Report

EDGE LANDS PLANNING PROPOSAL — ODOUR ASSESSMENT

BILLBERGIA

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GLOSSARY OF TERMS

Term	Definition
Air dispersion modelling	Mathematical simulation of how air quality parameters, including odour, disperse in the atmosphere.
CALPUFF	A multi-layer, multi-species, non-steady state puff dispersion model that can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation and removal.
Emissions	Release of air quality parameters to air.
Gaussian	The assumption that air dispersion model predictions have a Gaussian distribution, meaning that the pollutant distribution has a normal probability distribution
Mixing height	The depth of the atmospheric mixed layer, the height to which the air is mixed.
OU	Odour unit
Percentile	A value on a scale that indicates the percent of a distribution that is equal to it. For example, the 99^{th} percentile indicates that there are one percent of all predicted values that are greater than this value, and 99 percent that are lower
Sensitive receptor	A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors
Stability class	A measure of the ability of the atmosphere to mix or disperse a plume. One method of classifying varying stability classes is the Pasquill-Gifford scheme where A-B-C refer to unstable (well mixed) atmospheric conditions, D refers to neutral and E-F refer to stable (unmixed).
Wind rose	A graphical representation showing the frequency of occurrence of winds by direction and strength

1 INTRODUCTION

Billbergia wish to prepare and lodge a planning proposal with Campbelltown City Council for the Edge Lands Planning Proposal at Bensley Road, Ingleburn (herein referred to as "The development").

The first stage of the planning gateway/rezoning process requires a planning proposal to be prepared and presented/submitted to Campbelltown City Council. For the planning proposal to be successful at this first stage and to proceed to planning gateway, this requires Campbelltown City Council to support the rezoning of the land.

Council officers have raised a concern regarding a poultry farm operation located on the corner of Bensley Road and Mercedes Road at 315-317 Bensley Road, Ingleburn (herein referred to as the "poultry farm"). The sheds of the poultry farm are located approximately 100 m from the southern boundary of the development. Given the relative proximity, the ability of the poultry farm to cause odour impacts at the development is required to be evaluated.

Billbergia has commissioned Pacific Environment to assess potential adverse odour impacts on the proposed rezoning at the development resulting from the poultry farm operations.

An initial Level 1 (screening) Odour Assessment carried out by Pacific Environment deemed that further detailed evaluation (a Level 2 Odour Assessment) was required.

This report documents the process and outcomes of a Level 2 Odour Assessment, completed in accordance with the Approved *Methods for the Modelling and Assessment of Air Pollutants in NSW* developed by the **NSW EPA** (**2005**) (herein referred to as the "Approved Methods").

1.1 Project description

The location of the development is shown in **Figure 1-1**. The land is generally bounded by Mercedes Road, Bensley Road and Oxford Road in Ingleburn and also some existing residences to the north.

Figure 1-1: Location of proposed development site

1.2 Poultry Farm Operations

The chicken sheds operated by the nearby poultry farm are located at 315 Bensley Road, Ingleburn. Information regarding this poultry farm was sourced from minutes of a Campbelltown Council Planning and Environment Committee Meeting (**PEC, 2015**). The property contains two dwellings and four naturally-ventilated poultry sheds behind the dwellings. The chicken sheds have a capacity of 62,500 birds at a stocking rate of 15 birds per square metre of shed space.

The farm receives day-old chicks, where they are kept and fed within sheds for 54 days. After this 54-day period, the birds are removed from the farm for off-site processing. The sheds are then cleaned and made ready for the next batch of chicks. In between batches, the sheds are empty for two weeks. The farm accommodates approximately 5½ batches per year.

1.3 Objectives of the study

The study objectives are to:

- Investigate the potential odour impact on future dwellings associated with the ongoing operation of the poultry farm;
- Perform a Level 2 Odour Assessment in accordance with the Approved Methods;
- Determine the potential odour impacts and make recommendations for controlling impact on the development, as required.

