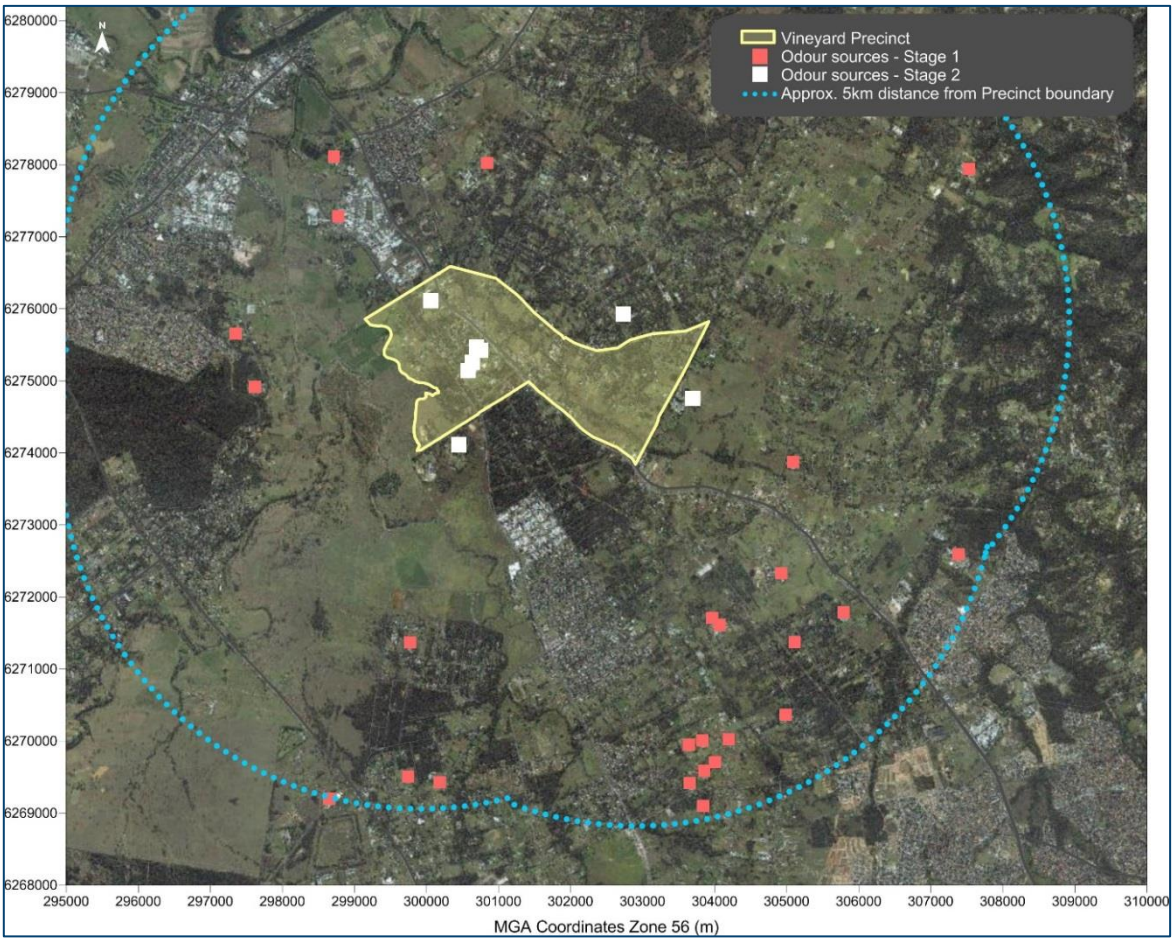
Following the Stage 1 odour study, further investigation was conducted into odour sources to determine in detail the nature and type of the operations for the purposes of air dispersion modelling. The operations highlighted in blue in Table 8-2 and identified in Figure 8-4 have been considered for the Stage 2 odour assessment.

The Stage 2 odour assessment includes those operations identified to have potential to cause an impact upon the Stage 1 development area of the Precinct. For the poultry operations situated within the Precinct area, these operations have been included in the Stage 2 odour assessment due to the potential for cumulative odour impacts to occur.

Table 8-2: Odour sources near to precinct development

Poultry operations	X	Y	Type
100 Worcester Rd, Rouse Hill	305790	6271783	Layer Farm
21 Terry Rd, Box Hill	305091	6273873	Broiler Farm
181 Cudgegong Rd, Rouse Hill	305109	6271372	Layer Farm
25 Schofields Rd, Schofields	303651	6269420	Broiler Farm
26 Schofields Farm Rd, Schofields	303857	6269585	Broiler Farm
34-36 Schofields Rd, Schofields	303837	6269098	Duck Farm
68 Schofields Farm Rd, Schofields	303640	6269948	Layer Farm
73 Boundary Rd, Schofields	303830	6270012	Layer Farm
37-39 Boundary Rd, Schofields	304004	6269710	Layer Farm
95 Tallawong Rd, Schofields	304985	6270368	Broiler Farm
20 Clarke St, Riverstone	304069	6271609	Broiler Farm
16 Clarke St, Riverstone	303965	6271710	Broiler Farm
31-33 Boundary Rd, Box Hill	303699	6274758	Layer Farm
372 Windsor Rd, Vineyard	300057	6276110	Broiler Farm
466 Windsor Rd, Vineyard	300690	6275472	Broiler Farm
45 Farm Rd, Riverstone	299774	6271368	Duck Farm
138 Clifton Rd, Marsden Park	300181	6269426	Layer Farm
199 Stahls Rd, Oakville	302733	6275925	Broiler Farm
169 Clifton Rd, Marsden Park	299746	6269507	Layer Farm
205 Maguires Rd, Maraylya	307534	6277943	Breeder Farm
115 Wolseley Rd, Oakville	300843	6278024	Broiler Farm
1 Dunns Rd, Maraylya	305889	6280356	Broiler Farm
1132 Richmond Rd, Marsden Park	298647	6269197	Layer Farm
291 Fairey Rd, South Windsor	297349	6275653	Broiler Farm
472 Windsor Road, Vineyard	300745	6275424	Layer Farm
53 Wallace Road, Vineyard	300575	6275142	Broiler Farm
Piggery operations	**X**	**Y**	**Type**
21 Gordon Rd, Schofields	304194	6270026	Piggery
Other operations	**X**	**Y**	**Type**
1106 Windsor Rd, Rouse Hill	304924	6272326	Meat Rendering
Riverstone STP	300447	6274118	Sewage Treatment Plant
McGraths Hill STP	298712	6278109	Sewage Treatment Plant
61 Wallace Rd, Vineyard	300575	6275142	Mushroom Production
108 Mulgrave Rd, Mulgrave	298772	6277284	Mushroom Composting
Rouse Hill WRP	307386	6272593	Wastewater Treatment Plant
South Windsor STP	297618	6274914	Sewage Treatment Plant

Figure 8-4: Location of odour sources near to precinct development



8.4 Emission estimation

The main source of potential significant odour emissions identified to influence the Stage 1 development area would be from animal husbandry operations including poultry operations and a mushroom production facility.

8.4.1 Poultry emission estimation

For the purposes of this study and in the absence of site specific measurements for each of the various poultry operations, an emission estimation methodology was developed based on data collected for other similar studies. The methodology used in this assessment applied variable emission rates for each modelled shed to account for the changing ventilation rate with temperature.

The poultry farms are assumed to all be naturally ventilated shed operations. Odour emissions from the farms were estimated based on available odour measurement data taken at naturally ventilated chicken farm operations [13]. Table 8-3 summarises the odour measurements taken and show a mean odour emission rate (OER) per 1,000 birds of 200, which has been applied in the modelling.

Table 8-3: Summary of odour emission data for broiler sheds

Farm	Bird numbers	Odour concentration	OER ou.m^3/s	OER| 1000 birds	Mean OER| $_{1000\ birds}$
P (natural)	18,900	1,380	4,301	227	200
		228	4,057	215	
		1,250	4,193	222	
		121	3,337	117	
D (natural)	24,000	598	8,587	358	
		213	2,300	96	
		286	3,884	162	
		184	3,532	147	

NOTES: Source: GHD (2003) [13]

A study by Jiang and Sands [14] observed that the moveable louvers on naturally ventilated poultry sheds are generally closed when the temperature drops below 15°C and suggests that for temperatures 15°C and below, odour emission rates from these sources should be 10% of those used for temperatures above 15°C.

The Jiang and Sands [15] data and Pollock [16] data both show that on a "per bird" basis, odour emissions from chicken egg-layer farms may be about 0.4 times that of broiler farms. This factor has been applied in the emissions estimation for the base odour emission level for the layer farms.

The odour emission from each source was calculated based on the OER presented in Table 8-4 and the observed dimensions of each shed obtained from available satellite imagery with an assumed stocking density of 15 birds per square metre to calculate the number of birds likely to be housed in each shed.

Peak-to-mean factors to account for the nose response time relative to the modelled time period were applied in the dispersion modelling. A peak-to-mean factor of 2.3 was applied to multiply the results, per the applicable EPA Approved Methods [9] guidelines.

The estimated bird numbers and associated odour emission rates for each farm are presented in Table 8-4.

Table 8-4: Estimated odour emissions for poultry operations

Operation	Bird numbers	OER (ou.m^3/s)	Peak OER - P/M = 2.3 (ou.m^3/s)
372 Windsor Road (Broiler)	62,370	12,474	28,690
466 Windsor Road (Broiler)	36,645	7,329	16,857
472 Windsor Road (Layer)	23,490	1,879	4,322
199 Stahls Road (Broiler)	74,790	14,958	34,403
53 Wallace Road (Broiler)	56,355	11,271	25,923
31-33 Boundary Road (Layer)	79,605	6,368	14,647

8.4.2 Mushroom production emission estimation

The main source of odorous emissions from the mushroom production operations will arise from the stockpile of spent mushroom compost.

The area of the spent mushroom compost is based on available historical aerial imagery of the site. As a conservative approach the largest area has been selected for the purposes of this assessment.

Odour emissions have been obtained from a report on a similar mushroom production facility [17] and are summarised in Table 8-5. The average odour emission rate of the measurements has been applied in the modelling and is assumed to emit constantly for the period of modelling.

Table 8-5: Odour measurements for spent compost

Spent compost	Odour concentration (ou)	Specific odour emission rate (ou.m^3/s)
Fresh	1,020	0.655
One day	236	0.152
Six weeks	731	0.469

Notes: Source: PAEHolmes, 2010 [17]

8.5 Dispersion Modelling Results

8.5.1 Poultry operations

The spatial distribution of the dispersion modelling predictions for the modelled poultry operations are presented as an isopleth diagram showing the 99th percentile nose-response ground level odour concentrations in Figure 8-5.

The dispersion model results show a similar area of influence on the Stage 1 development area when compared with the Level 1 Assessment results (see APPENDIX E) and show impacts above the 2 OU guideline across the Stage 1 development area. Odour impacts are greatest across the northern portion of the Stage 1 development area.

It is noted that this assessment is based on conservative assumptions of chicken shed operations and conservative emissions rates. In reality, it is likely that odour emissions could be lower and impacts reduced, however the results provide an indication of potential odour impacts and the results can be used to inform planning decisions.

