Air Quality and Odour Study

Stage 2 Assessment for the Western Sydney Aerotropolis

Addressee(s):	Aurecon Australasia Pty Ltd on behalf of the Western Sydney Planning Partnership
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EXECUTIVE SUMMARY

Northstar Air Quality Pty Ltd has been commissioned by Aurecon Australasia Pty Ltd on behalf of the Western Sydney Planning Partnership to perform a Stage 2 constraints and land capability analysis, with a focus on air quality and odour, to support precinct planning for the development of the Western Sydney Aerotropolis.

The Aerotropolis relates to land identified in the Western Sydney Aerotropolis Plan which comprises 11 200 hectares surrounding the Western Sydney International (Nancy Bird Walton) Airport site.

The Western Sydney Aerotropolis is part of the wider Metropolitan Cluster which includes Greater Penrith, Liverpool and Campbelltown-Macarthur, and will play an important role in improving connectivity between these centres. The Stage 1 Land Use and Infrastructure Implementation Plan identified the Aerotropolis Core, Northern Gateway and Wianamatta-South Creek for initial precinct planning.

As planning for the Western Sydney Aerotropolis has progressed, the Western Sydney Aerotropolis Plan has identified that, in addition to the above precincts, the Agribusiness, Badgerys Creek and Mamre Road Precincts are suitable to be brought forward and be planned as initial precincts. Planning for Mamre Road is being led by the Department of Planning, Industry & Environment and therefore does not form part of the detailed planning of initial precincts to be undertaken as a part of this project.

For the purpose of precinct planning, the initial precincts have been sorted into three groupings:

- Northern Gateway;
- Agribusiness; and
- Aerotropolis Core, Badgerys Creek and adjoining areas of Wianamatta-South Creek.

Note: This report does not address air quality impacts or risks associated with the Western Sydney Airport. Aurecon Australasia Pty Ltd has been advised by the Department of Planning, Industry and Environment that these risks are being established separately.

Scope

The Air Quality and Odour Study is delivered in two stages, with the requirement and scope of Stage 2 (this report) being informed by the findings of Stage 1. The purpose of this Stage 2 Air Quality and Odour Study report is to provide a more detailed assessment of a number of high-risk outcomes identified in the Stage 1 Baseline Study report. By design, it therefore does not assess all identified risks but provides a targeted study to assess the higher-risk outcomes in more detail.

The Stage 1 Air Quality and Odour Study – baseline study identified that a number of intensive agricultural facilities (poultry farms) and a number of waste / resource management facilities represented the highest risks, and these facilities have been subject to more detailed assessment in this Stage 2 Air Quality and Odour Study report.

Methodology

The Stage 2 study uses a risk assessment methodology based upon ISO 31000, which provides principles, a framework, and a process for managing risk.

In this study, 'risk' has been evaluated as the product of scales applied to 'sensitivity' and to 'magnitude'. For air quality and odour studies, that approach is appropriate given the potential significance of impacts of air pollutants and odour may vary depending on the nature and 'sensitivity' of the receiving environment.

'Sensitivity' has been defined on a simplified 4-point scale using land use data derived from the Western Sydney Aerotropolis Plan.

Note: This Stage 2 Air Quality and Odour Study is based upon the Precinct boundaries provided in the Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020).

The potential 'magnitude' of emissions of air pollutants and odour has been defined using an atmospheric dispersion modelling assessment to predict the level of air quality and/or odour impacts from the identified potential sources and evaluated on a simplified 4-point scale to assess magnitude.

The resultant values for 'sensitivity' and 'magnitude' have been mapped within a Geographical Information System and overlaid to generate a product evaluation of 'risk'. The maps for 'sensitivity', 'magnitude' and 'risk' are presented in the report for the study area.

Key Findings

Overall, the assessment identifies a smaller area of land as high risk than was assessed in the Stage 1 study report, which is to be expected. The methodology adopted in the Stage 1 study report utilised higher-level screening assessment procedures from relevant NSW guidance, which are designed to be conservative. The Stage 2 risk assessment identifies a number of areas that are considered to be 'high risk', although those areas are less widespread than assessed in the Stage 1 study report.

The Stage 2 study report presents a hierarchical control process for managing the identified risks based upon a hierarchy from '*elimination*' (most effective) '*substitution*', '*engineered controls*', *administrative controls*' to '*protection*' (least effective). The Stage 2 study report provides a range of practical and specific examples of how these may relate to the sources assessed within the Stage 2 Air Quality and Odour Study.