1.4 Scope of work

As discussed above, an initial Level 1 (screening) Odour Assessment was conducted for the development by Pacific Environment. As a result of the outcomes from this assessment (results are typically highly conservative), a Stage 2 Odour Assessment was deemed necessary. The scope of work conducted included provision of a Level 2 Odour Assessment report, guided by the following documentation:

- *Assessment and management of odour from stationary sources in NSW* (**NSW EPA, 2006a**) and its *Technical Notes* (**NSW EPA, 2006b**);
- *Approved Methods* (**NSW EPA, 2005**).

2 ODOUR LEGISLATION AND GUIDELINES

2.1 Legislation

The three most important pieces of legislation for preventing and controlling odour in NSW are:

- Environmental Planning and Assessment Act 1979 (EP&A Act);
- Protection of the Environment Operations Act 1997 (POEO Act); and
- Local Government Act 1993 (LG Act).

The EP&A Act deals with land-use planning, development, assessment and approvals. The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. The operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act).

The POEO Act includes the concept of "offensive odour" (section 129) and states it is an offence for scheduled activities to emit "offensive odour".

The LG Act gives local councils the power to deal with public nuisance, including odour emissions.

2.2 Guidelines

Odour is probably the most widespread and complex local air quality issue in Australia. It often accounts for the majority of complaints received by regulatory authorities and can be a major source of annoyance and stress in affected communities.

In November 2006, the NSW EPA released two guidance documents: *Technical framework for the Assessment and Management of Odour from Stationary Sources in NSW* and its associated *Technical notes for the Assessment and Management of Odour from Stationary Sources in NSW*. These documents require the user to follow the dispersion modelling requirements in the Approved Methods (**NSW EPA, 2005**).

The discussion in this report draws extensively from those documents, which outline the NSW EPA's proposed approach for the assessment of odour emissions, using a three-level system of odour impact assessment of increasing complexity and detail. Depending on the individual characteristics of a new development and its proposed location, a varying degree of investigation into the potential for odour impacts may be required.

- Level 1 is a screening-level technique based on generic parameters for the type of activity and site. It requires minimal data and uses simple equations to provide a broad estimate of the extent of any odour impact. It may be used to identify the potentially affected zone and site suitability for a proposed facility or new neighbouring development or expansion of an existing facility.
- Level 2 is a screening-level dispersion modelling technique, using worst-case input data (rather than site-specific data). It is more rigorous and more realistic than a Level 1 assessment. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities. This approach has been taken in this assessment.
- Level 3 is a refined-level dispersion modelling technique using site-specific input data. This is the most comprehensive and most realistic level of assessment available. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities.

2.2.1 Odour performance criteria

Odour impacts are determined by several factors. The most important factors (the so-called **FIDOL** factors) are:

- The **F**requency of the exposure;
- The **I**ntensity of the odour;
- The **D**uration of the odour episodes;
- The **O**ffensiveness of the odour; and
- The **L**ocation of the source.

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDOL factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable.

The Approved Methods and NSW EPA framework documents include some recommendations for odour criteria. The criteria have been refined by NSW EPA to take account of population density in the area.

The difference between odour criteria is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The criteria assumes that 7 odour units (OU) at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is a risk that sensitive individuals would be exposed. The criterion of 2 OU at the 99th percentile is considered to be acceptable for a large population group with a variety of sensitivities to odours.

Table 2-1 lists the odour criteria, to be exceeded not more than 1% of the time, for different population densities.

Table 2-1: Odour assessment performance criteria

Population of affected community	Odour Units (OU)
Rural single residence (≤ ~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (~2000) and/or schools and hospitals	2

Sources: **NSW EPA, 2005, p.38, NSW EPA, 2006a, p.21**

Based on the number of residential dwellings proposed for the development, the number of people potentially affected by odour is likely to be approximately 500. The appropriate odour criterion for the assessment of odour impacts upon the development is therefore 3 OU. However, for conservatism, an odour impact criterion of 2 OU has been used in this assessment.

2.2.1 Peak-to-mean ratios

It is common practice to use dispersion models to determine compliance with odour criteria. This introduces a complication because conventional dispersion models are only able to directly predict concentrations over an averaging period of 3 minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a 3-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a dispersion model, the NSW EPA commissioned a study by **Katestone Scientific Pty Ltd (1995, 1998)**. This study recommended peak-to-mean ratios for a range of circumstances. The ratio is also dependent on atmospheric stability and the distance from the source. For this assessment peak-to-mean ratios have been applied to each source type accordingly.