In this case, the chicken farms identified largely preclude urban development. Even with very high levels of odour control, the farms would generate unacceptable levels of odour across a wide area of the precinct. As a guide, odour levels are unlikely to be less than half that predicted, but if they were, the 4 OU contour (instead of the 2 OU contour) would represent the likely smallest realistic zone of impact that may actually occur whilst the farms remain in operation.

It is noted that due to the development of the North West Priority Growth Areas that some operations have already been shut down.

Figure 8-5: Predicted 99th percentile nose-response average ground level odour concentrations - poultry operations

8.5.2 Mushroom production operation

The spatial distribution of the dispersion modelling predictions for the modelled mushroom production operation are presented as an isopleth diagram showing the 99th percentile nose-response ground level odour concentrations in Figure 8-6.

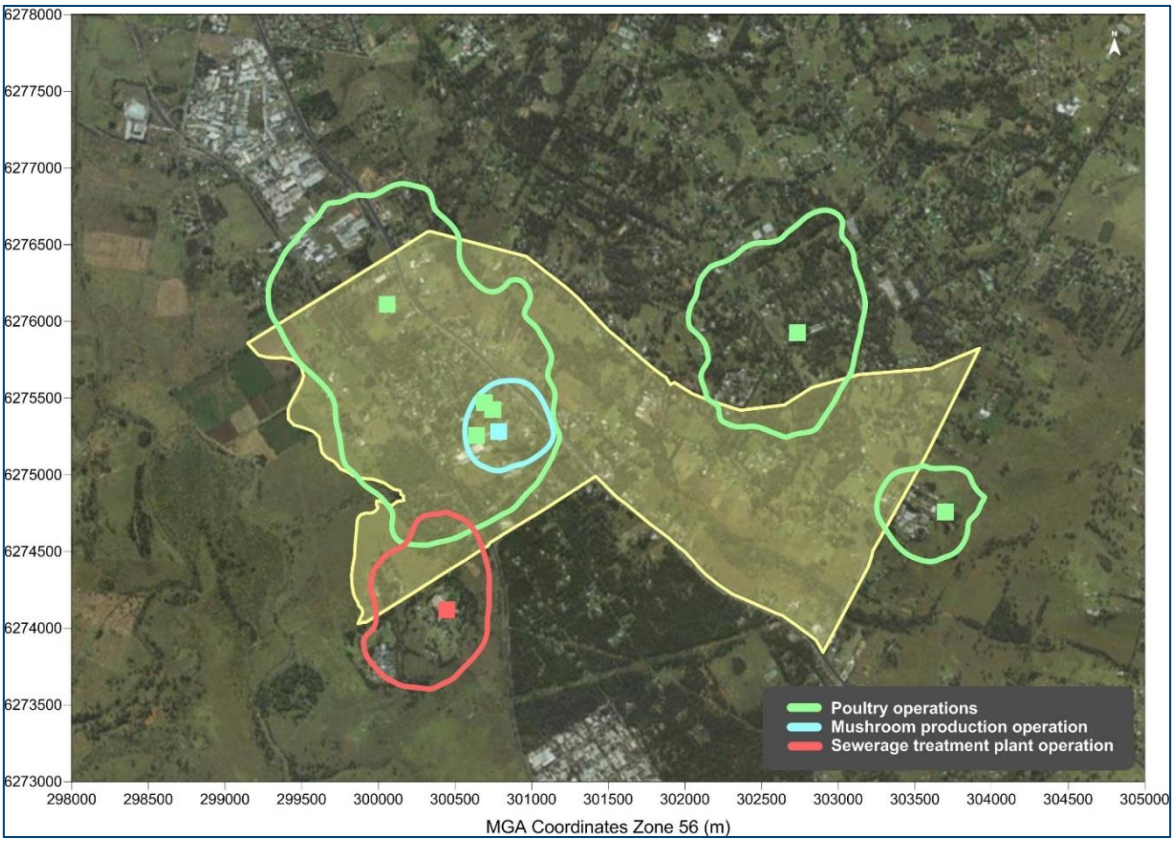
The dispersion modelling results indicate that odour impacts are generally restrained to the immediate area around the operation. It is noted that the conservative assumptions of operations and constant emissions rates are likely to overestimate the potential odour impacts. In reality, it is likely that odour emissions would be lower and impacts reduced; however, the results provide an indication of the likelihood of potential odour impacts and indicate that the mushroom production operation could potentially operate per diligent good practice odour control to achieve acceptable levels of odour.

Figure 8-6: Predicted 99th percentile nose-response average ground level odour concentrations - mushroom production operation

8.6 Indicative layout plan

Figure 8-7 shows the potential zone of effect for the poultry operations and mushroom production with best practice measures in place.

Figure 8-7: Potential zone of effect with best practice measures



8.7 Odour assessment recommendations

The Level 1 assessment approach identified that the odour sources in the area would impact all but two small sections of the Vineyard Precinct located to the western extent and slightly east of the centre (see Figure E-8), hence a more accurate Level 2/3 assessment was conducted.

The results of the Level 2/3 assessment indicate that the predicted level of potential odour impacts from all assessed operations may be compatible with industrial use in the Precinct, but is not ideal for the immediate development of large commercial office use or residential use. The results indicate that it would be preferable to transition the development of commercial or residential land use over time, allowing for the gradual improvement or cessation of odorous operations.

If the area is transitioned over time to urban land use, it can be expected that the area would be subject to a state of flux in regard to odour, depending odour, depending on the exact timing of odour mitigation or cessation of odorous activities and the occupation of the nearby land for urban uses. For this reason, it is suggested that future land owners be made aware of the potential for transitional odour impact to arise.

Recommendations are provided for consideration in the planning process in order to mitigate the potential for odour impacts. These recommendations incorporate an expectation that the measures would be progressively revised on the basis of more specific assessment for future individual developments.

8.7.1 Land release staging recommendations

In regard to the poultry operations, it is often the case that when land is re-zoned, the poultry farm is likely to be wound down and the land used otherwise, thus negating any impact. Nevertheless, the following should be considered:

- Stage residential land releases nearest the farms to the last stages of the Precinct's land releases; or
- Zoning industrial use in the potentially affected areas rather than residential use.

8.7.2 Indicative layout plan recommendations

- Ensure that residential (sensitive) land uses are located outside of the 2 OU buffer,
- Where possible plan for land uses to be transitioned according to odour sensitivity in order to maximise the separation of the most sensitive uses furthest from odour sources, and to avoid zoning residential land use adjacent to odour generating activities,
- Plan for the least odour sensitive land uses to be located near to odour generating sources. Compatible land uses include industrial land use, bushland reserves and car parks.

8.7.3 Development Control Plan recommendations

Generally, in addition to the above specific recommendations, appropriate development controls could be implemented to better manage odour (and air quality) impacts that may impact on people residing in the Precinct area. Potential options in this regard include:

- Orientate large commercial or apartment buildings to provide adequate air flow around the building and design buildings to encourage air flow in a particular direction (e.g. away from outdoor café areas. (This can be aided by road orientation and block size and shapes, but requires detailed restrictions in terms of building envelope and site layout to be specified in the DCP). Avoid construction of dead end courtyards or long narrow spaces perpendicular to the prevailing winds where air can lay dormant and stagnate,
- Build continuous dense landscaping (bunds and vegetation) around local odour sources to assist in odour dispersion from the odour source, thus reducing the odour impact on the Precinct area,
- Consider air conditioning and ventilation, and design buildings so living and work spaces such as bedrooms and offices do not face odorous sources. Large apartment buildings could have non-opening windows on the odorous side of the building and could duct cleaner air into the building from the far side, and out to the odorous side,
- Evaluate whether the nature of a development is compatible with odour affected lands, and whether odour nuisance will be detrimental to the long term success of the completed development, and

- Consider removing a separation buffer or removing development restrictions if an odour source ceases operation.

8.7.4 Ongoing operational recommendations

With regard to the mushroom production operation, potential risk occurs in the immediate vicinity of these operations. The use and consideration of best practice odour control measures and mitigation strategies are likely to ensure that the potential for excessive odour generation is reduced and the likely impacts managed.

The following actions could be considered;

- Inform operations and regulators of the potential risk;
- Conduct a more refined assessment with site specific emission rates and an odour survey of the local area;
- Ensure these operations are in line with best practice (if not already so); and
- Implement the land release staging recommendations in Section 8.1.1.

9 Conclusion

The study to date identifies the major noise and odour generating development and activities within and surrounding the Precinct, specifically for the Stage 1 development area, with the potential to constrain development or otherwise require consideration of site specific controls or mitigation measures.

9.1 Noise

The primary constraint for development within the Vineyard Precinct was identified as:

- Road traffic noise from Winsor Road

The assessment concludes that the proposed land uses within the Precinct with appropriate assessment and design of noise generating and noise sensitive developments.

With regard to noise sensitive development along the Windsor Road and other lower order sub-arterial roads, development can be designed to achieve satisfactory internal noise amenity. Requirements for acoustic amenity in areas of principle private open space of low-density residential development could also be considered however is not part of current EPA noise policy and would be required to be adopted and enforced by Council's own planning policy.

9.2 Odour

A Level 1 odour impact assessment was initially conducted to determine separation distances for all potential odour sources which may impact on the Vineyard Precinct.

This study presents a more accurate Level 2/3 odour assessment of the sources identified in the Level 1 assessment as having the potential to cause adverse air quality impacts within the Stage 1 Vineyard Precinct development area.

A Level 2/3 odour assessment is the most accurate possible assessment that can be made using the available data, and hence provides the most appropriate basis for planning considerations.

The assessment finds that there are several odour sources that have potential to impact upon the proposed Stage 1 Vineyard Precinct development area. The sources include several poultry farms and a mushroom production operation. It is noted that it is likely that one or more of the poultry farms may already have ceased, or will soon cease operations (eg. when re-zoned as part of the Box Hill Precinct).

Application of best practice mitigation may permit operation of the mushroom production operation, in a manner that may limit the extent of the likely odour impacts. However, careful consideration of the continued operation of the assessed poultry operations is required to determine the compatibility with the full development of the Stage 1 Vineyard Precinct development area as proposed.

Recommendations have been made to minimise the impact of these odour sources, however ultimately it needs to be recognised that these odour sources are generally not compatible with the residential uses proposed, thus in the longer term may need to cease or relocate to an appropriate location. In some cases, it would be possible that the residential development near the odour sources be staged to provide sufficient time for operators to recoup their capital investment or relocate. For example, releasing land from the east initially and progressing west over a period of time as appropriate.

This report also provides general options to consider in the planning and development process in order to mitigate potential odour and air quality impacts within the Stage 1 Vineyard Precinct development area.

References

[1] NSW DEC, *Technical framework – Assessment and management of odour from stationary sources in NSW,* Sydney, NSW: NSW Department of Environment and Conservation, 2006.

[2] NSW EPA, NSW Industrial Noise Policy, Sydney: NSW EPA, 2000.

[3] NSW Department of Planning, "Development in Rail Corridors and Busy Roads – Interim Guideline," NSW Department of Planning, Sydney, 2008.

[4] NSW EPA, NSW Road Noise Policy, Sydney: NSW EPA, 2012.

[5] NSW Government, "State Environmental Planning Policy (Infrastructure)," Sydney, 2007.

[6] Standards Australia International, "AS 2021 Acoustics: Aircraft Noise - Building Siting and Construction," Standards Australia International Ltd, Sydney, 2000.

[7] NSW DEC, "Technical Notes – Assessment and management of odour from stationary sources in NSW," NSW Department of Environment and Conservation, Sydney, 2006.

[8] Bureau of Meteorology, "Climatic Averages Australia," 2014. [Online]. Available: http://www.bom.gov.au/climate/averages. [Accessed 2014].

[9] NSW DEC, "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW," NSW Department of Environment and Conservation, August 2005.

[10] Katestone Scientific Pty Ltd , "Peak-to-Mean Concentration Ratios for Odour Assessments," 1998.

[11] Katestone Scientific Pty Ltd , "The evaluation of peak-to-mean ratios for odour assessments" Volume 1 - Main Report," May 1995.

[12] TRC Environmental Corporation, "Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia," Prepared for the NSW Office of Environment and Heritage , 2011.

[13] GHD, "Review of modelling, emission measurement and treatment of odour and dust emissions from broiler farms," Prepared for Australian Poultry Cooperative Research Centre, 2003.

[14] Jiang and Sands, "Odour and Ammonia Emissions from Broiler Farms Farms - A report for the Rural Industries Research and Development Corporation," 2000.

[15] Jiang and Sands, "Report on Odour Emissions from Poultry Farms in Western Australia – Principal Technical Report," Centre for Water and Waste Technology, University of NSW, Sydney, 1998.

[16] Pollock, "Review of Modelling, Emission measurement and treatment of Odour and Dust Emissions from Broiler farms," Australian Poultry CRC, November 2003.

[17] PAEHolmes, "Air Quality Assessment Proposed Mushroom Farm, Londonderry," Prepared for Elf Mushroom, January 2010.

[18] PAEHolmes, "Odour Assessment for Precinct Planning, Box Hill and Box Hill Industrial Precincts, North West Growth Centre, Box Hill, NSW," Department of Planning, 2011.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L_{eq} sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-term noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA04 (CESVA SC310)	Type 1	1/1	L3
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1	L1 and L2

Note: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long-term noise monitoring results

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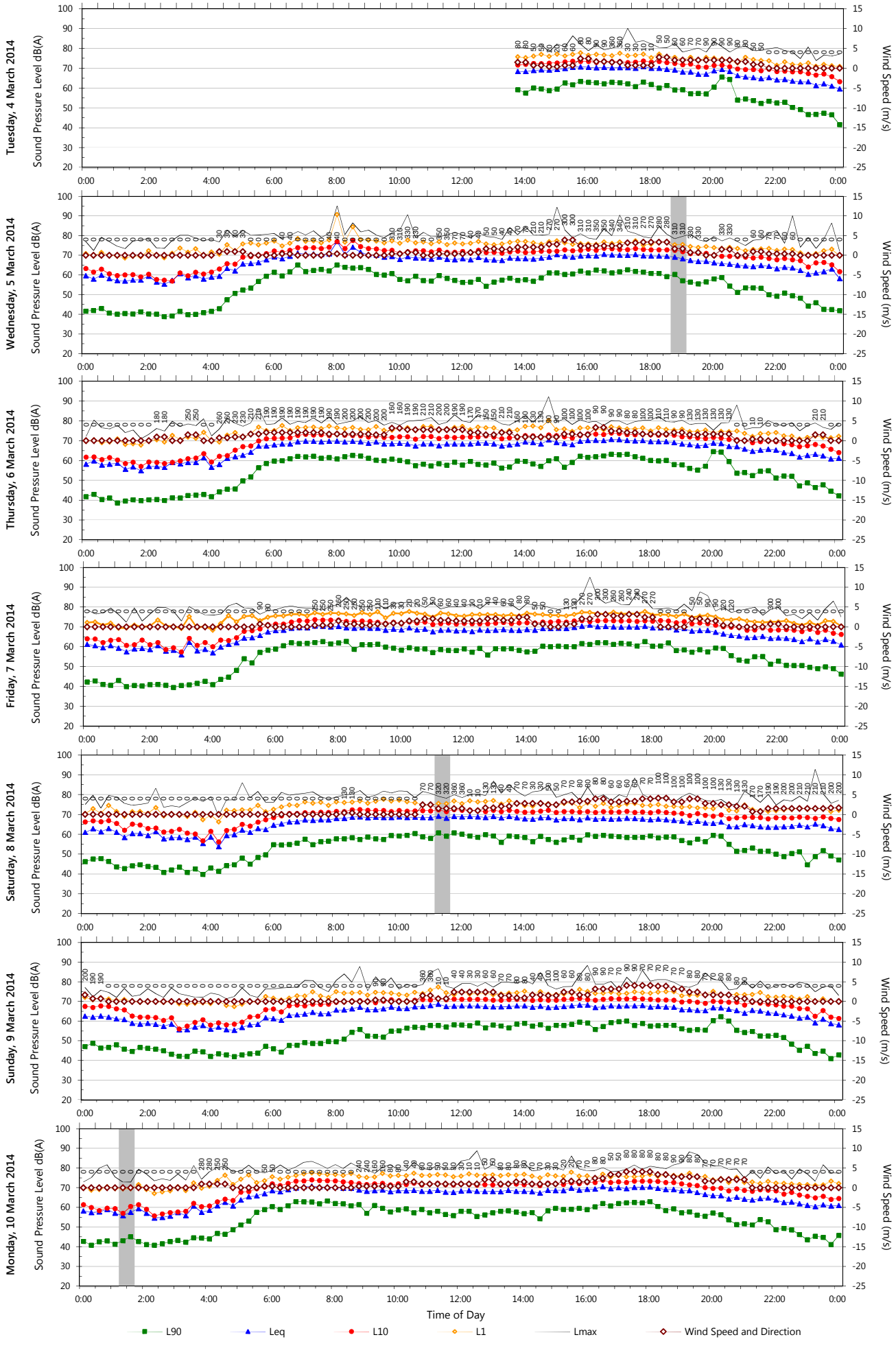
L1 - 372 Windsor Rd, Vineyard

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000						
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Date	Day	Evening	Night	Day	Evening	Night
Tuesday-04-March-2014	-	53	40	-	68	64
Wednesday-05-March-2014	57	50	40	70	66	63
Thursday-06-March-2014	57	52	40	69	68	64
Friday-07-March-2014	58	53	41	69	67	62
Saturday-08-March-2014	56	51	43	68	66	62
Sunday-09-March-2014	53	53	41	67	66	64
Monday-10-March-2014	56	51	42	69	67	64
Tuesday-11-March-2014	57	52	40	69	67	64
Wednesday-12-March-2014	56	50	38	69	67	63
Thursday-13-March-2014	-	-	-	-	-	-
Representative Week	**57**	**52**	**40**	**69**	**67**	**63**

Road / Rail Noise Monitoring Results (at one metre from façade)						
	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-04-March-2014	71	67	73	67	72	60
Wednesday-05-March-2014	72	66	75	67	72	59
Thursday-06-March-2014	71	66	73	69	72	61
Friday-07-March-2014	71	65	73	68	69	60
Saturday-08-March-2014	70	64	71	67	67	59
Sunday-09-March-2014	69	66	70	67	72	58
Monday-10-March-2014	71	66	73	67	72	58
Tuesday-11-March-2014	71	66	73	68	72	61
Wednesday-12-March-2014	71	66	73	67	72	60
Thursday-13-March-2014	71	-	72	70	-	-
Representative Weekday	**71**	**66**	**73**	**68**	**72**	**60**
Representative Weekend	**70**	**65**	**71**	**67**	**70**	**59**
Representative Week	**71**	**66**	**73**	**68**	**71**	**60**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Rating Background Level (RBL) for L90 and logarithmic average for Leq
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq



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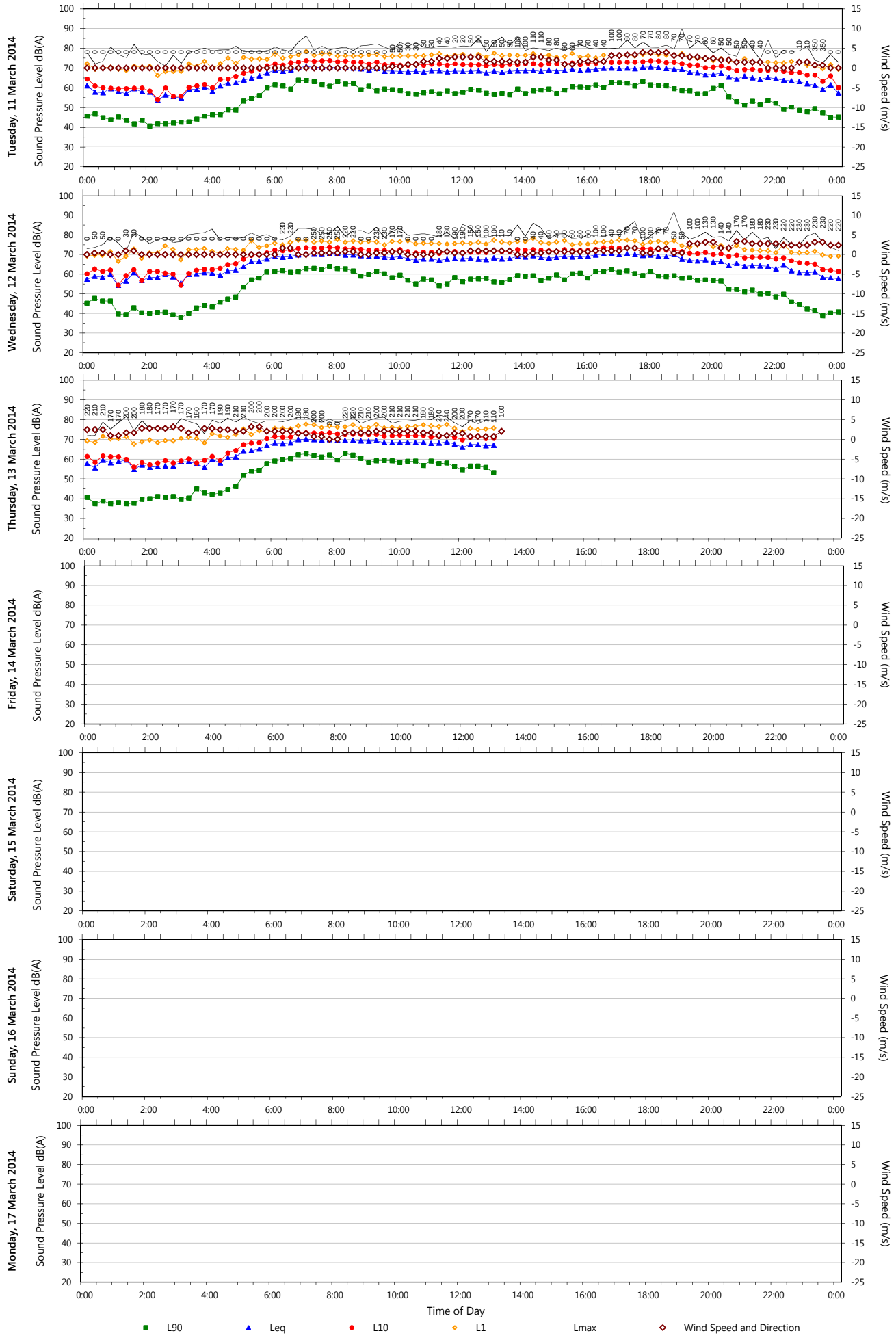
Template QTE-05B (rev 109) Sydney Logger Graphs