The Approved Methods take account of this peaking factor and the criteria shown in **Table 2-1** are based on nose-response time. **Table 2-2** shows the NSW EPA Approved Methods peak-to-mean factors to be used for odour impact assessments. As dispersion modelling for this study used wake-affected point sources, a peak-to-mean factor of 2.3 was applied.

Table 2-2: Factors for estimating peak concentrations on flat terrain

Source Type	Pasquill-Gifford stability class	Near field P/M60*	Far field P/M60
Area	A, B, C, D	2.5	2.3
	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

*Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

3 ODOUR MODEL SET-UP

The dispersion model chosen for this odour impact assessment was *CALPUFF* – a multi-layer, multi species, non-steady-state puff dispersion model[a] that can simulate the effects of time-varying and space-varying meteorological conditions on pollutant transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across released puffs and takes into account the complex arrangement of emissions from point, area, volume and line sources (**Scire *et al*, 2000**).

Site specific inputs to the odour emissions modelling were sourced from a Campbelltown Council report (**PEC, 2015**), as discussed in **Section 1.2**. Consistent with current industry standards, as the chicken sheds are naturally ventilated, the sheds were modelled as large point sources in CALPUFF to preserve plume mass.

A modelling domain of 3 km by 2 km was chosen to incorporate the development and the chicken sheds. Odour sources and emission rates are described in more detail in **Section 3.4**. Model predictions were made across the domain at gridded receptors at a spacing of 100 m x 100 m.

The model requires meteorological data (e.g. wind speed, wind direction, atmospheric stability and mixing height) together with odour emission rates from the chicken shed sources.

3.1 Meteorology

Odour impacts in the proposed development area will be influenced by local meteorology. Meteorological conditions, such as wind speed, wind direction and atmospheric turbulence affect how often receptors are likely to be downwind of an odour source as well as how well the odour disperses in the atmosphere.

Ground-level meteorological data for the site was obtained from Holsworthy Control Range (**BOM, 2015**), which is located approximately 6 km northeast of the development. The calendar year 2013 was chosen as the station was moved in 2014 and the meteorological data for that year is incomplete.

The annual wind-rose for 2013 is shown in **Figure 3-1**. Wind roses show the frequency of occurrence of winds by direction and strength.

In 2013, the winds were predominantly west-southwesterly, and there was less than 1% frequency of calm wind conditions (defined as <0.5 m/s).

[a] Gaussian plume models are considered steady-state because the plume equation is independent of time, that is, dispersion from the source to receptor is instantaneous for each hour of meteorological data. CALPUFF however, 'remembers' the plume from the previous hour taking into account residual concentrations at each grid point from the hours before and is therefore non-steady-state.