Data File: 2014-03-04_SLM_000_123_Rpt_Report.txt

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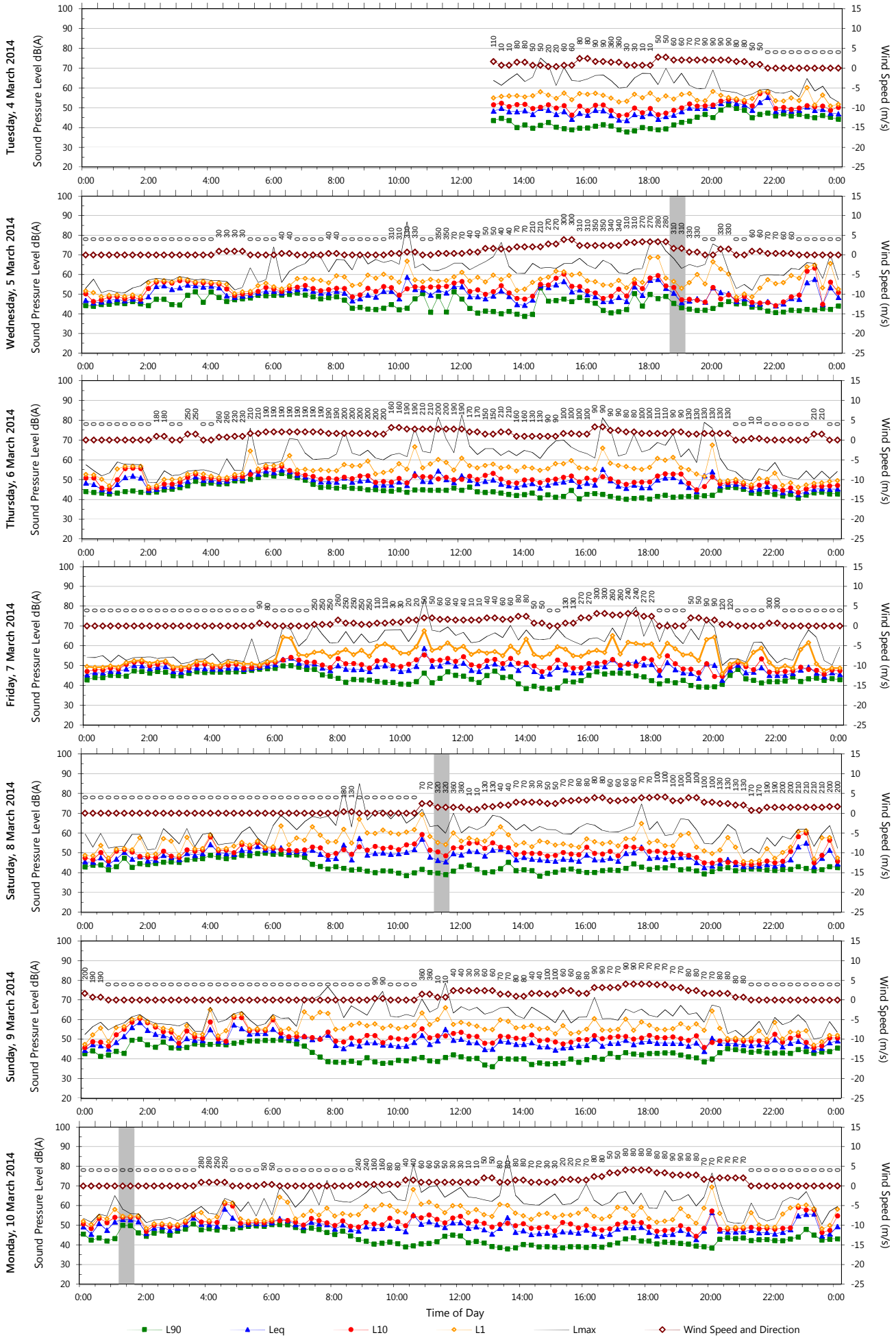
L2 - 170 Commercial Rd Vineyard

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000						
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Date	Day	Evening	Night	Day	Evening	Night
Tuesday-04-March-2014	-	39	45	-	51	51
Wednesday-05-March-2014	40	41	42	52	51	51
Thursday-06-March-2014	41	41	43	49	49	49
Friday-07-March-2014	40	39	43	50	48	49
Saturday-08-March-2014	40	41	41	50	46	52
Sunday-09-March-2014	38	40	43	48	48	51
Monday-10-March-2014	39	39	42	49	48	56
Tuesday-11-March-2014	38	39	43	49	46	53
Wednesday-12-March-2014	38	39	40	49	48	51
Thursday-13-March-2014	-	-	-	-	-	-
Representative Week	**39**	**39**	**43**	**50**	**49**	**52**

Road / Rail Noise Monitoring Results (at one metre from façade)						
	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-04-March-2014	52	53	55	48	57	49
Wednesday-05-March-2014	54	54	58	49	56	49
Thursday-06-March-2014	52	51	54	48	55	46
Friday-07-March-2014	52	52	55	49	54	48
Saturday-08-March-2014	52	55	56	47	58	50
Sunday-09-March-2014	51	53	54	49	57	50
Monday-10-March-2014	51	59	54	48	67	48
Tuesday-11-March-2014	51	55	55	47	58	51
Wednesday-12-March-2014	51	53	53	48	59	47
Thursday-13-March-2014	55	-	61	51	-	-
Representative Weekday	**53**	**55**	**56**	**49**	**60**	**48**
Representative Weekend	**51**	**54**	**55**	**48**	**58**	**50**
Representative Week	**52**	**54**	**56**	**49**	**60**	**49**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Rating Background Level (RBL) for L90 and logarithmic average for Leq
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq



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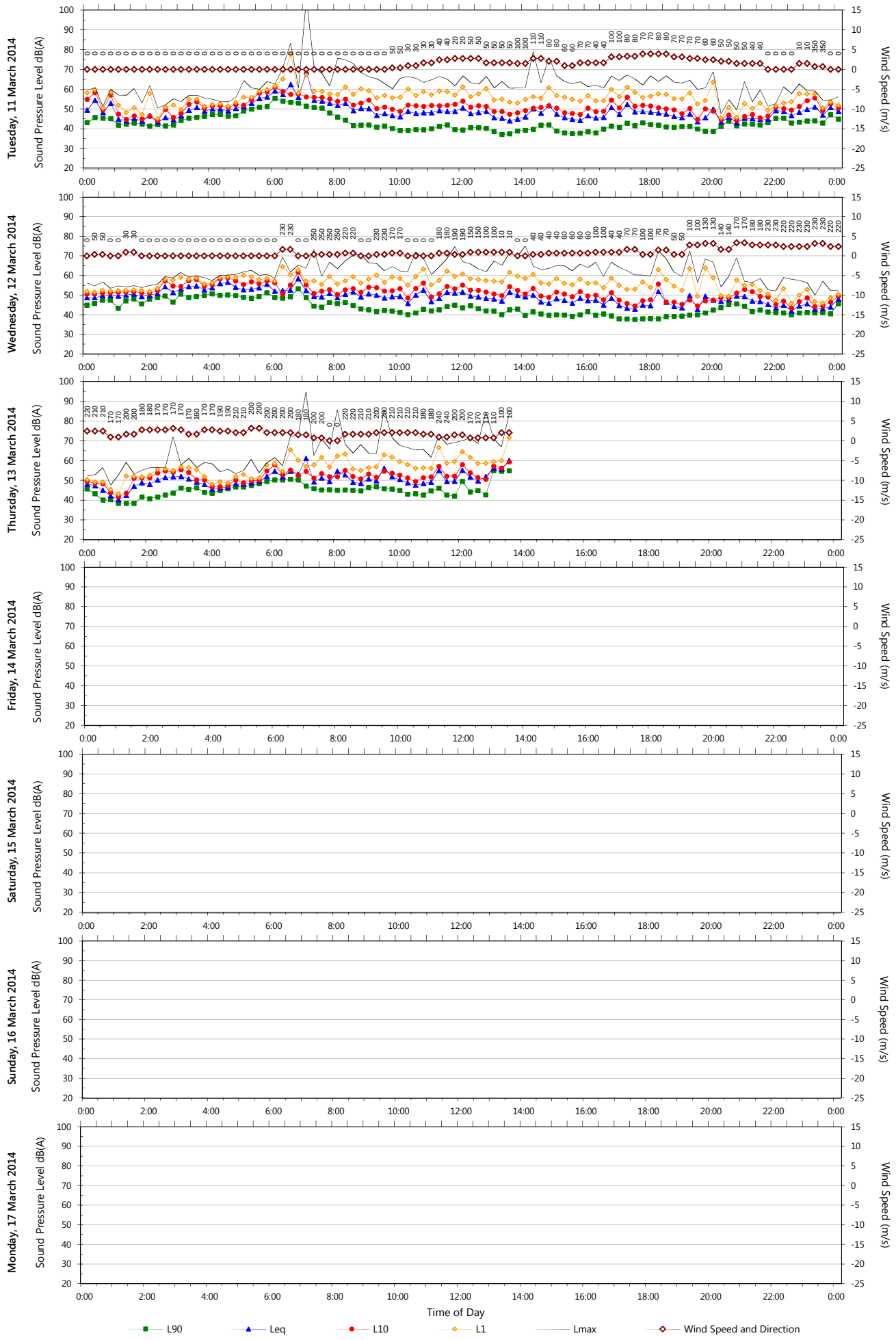

Data File: 2014-03-04_SLM_000_123_Rpt_Report.txt

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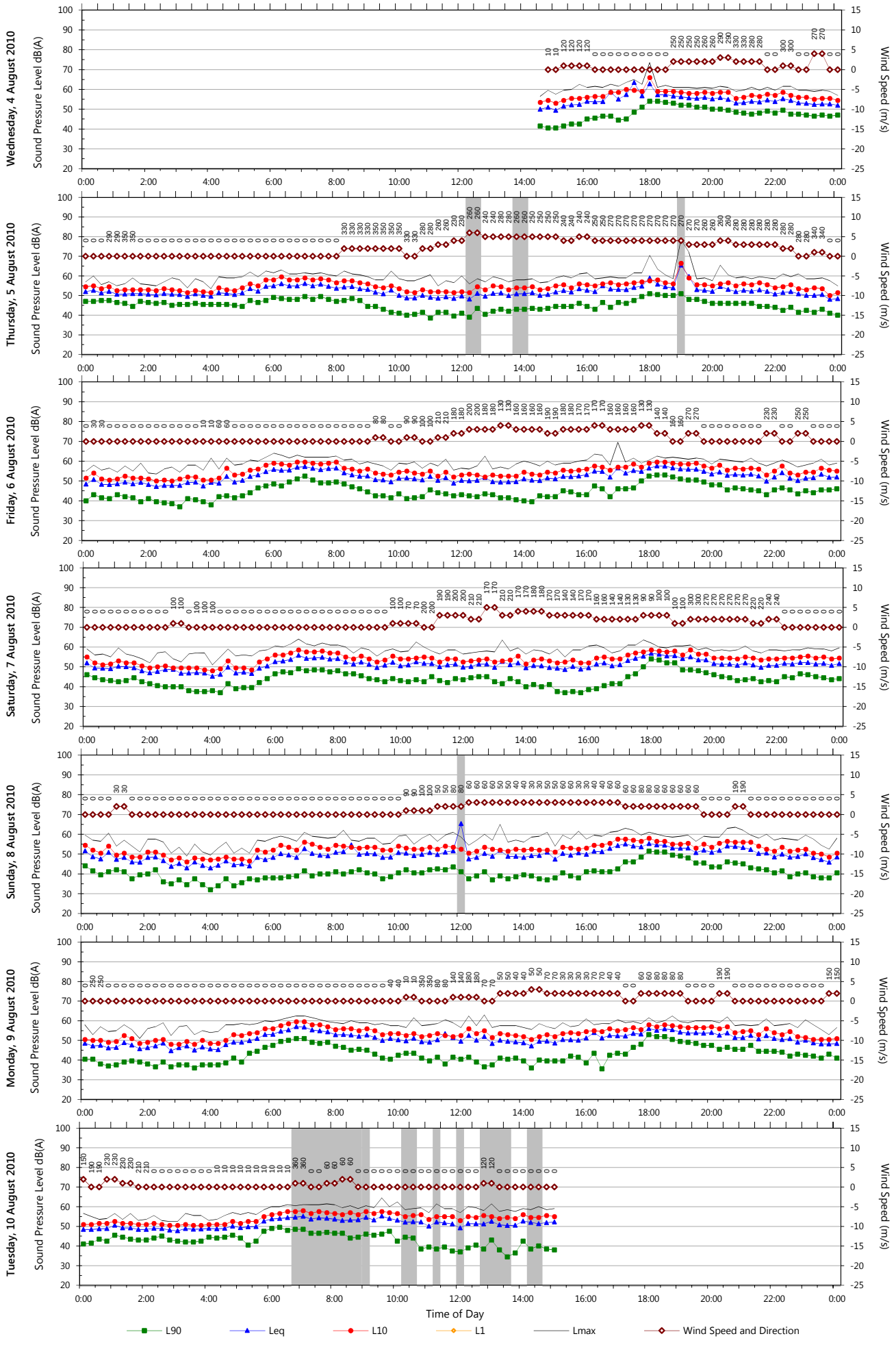
L3 - 47 Boundary Rd, Box Hill

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000						
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Date	Day	Evening	Night	Day	Evening	Night
Wednesday-04-August-2010	-	48	45	-	55	53
Thursday-05-August-2010	41	45	39	52	54	52
Friday-06-August-2010	42	45	38	53	55	51
Saturday-07-August-2010	39	43	35	52	53	49
Sunday-08-August-2010	38	42	37	51	53	50
Monday-09-August-2010	38	45	42	52	53	50
Tuesday-10-August-2010	-	-	-	-	-	-
Representative Week	**39**	**45**	**39**	**52**	**54**	**51**

Road / Rail Noise Monitoring Results (at one metre from façade)						
	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Wednesday-04-August-2010	59	55	64	53	58	53
Thursday-05-August-2010	56	54	58	52	59	50
Friday-06-August-2010	56	53	59	53	57	49
Saturday-07-August-2010	55	51	58	52	54	47
Sunday-08-August-2010	54	53	57	52	59	49
Monday-09-August-2010	55	52	57	52	57	51
Tuesday-10-August-2010	55	-	56	54	-	-
Representative Weekday	**56**	**54**	**60**	**53**	**58**	**51**
Representative Weekend	**54**	**52**	**57**	**52**	**57**	**48**
Representative Week	**56**	**53**	**59**	**52**	**57**	**50**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Rating Background Level (RBL) for L90 and logarithmic average for Leq
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq



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APPENDIX D Odour assessment Peak-to-mean ratios

The following table shows the recommended factors to be applied for estimating peak concentrations from different source types, stabilities and distances.

Source Type	Pasquill-Gifford stability class	Near field P/M 60*	Far field P/M 60*
Area	A, B, C, D	2.5	2.5
	E, F	2.3	1.9
Line	A-F	6	6
Surface point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

NOTES: * Ratio of peak 1-second average concentrations

APPENDIX E Level 1 Odour assessment summary

E.1 Assessment methodology

E.1.1 Poultry Operations

A Level 1 odour impact assessment was conducted for the identified poultry farm operations located near the Vineyard Precinct. It was not possible to conclusively determine whether all of the poultry farms are in active operation, or would continue to operate into the future. All farms were assumed operational.

The number of birds for each of these operations was derived from previously published studies. Where no published data exist, the number of birds at each farm was estimated based on the dimensions of each shed and assumes a stocking density of 15 birds per square metre.

Duck farms were included in the poultry farm emissions estimations. Poultry farms are considered to generate more odours than duck farms, and thus the approach would provide a conservative estimate of the odour impact from duck farms.

The recommended separation distances for all bird farms included in this assessment are assessed using the broiler farm Level 1 odour assessment methodology, as outlined in the '*Technical notes for the Assessment and Management of Odour from Stationary Sources in NSW*' [7]. Separation distances are calculated using the following equation:

$$\boldsymbol{D = (N)^{0.71} \times S}$$

Where:

N = Number of standard broiler chicken shed units (SBCSU), where 1 SBCSU is equivalent to 22,000 broiler chickens;

D = Separation distance in metres between the closest points of the broiler chicken sheds and the most sensitive receptor or impact location;

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 relate to shed design, receptor, terrain, vegetation and wind frequency.

E.1.2 Shed Factor (S1)

The shed factor (S1) depends on how the shed is ventilated and as outlined in Table E-1.

Table E-1: Shed factor (S1)

Shed Type	Value
Controlled fan ventilation without barriers*	980
Controlled fan ventilation with barriers	690

Shed Type	Value
Natural ventilation	690

Source: [7]

* Barriers - walls, berms and other structures designed to mitigate dust and odour emissions from controlled fan ventilation sheds.

E.1.3 Receptor Factor (S2)

The receptor factor varies depending upon the likely impact area and is determined from factors outlined in Table E-2. The development of the Vineyard Precinct considers a capacity of approximately 2,500 homes for 7,000 residents with the potential to increase to 4000 homes. Therefore, accordingly, the receptor factor for this assessment is set to 1.05 for all bird farms.

Table E-2: Receptor factor (S2)

Receptor Type	Value
Large towns, greater than 2,000 persons	1.05
Medium towns, 500-2,000 persons	0.75
Medium towns, 125-500 persons	0.55
Small towns, 30-125 persons	0.45
Small towns, 10-30 persons	0.35
Single rural residence	0.30
Public area (occasional use)	0.05*

Source: [7]

* The value for public area would apply to areas subject to occasional use. Higher values may be appropriate for public area used frequently or sensitive in nature, such as frequently used halls and recreation areas. These should be assessed individually.

E.1.4 Terrain Factor (S3)

The terrain factor (S3) varies according to topographical features and its capability to disperse odours and is determined from factors outlined in Table E-3. Topographical features portray relatively flat or undulating terrain. A low level ridge line runs through the centre of the Vineyard Precinct, though this feature is not deemed to have an effect on odour dispersion. Undulating terrain becomes more prominent to the northeast of the study area, and as such, farms in these areas have been valued as 0.9 for undulating terrain. All other farms have been assigned as flat terrain.

Table E-3: Terrain factor (S3)

Receptor	Value
Valley drainage zone	2.0
Low relief	1.2
Flat	1.0
Undulating country between broiler chicken farm and receptor	0.9
High relief or significant hills and valleys between broiler chicken farm and receptor	0.7

Source: [7]

E.1.5 Vegetation Factor (S4)

The vegetation factor (S4) varies according to vegetation density and is determined from factors outlined in Table E-4.

Table E-4: Vegetation factor (S4)

Vegetation	Value
Crops only, no tree cover	1.0
Few trees, long grass	0.9
Wooded country	0.7
Heavy timber	0.6
Heavy forest (both upper and lower storey)	0.5

Source: [7]

E.1.6 Wind Frequency Factor (S5)

The wind frequency factor is determined using Table E-5. Local dispersion meteorology has been considered and winds are considered normal.

Table E-5: Wind frequency factor (S5)

Wind frequency	Value
High frequency towards the receptor (greater than 60%)	1.5
Normal wind conditions	1
Low frequency towards the receptor (less than 5%)	0.7

Source: [7]

E.1.7 Intensive piggeries

A Level 1 odour impact assessment for intensive piggeries has been conducted on the piggery farms located near the Vineyard Precinct.

The recommended separation distances for piggery farms included in this assessment are assessed using the intensive piggeries Level 1 odour assessment methodology, as outlined in the Technical notes [7]. Separation distances are calculated using the following equation:

$$\boldsymbol{D = \sqrt{N} \times 50 \times S}$$

Where:

N = Number of standard pig units (SPU), where 1 SPU is defined as a grower pig of 26-60 kg live weight;

D = Separation distance in metres between the closest points of the piggery and the most sensitive receptor or impact location;

S = Composite site factor = S1 x S2 x S3 x S4 x S5. Site factors S1, S2, S3, S4 and S5 relate to shed design, maintenance schedule, receptor, terrain, vegetation and wind factor.

E.1.8 Odour potential factor (S1)

The odour potential factor varies with the shed design and maintenance schedule determined by multiplying factors in Table E-6.

Table E-6: Odour potential factor (S1)

Odour potential factors		Value
A	Type of building	
	1 Slatted floor and deep pit	1.0
	2 Partly slatted floor and shallow pit or open drain with regular flushing	0.9
	3 Partly slatted floor and sloping floor and regular flushing	0.8
	4 Partly slatted floor and 'pull plug' and recharge system	0.6
B	Ventilation of buildings	
	1 Limited ridge and side-ventilators (or side only) or limited forced (fan) ventilation	1.0
	2 Ridge ventilators which are at least 90% of the roof length and are at least 10% of the roof width and side ventilators are at least 90% of the length of the two long sides of the building and at least 30% of the side wall height, with roof walls insulated	0.9
	3 Fan forced ventilated shed with well-designed uniform ventilation throughout shed	0.9
C	Effluent collection frequency within all pig buildings	
	1 Faeces, urine and other biological material removed from the confines of the buildings every 24 hours or less often	1.0
	2 Faeces, urine and other biological material removed from the confines of the buildings every 24 hours or less often	0.9
D	Effluent treatment system (within the piggery compound)	
	1 Anaerobic lagoon(s) (including all inlet pipes/channels)	1.0
	2 Series lagoons anaerobic/aerobic (or facultative) and evaporation lagoons	1.0
	3 Facultative lagoon(s) (including all inlet pipes/channels)	0.95
	4 Aerated lagoon(s) (aerobic surface layer over entire lagoon)	0.75
	5 Aerobic lagoon(s)	0.6
	6 No effluent storage within at least 500 m of the piggery	0.6
E	Feeding	
	1 Conventional feeding	1.0
	2 Phase feeding	0.9
	3 Phase feeding with optimal protein	0.8

Source: [7]

E.1.9 Receptor factor (S2)

The receptor factor varies depending upon the likely impact area and is determined from factors outlined in Table E-7. The development of the Precinct considers a capacity of approximately 2,500 homes for 7,000 residents, with the potential to increase to 4,000 homes. The receptor factor for this assessment is therefore set to 1.6.