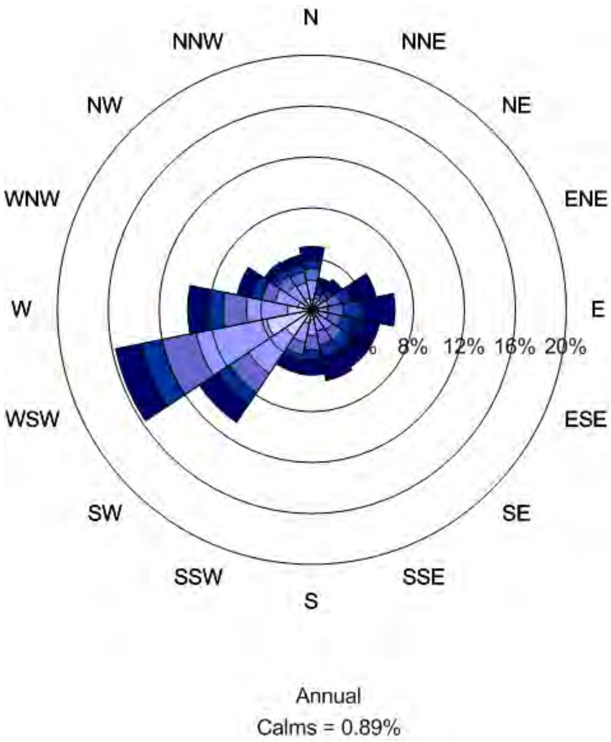

Figure 3-1 Annual wind rose for 2013 at the Holsworthy Control Range

3.2 Atmospheric stability

An important aspect of pollutant dispersion is the level of turbulence in the lowest 1 km or so of the atmosphere, known as the planetary boundary layer (PBL). Turbulence controls how effectively a plume is diffused into the surrounding air and hence diluted. It acts by increasing the cross-sectional area of the plume due to random motions. With stronger turbulence, the rate of plume diffusion increases. Weak turbulence limits diffusion and contributes to high plume concentrations downwind of a source.

Turbulence in the boundary layer is influenced by the vertical temperature gradient, which is one of several indicators of stability. Plume models use indicators of atmospheric stability in conjunction with other meteorological data to estimate the dispersion conditions in the atmosphere.

Hourly cloud content data from Camden Airport was used to represent upper-level meteorological conditions (**BOM, 2015**). This station is located approximately 17 km southwest of The Development.

3.3 Odour sources and receptors

The odour sources are based on emission inputs documented in a Campbelltown Council Report and are shown in **Figure 3-2**. The locations of the four chicken sheds at 315 Bensley Road were identified from satellite imagery and chosen to represent odour sources in the dispersion model.

Gridded receptors were chosen to assess predicted odour impacts across the entire modelling domain at a resolution of 0.1 x 0.1 km.