Table E-7: Receptor factor (S2)

Receptor Type	Value
Large towns, greater than 2,000 persons	1.6
Medium towns, 500-2,000 persons	1.2
Medium towns, 125-500 persons	1.1
Small towns, 30-125 persons	1.0
Small towns, 10-30 persons	0.6
Single rural residence	0.3
Public area (occasional use)	0.05*

Source: [7]
*. The value for public area would apply to areas subject to occasional use. Higher values may be appropriate for public area used frequently or sensitive in nature, such as frequently used halls and recreation areas. These should be assessed individually.

E.1.10 Terrain Factor (S3)

The terrain factor (S3) varies according to topographical features and its capability to disperse odours and is determined from factors outlined in Table E-8. Topographical features portray relatively flat or undulating terrain. A low level ridge line runs through the centre of the Precinct, though this feature is not deemed to have an effect on odour dispersion. Undulating terrain becomes more prominent to the northeast of the study area, and as such, farms in these areas have been valued as 0.9 for undulating terrain. All other farms have been assigned as flat terrain.

Table E-8: Terrain factor (S3)

Receptor	Value
Valley drainage zone	2.0
Low relief	1.2
Flat	1.0
Undulating country between broiler chicken farm and receptor	0.9
High relief or significant hills and valleys between broiler chicken farm and receptor	0.7

Source: [7]

E.1.11 Vegetation factor (S4)

The vegetation factor (S4) varies according to vegetation density, as outlined in Table E-9.

Table E-9: Vegetation factor (S4)

Vegetation	Value
Crops only, no tree cover	1.0
Few trees, long grass	0.9
Wooded country	0.7
Heavy timber	0.6
Heavy forest (both upper and lower storey)	0.5

Source: [7]

E.1.12 Wind frequency factor (S5)

The wind frequency factor is determined using Table E-10. Local dispersion meteorology has been considered and winds are considered normal.

Table E-10: Wind frequency factor (S5)

Wind frequency	Value
High frequency towards the receptor (greater than 60%)	1.5
Normal wind conditions	1
Low frequency towards the receptor (less than 5%)	0.7

Source: [7]

E.1.13 Sewerage and water recycling plant

There is no Level 1 odour impact assessment methodology for sewage treatment plants outlined by the Technical Notes [7].

Based on the methodology used for previously published Level 1 odour impact assessments for nearby precinct developments, a buffer distance of 400 metres has been applied to the local sewage treatment plants in this assessment.

E.1.14 Meat rendering

There is no Level 1 odour impact assessment methodology for the meat rendering operation outlined by the Technical Notes [7].

Based on the methodology used for previously published Level 1 odour impact assessments for nearby precinct developments, a buffer distance of 1,000 metres has been applied to the local meat rendering plant in this assessment.

E.1.15 Mushroom production

There is no Level 1 odour impact assessment methodology for mushroom production outlined by the Technical Notes [7].

Based on the methodology used for previously published Level 1 odour impact assessments for nearby precinct developments, a buffer distance of 1,000 metres has been applied to the local mushroom production facility in this assessment.

E.2 Level 1 - assessment results

E.2.1 Poultry operations

There are 25 poultry operations identified with a 5km separation distance from the Vineyard Precinct study area. Table E-11 provides the Level 1 assessment calculations and calculated separation distance for poultry operations that were included in the assessment. Calculated separation distances for poultry operations predicted to encroach on the Vineyard Precinct are shown in bold.

The poultry operations with a predicted influence on the Project study area are:

- 372 Windsor Rd, Vineyard
- 466 Windsor Rd, Vineyard
- 472 Windsor Rd, Vineyard
- 31-33 Boundary Rd, Box Hill
- 199 Stahls Rd, Oakville, and
- 53 Wallace Road, Vineyard.

The recommended individual separation distances for these poultry farms are visually presented in Figure E-1 to Figure E-6. The orange circles indicate the recommended buffer distances for individual farms and the yellow circles are the buffer distances with a 20% increase to account for potential interaction of two farms influencing the same area.

E.2.2 Intensive piggeries

There are two intensive piggeries identified within a 5km separation distance from the Vineyard Precinct study area.

Table E-12 provides the Level 1 assessment calculations. Based on the Level 1 odour impact assessment, the identified intensive piggery operation is deemed not to have an impact within the Vineyard Precinct area.

E.2.3 Meat rendering

The meat rendering operation located at 1106 Windsor Rd is not predicted to influence the Vineyard Precinct based on the 1,000m default buffer distance assumed for this operation.

E.2.4 Mushroom farm and mushroom composting

The default buffer distance of 1,000m has been applied to the mushroom farm and mushroom composting facilities located at 61 Wallace Rd and 108 Mulgrave Rd, respectively.

The mushroom farm at 61 Wallace Rd lies within the Vineyard Precinct boundary and would have an influence on the Vineyard Precinct, Figure E-7 presents visually the predicted separation distance. The mushroom composting facility at 108 Mulgrave Rd is not predicted to influence the Vineyard Precinct.

E.2.5 Sewage treatment plants and water recycling plants

The South Windsor, McGraths Hill and Quakers Hill Sewage Treatment Plants and the Rouse Hill Water Recycling Plant are not predicted to influence the Vineyard Precinct. The Riverstone Sewage Treatment Plant, however, is deemed to have an impact within the Vineyard Precinct study area.

Table E-13 presents the default buffer distance of 400m surrounding each side and distance from the Vineyard Precinct area. Figure E-8 presents visually the recommended separation distance for the Riverstone Sewage Treatment Plant.

Table E-11: Recommended separation distances for poultry operations (Level 1 assessment method)

Address	operation	Est. Total Birds	SBCSU	S1	S2	S3	S4	S5	Separation Distance (m)		Distance from the Precinct (m)
									radius	+20% radius	
100 Worcester Rd, Rouse Hill	Layer farm	32,000	1.455	690	1.05	1.0	1.0	1.0	473	567	3,545
21 Terry Rd, Box Hill	Broiler farm	61,050	2.775	690	1.05	1.0	1.0	1.0	748	897	1,920
181 Cudgegong rd, Rouse Hill	Layer farm	10,000	0.455	690	1.05	1.0	0.9	1.0	186	224	3,427
25 Schofields Rd, Schofields	Broiler farm	75,000	3.409	690	1.05	1.0	0.9	1.0	779	935	4,524
26 Schofields Farm Rd, Schofields	Broiler farm	42,837	1.947	690	1.05	1.0	1.0	1.0	581	698	4,390
34-36 Schofields Rd, Schofields	Duck farm	27,030	1.229	690	1.05	1.0	1.0	1.0	419	503	4,900
68 Schofields Farm Rd, Schofields	Layer farm	48,150	2.189	690	1.05	1.0	1.0	1.0	632	758	4,008
73 Boundary Rd, Schofields	Layer farm	34,560	1.571	690	1.05	1.0	1.0	1.0	499	599	3,998
37-39 Boundary Rd, Schofields	Layer farm	19,680	0.895	690	1.05	1.0	1.0	1.0	335	402	4,348
95 Tallawong Rd, Schofields	Broiler farm	92,000	4.182	690	1.05	1.0	0.9	1.0	900	1,080	4,090
20 Clarke St, Riverstone	Broiler farm	70,000	3.182	980	1.05	1.0	1.0	1.0	1,170	1,404	2,563
16 Clarke St, Riverstone	Broiler farm	28,350	1.289	690	1.05	1.0	1.0	1.0	434	520	2,445
31-33 Boundary Rd, Box Hill	Layer farm	87,662	3.985	690	1.05	1.0	1.0	1.0	967	1,160	**275**
22 Withers Rd, Kellyville	Broiler farm	130,000	5.909	690	1.05	1.0	1.0	1.0	1,279	1,535	4,900
372 Windsor Rd, Vineyard	Broiler farm	62,370	2.835	690	1.05	1.0	1.0	1.0	759	911	**Within the Project**
466 Windsor Rd, Vineyard	Breeder farm	40,065	1.821	690	1.05	1.0	0.9	1.0	499	599	**Within the Project**
45 Farm Rd, Riverstone	Duck farm	77,220	3.510	690	1.05	1.0	1.0	1.0	883	1,060	2,368
138 Clifton Rd, Marsden Park	Layer farm	52,683	2.395	690	1.05	1.0	1.0	1.0	673	808	4,430
199 Stahls Rd, Oakville	Broiler farm	65,910	2.996	690	1.05	0.9	0.9	1.0	639	767	**352**
169 Clifton Rd, Marsden Park	Layer farm	48,525	2.206	690	1.05	1.0	1.0	1.0	635	762	4,216
205 Maguires Rd, Maraylya	Breeder farm	170,220	7.737	690	1.05	0.9	0.9	1.0	1,254	1,505	3,914
115 Wolseley Rd, Oakville	Broiler farm	67,920	3.087	690	1.05	0.9	1.0	1.0	726	871	1,484

Address	operation	Est. Total Birds	SBCSU	S1	S2	S3	S4	S5	Separation Distance (m)		Distance from the Precinct (m)
									radius	+20% radius	
1 Dunns Rd, Maraylya	Broiler farm	216,300	9.832	690	1.05	0.9	1.0	1.0	1,652	1,982	4,880
1132 Richmond Rd, Marsden Park	Layer farm	169,425	7.701	690	1.05	1.0	1.0	1.0	1,543	1,852	4,560
179-195 Fairey, Rd, South Windsor	Broiler farm	113,775	5.172	690	1.05	1.0	1.0	1.0	1,163	1,396	**1,210**

Table E-12: Recommended separation distances for intensive piggeries (Level 1 assessment method)

Address	Operation	Sheds	SPU	S1	S2	S3	S4	S5	Separation distance (m)		Distance from the Precinct (m)
									radius	20% radius	
21 Gordon Rd	Piggery	3	182	0.87	1.6	0.9	0.9	1	760	912	4,090

Table E-13: Recommended separation distances for other sources (Level 1 assessment method)

Address	Operation	Separation distance (m)		Distance from the Precinct (m)
		radius	20% radius	
1106 Windsor Rd	Meat rendering	1,000	1,200	2,315
61 Wallace Rd	Mushroom farm	1,000	1,200	**Within the Project**
108 Mulgrave Rd, Mulgrave	Mushroom Composting	1,000	1,200	1,318
Riverstone STP	Sewage Treatment Plant	400	480	**128**
Rouse Hill WRP	Water Recycling Plant	400	480	4,471
McGraths Hill STP	Sewage Treatment Plant	400	480	2,100
South Windsor STP	Sewage Treatment Plant	400	480	1,170

Figure E-1: Recommended separation distance for breeder farm at 466 Windsor Rd, Vineyard

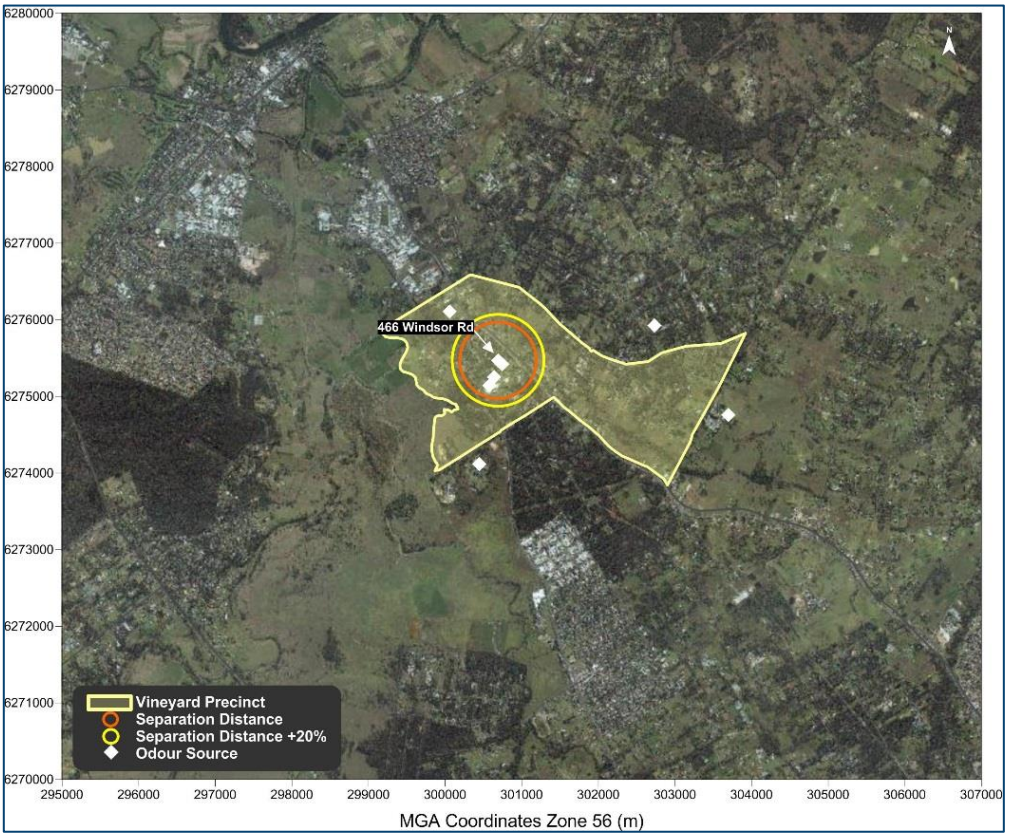

Figure E-2: Recommended separation distance for broiler farm at 372 Windsor Rd, Vineyard

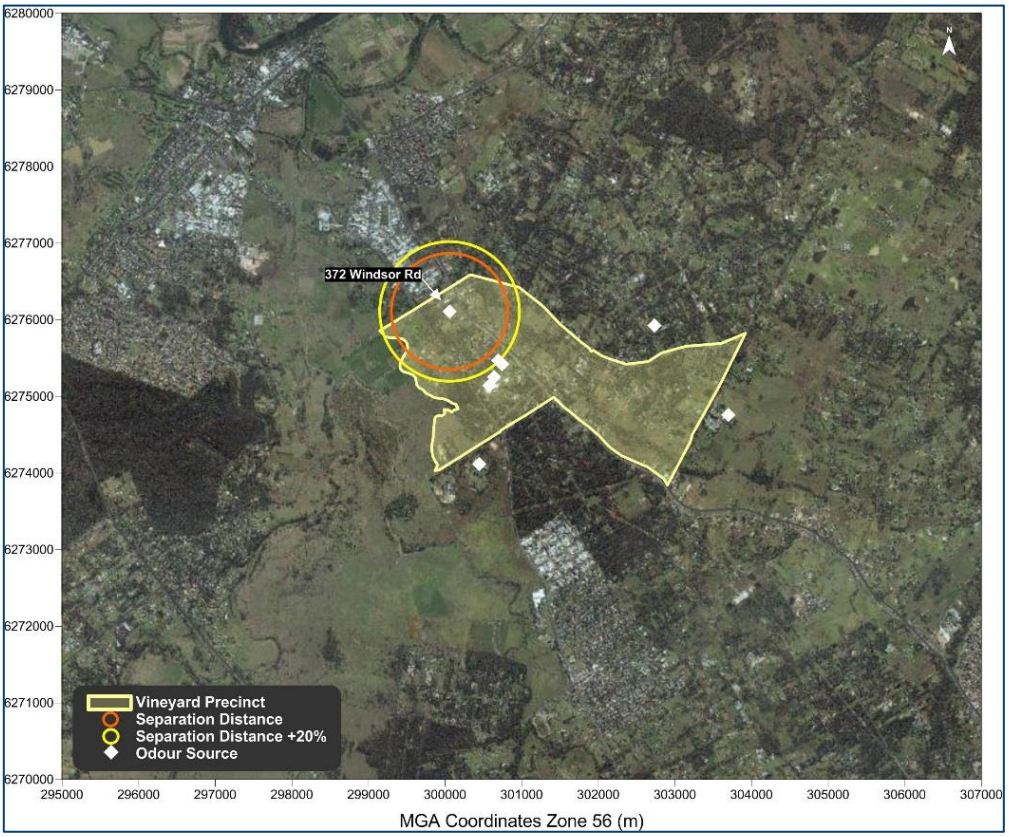

Figure E-3: Recommended separation distance for broiler farm at 199 Stahls Rd, Oakville

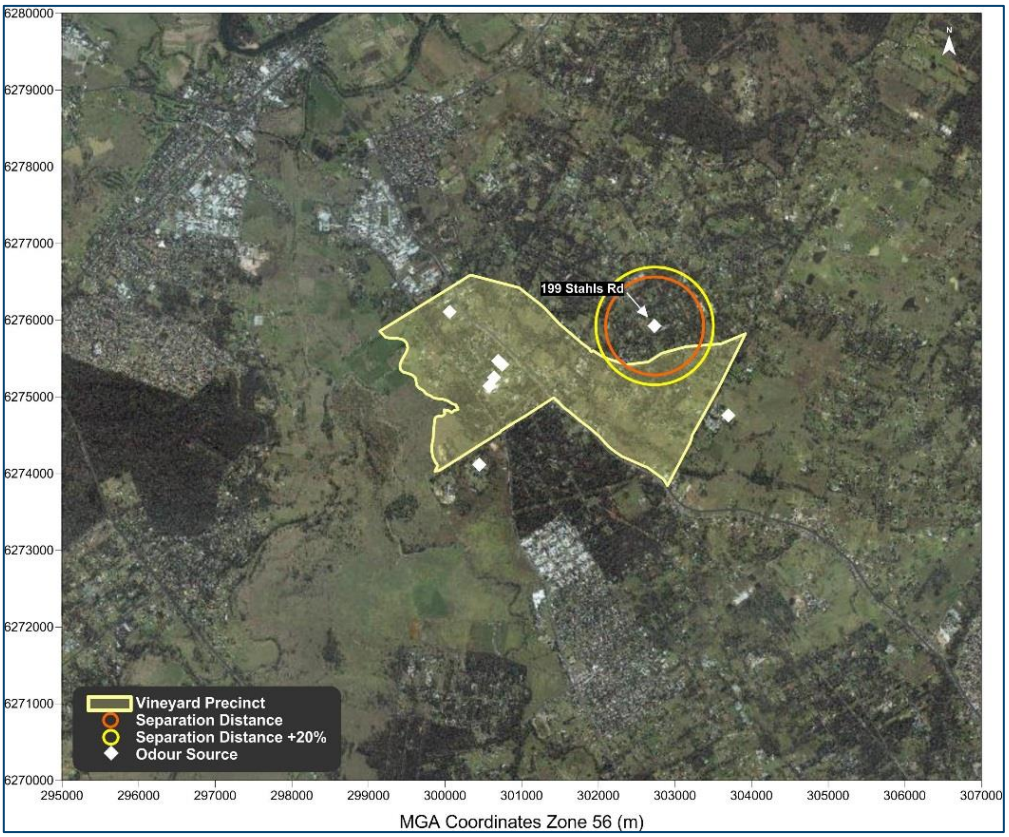

Figure E-4: Recommended separation distance for layer farm at 31-33 Boundary Rd, Box Hill