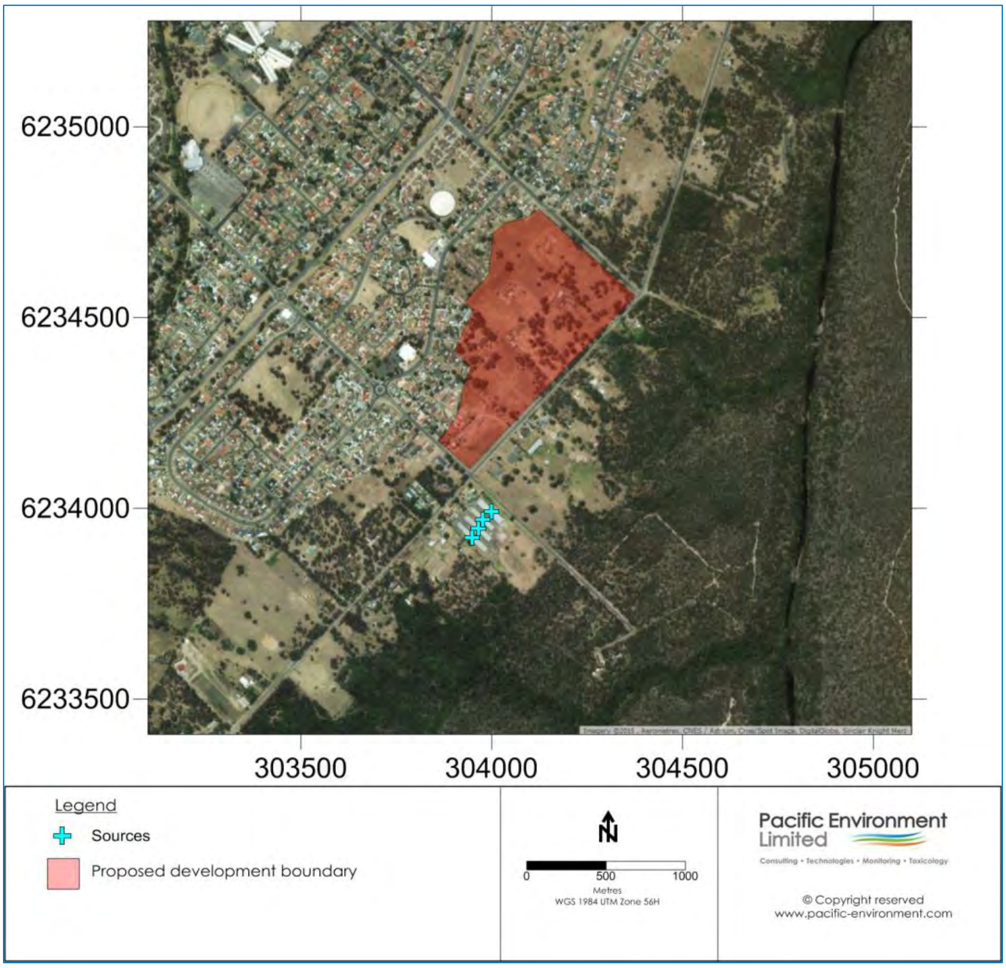

Figure 3-2: Odour sources for The Development

3.4 Odour emission rates

Odour emission rates (OERs) for this assessment have been estimated using a modelling approach based on data from a variety of meat chicken farms in Queensland and New South Wales, as well as theoretical considerations.

The approach generates hourly varying emission rates from each shed based on the following factors:

- The number of birds, which varies later in the batch as harvesting takes place.
- The stocking density of birds, which is a function of bird numbers, bird age and shed size.
- Ventilation rate, which depends on bird age and ambient temperature.
- Design and management practices, particularly those aimed at controlling litter moisture.

The dataset is based on data from existing tunnel ventilated sheds and chicken batches at approximately five weeks of age or more.

The predicted OER from a shed at any given stage of the growth cycle is given by **Equation 1**:

$$OER = 0.025\,K\,A\,D\,V^{0.5} \quad (1)$$

where:

OER = odour emission rate (ou.m³/s);

A = total shed floor area (m²);

D = average bird density (in kg/m²);

V = ventilation rate (m³/s); and

K = scaling factor between 1 and 5 where 1 represents an extremely well designed and managed shed, i.e., state of the art (see below for more information).

Bird density (D) is related to the age of the birds and the stocking density (i.e. the number of birds placed per unit area). It is common practice within the meat chicken industry to vary the stocking density with the time of year and market demands. Lower ambient temperatures during the winter months allow for higher bird densities. For this assessment, a maximum stocking density of approximately 15 birds/m² was used for the sheds based on site-specific data given in **PEC** (**2015**). With a known stocking density, a value of the mass per unit area can be estimated.

The ventilation rate (V) used at any given time is a function of the age of the birds, wind speed and the ambient temperature and humidity. Given the lack of available data on naturally ventilated sheds it has been assumed that the ventilation requirements for a tunnel ventilated shed may be used to approximate those of naturally ventilated sheds. Such an approach represents common industry practice for the evaluation of naturally ventilated sheds.

Parameters used for the chicken sheds in the emissions model are shown in **Table 2-1**.

Table 3-1 Parameters used within the chicken shed odour emissions model

Parameter	Value	Units
Assumed maximum ventilation	10	m³/hr/bird
Birds per shed	15625	birds
Shed length	65	m
Shed width	16	m
Shed Area	1040	m²
Density	15	Birds/m²
Ventilation Rate	156250	m³/hr
Maximum vertical velocity stack	0.22	m/s
Assumed number of fans	10	fans
K Factor	4	n/a
Total length	54	days
Days cleanout	14	days
Thinning 1 (day 32)	90	% chickens remaining
Thinning 2 (day 36)	52	
Thinning 3 (day 45)	37	

Hourly odour emission rates for the chicken sheds are shown in **Figure 3-3**, which were calculated using the inputs in **Table 3-1** and the meteorological data for the modelling period.

OERs gradually increase over the 54 day growth cycle and peak towards the end of the cycle. OERs then decrease to zero once the chickens are removed and the sheds are cleaned for two weeks. OERs were predicted to be lower for the cycle starting around day 130 as this represents winter in which temperatures were lower and less ventilation is required.

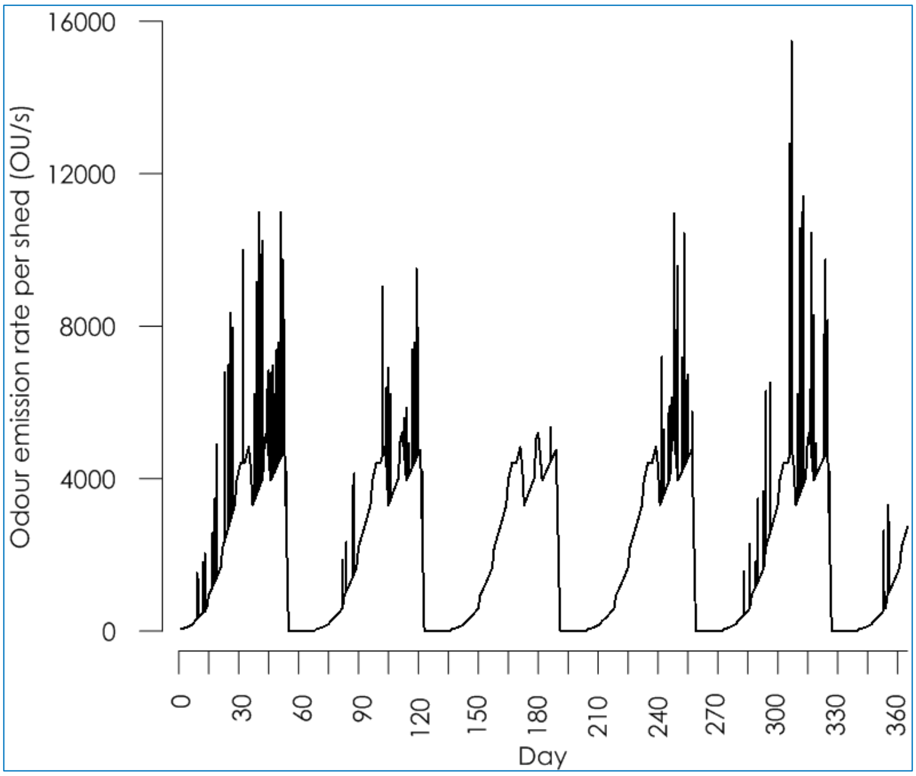

Figure 3-3 Hourly odour emission rates for the chicken sheds

4 ASSESSMENT OF IMPACTS

Figure 4-1 shows the 99th percentile 1-second peak odour concentrations resulting from the anticipated operation of the poultry farm.

Worst-case odour concentrations were predicted to be less than 2 OU across the entire of the development, and less than 1 OU across the majority of the site, except for the southern corner. Thus predicted odour concentrations at the development are less than the adopted odour assessment performance criterion of 2 OU.