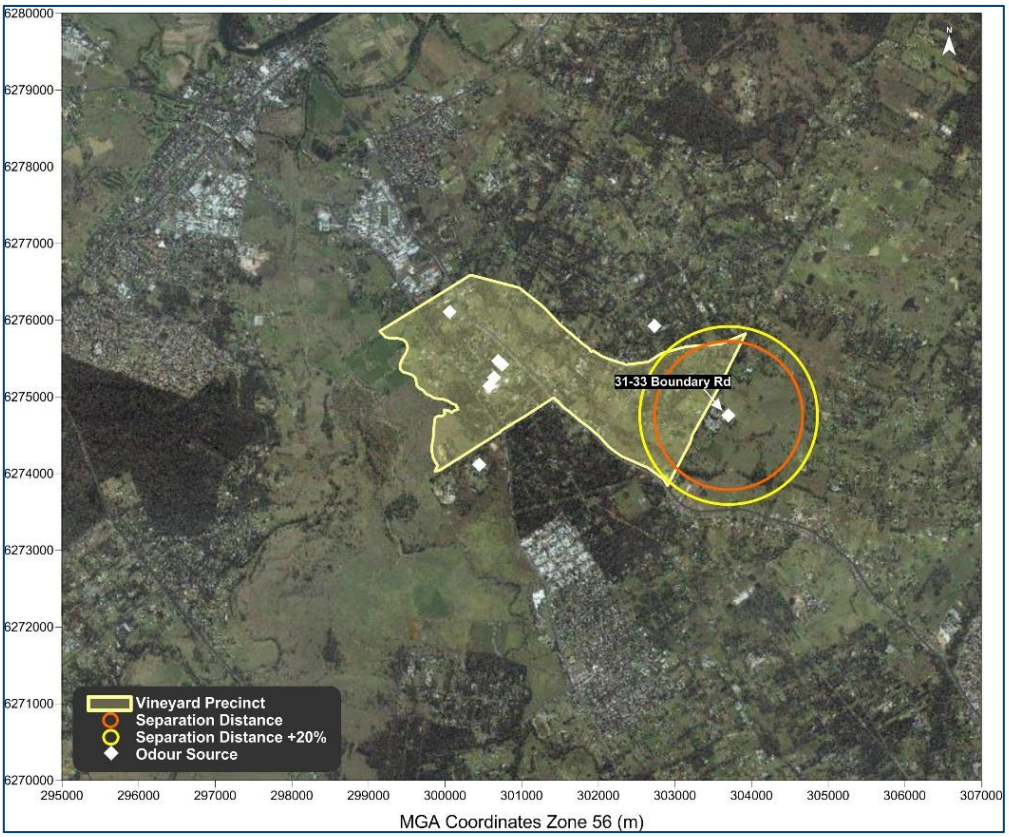

Figure E-5: Recommended separation distance for 472 Windsor Rd, Vineyard

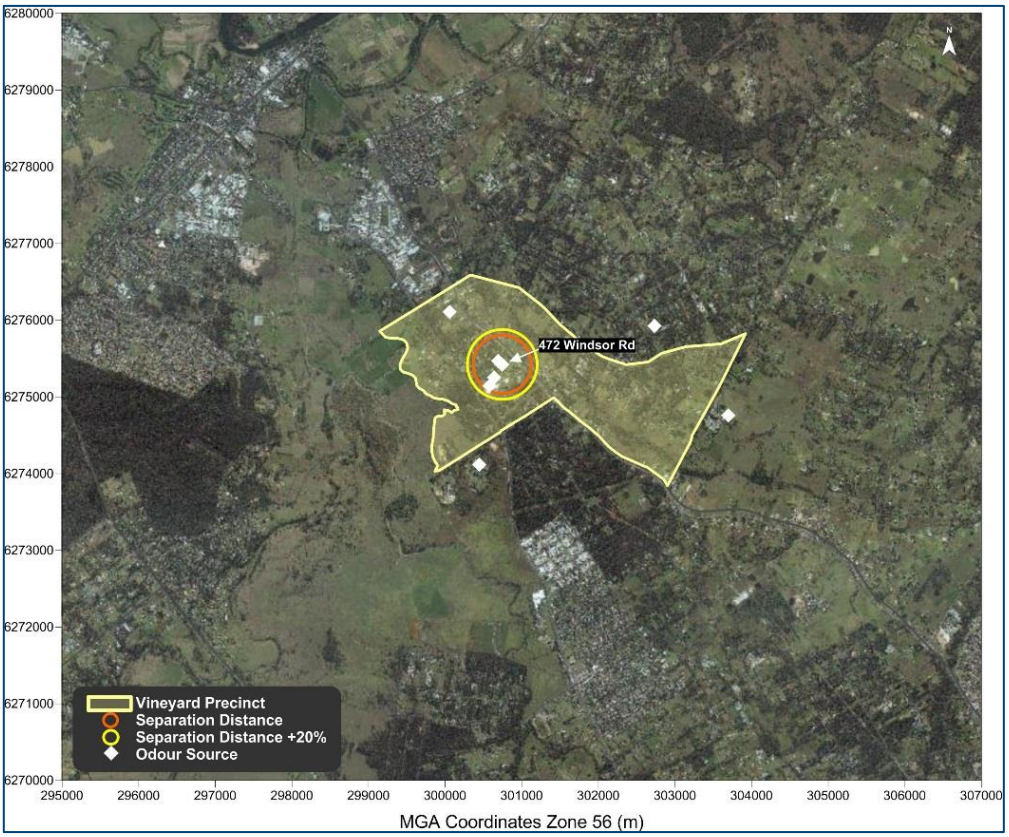

Figure E-6: Recommended separation distance for 53 Wallace Rd, Vineyard

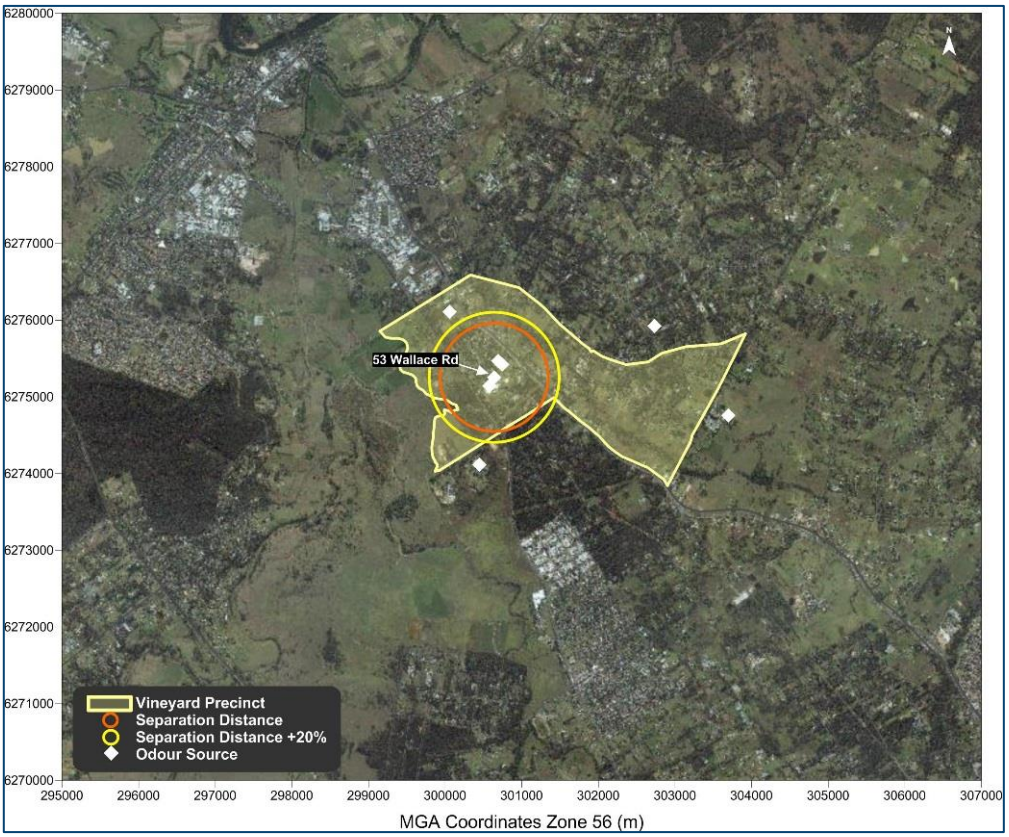

Figure E-7: Recommended separation distance for mushroom production farm at 61 Wallace Rd, Vineyard

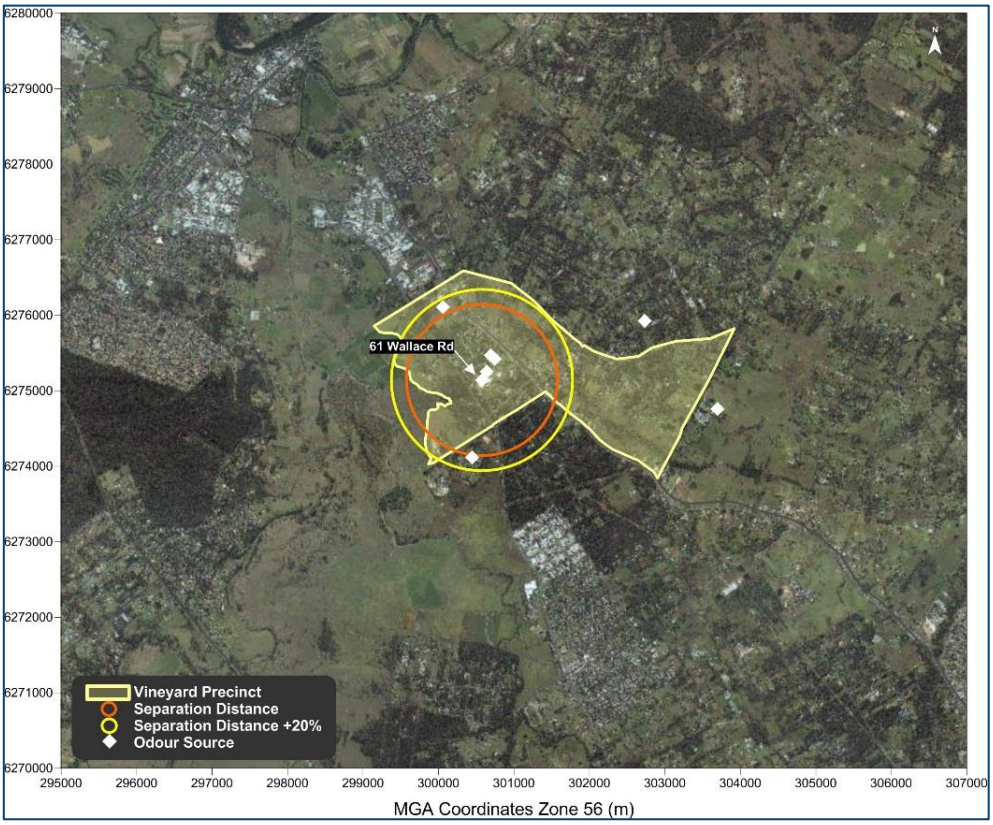

Figure E-8: Recommended separation distance for Riverstone sewage treatment plant

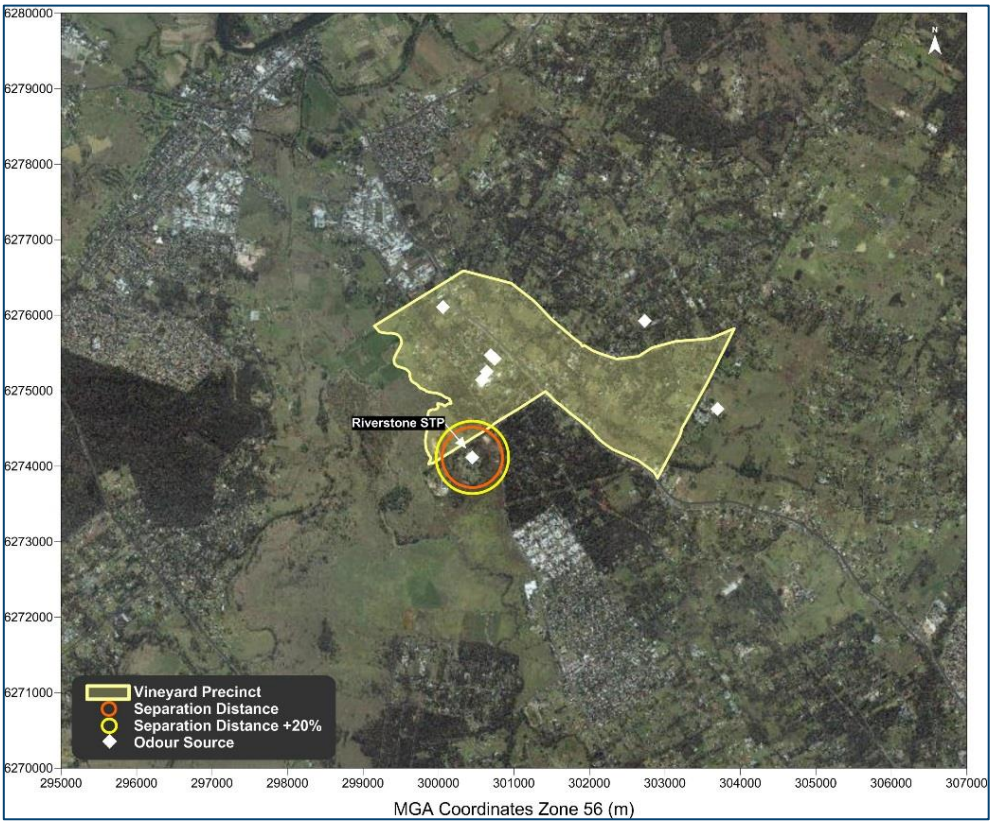

Figure E-9: Cumulative separation distances for all odour sources