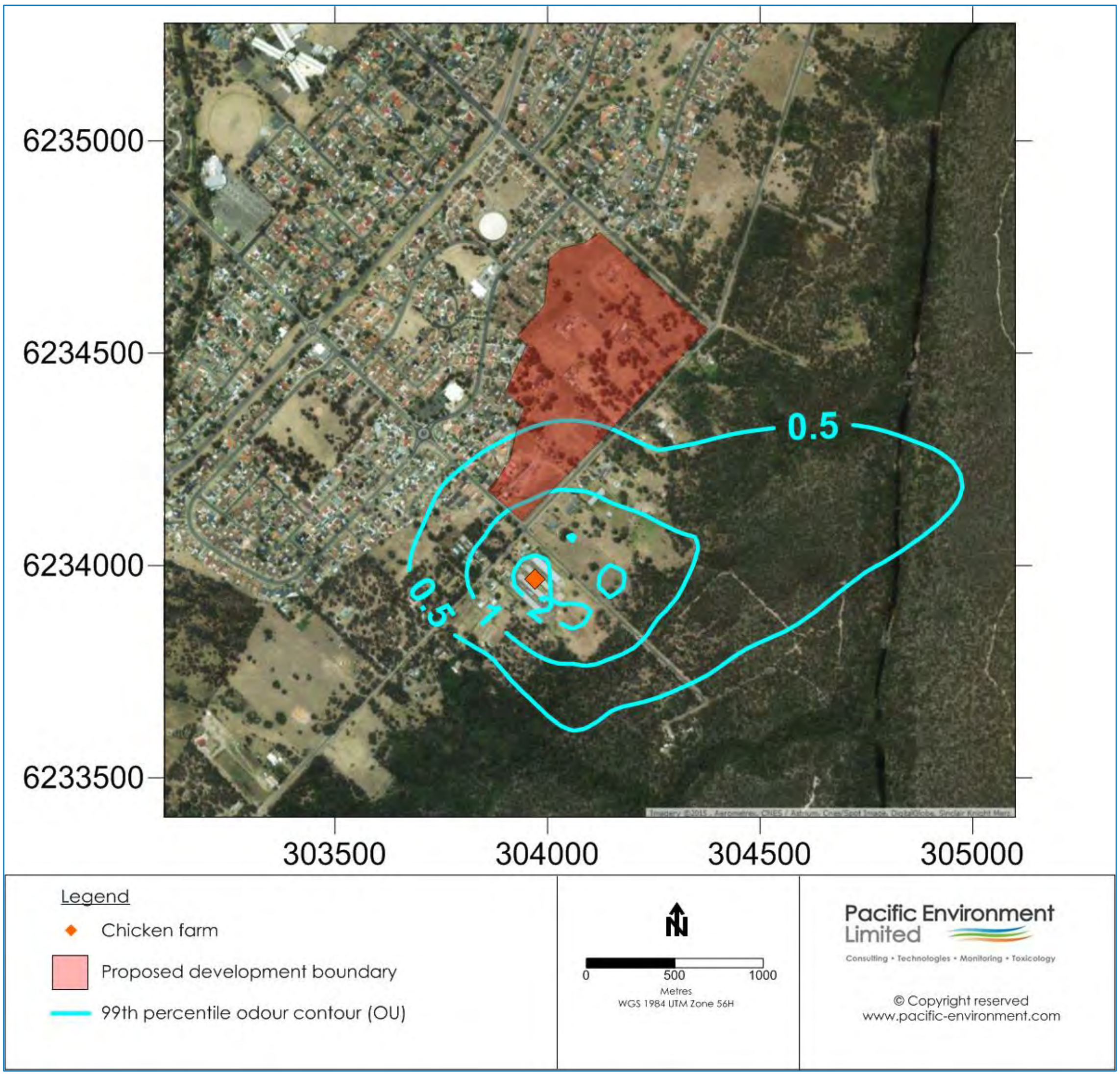

Figure 4-1: 99th percentile 1-second average odour concentration contours (OU) associated with operation of the nearby poultry farm

5 CONCLUSIONS

An investigation has been conducted to identify and develop an understanding of potential odour impacts that may affect the development at the Edge Lands Planning Proposal in Ingleburn, NSW.

A Level 2 Odour Assessment has been undertaken, consistent with the requirements outlined in the NSW EPA Approved Methods (2005), *Technical framework: assessment and management of odour from stationary sources in NSW* (**NSW EPA, 2006a**) and the associated Technical Notes (**NSW EPA, 2006b**).

The results of the odour assessment indicate that, under the conservative assumptions adopted, the predicted odour concentrations are anticipated to be below the adopted odour performance goal for the assessment of 2 OU.

Notwithstanding the above conclusions, recommendations to limit odour impacts are given in **Section 6**.

6 RECOMMENDATIONS

6.1 Potential development control provisions

Whilst the odour assessment predicts no adverse odour impacts, the following are considered good practice development controls to manage the potential for odour impacts on the proposed development:

- Plan a transition of land use zones that locates sensitive uses (i.e. residential dwellings) in areas that are not immediately adjacent to odour generating activities;
- Consider removing separation buffers and removing development restrictions if an odour source ceases operation and has no prospect of restarting;
- Plan compatible land uses in the areas closest to existing odour sources, e.g. car parks or recreational areas.
- Implement continuous dense landscaping on the boundary of the subject site to assist in screening the site from odorous activities.
- Orientate buildings to provide adequate air flow, i.e. no dead end courtyards, long narrow spaces, or areas where air may stagnate. Design buildings to encourage air flow;
- Consider ventilation and air conditioning and design buildings so living and work areas of buildings do not directly face the poultry farm operation.

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