Contents

Tables

Figures

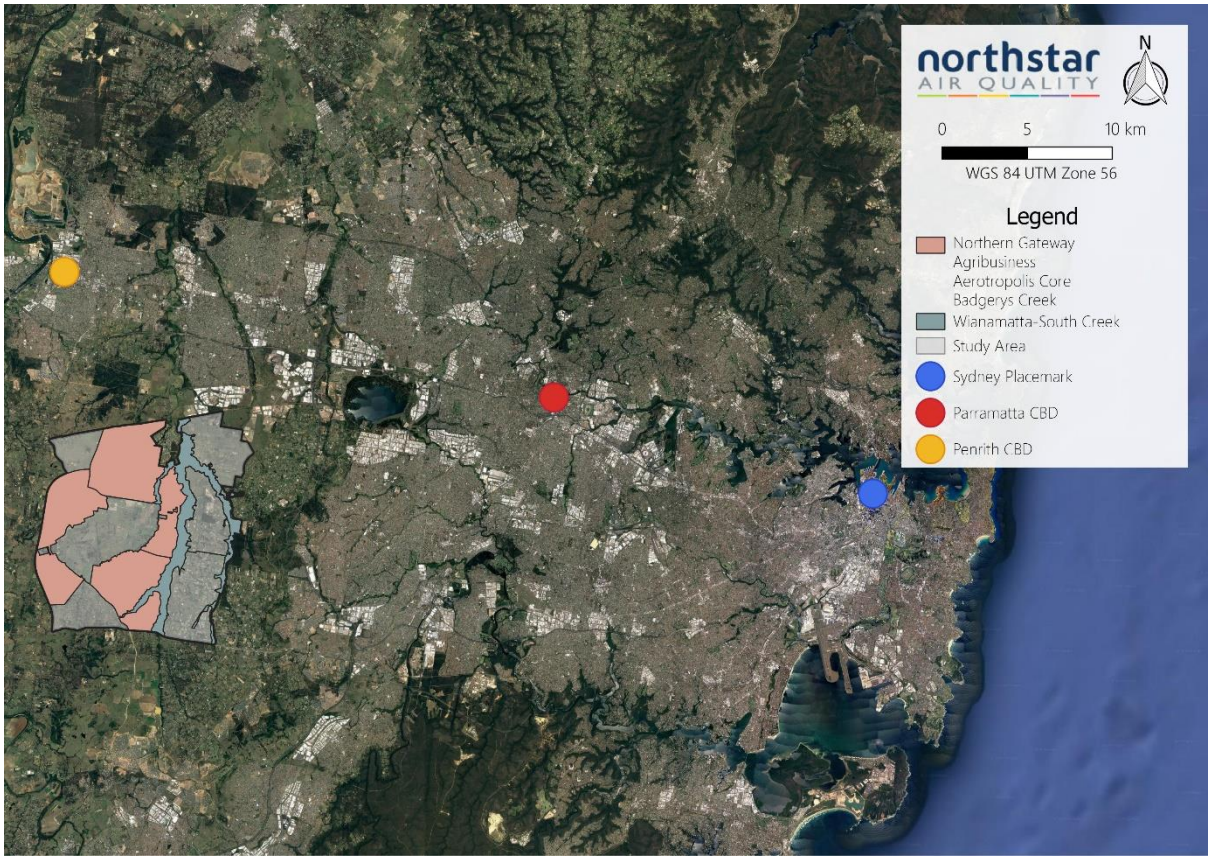
1. INTRODUCTION

Northstar Air Quality Pty Ltd (Northstar) has been commissioned by Aurecon Australasia Pty Ltd on behalf of the Western Sydney Planning Partnership to perform a constraints and land capability analysis, with a focus on air quality and odour, to support precinct planning for the development of the Western Sydney Aerotropolis (Aerotropolis).

1.1 Study Area

The Aerotropolis (study area) relates to land identified in the Western Sydney Aerotropolis Plan (WSAP) which comprises 11 200 hectares (ha) surrounding the Western Sydney International (Nancy-Bird Walton) Airport (Airport) (refer to **Figure 1**).

Figure 1 The Aerotropolis study area location



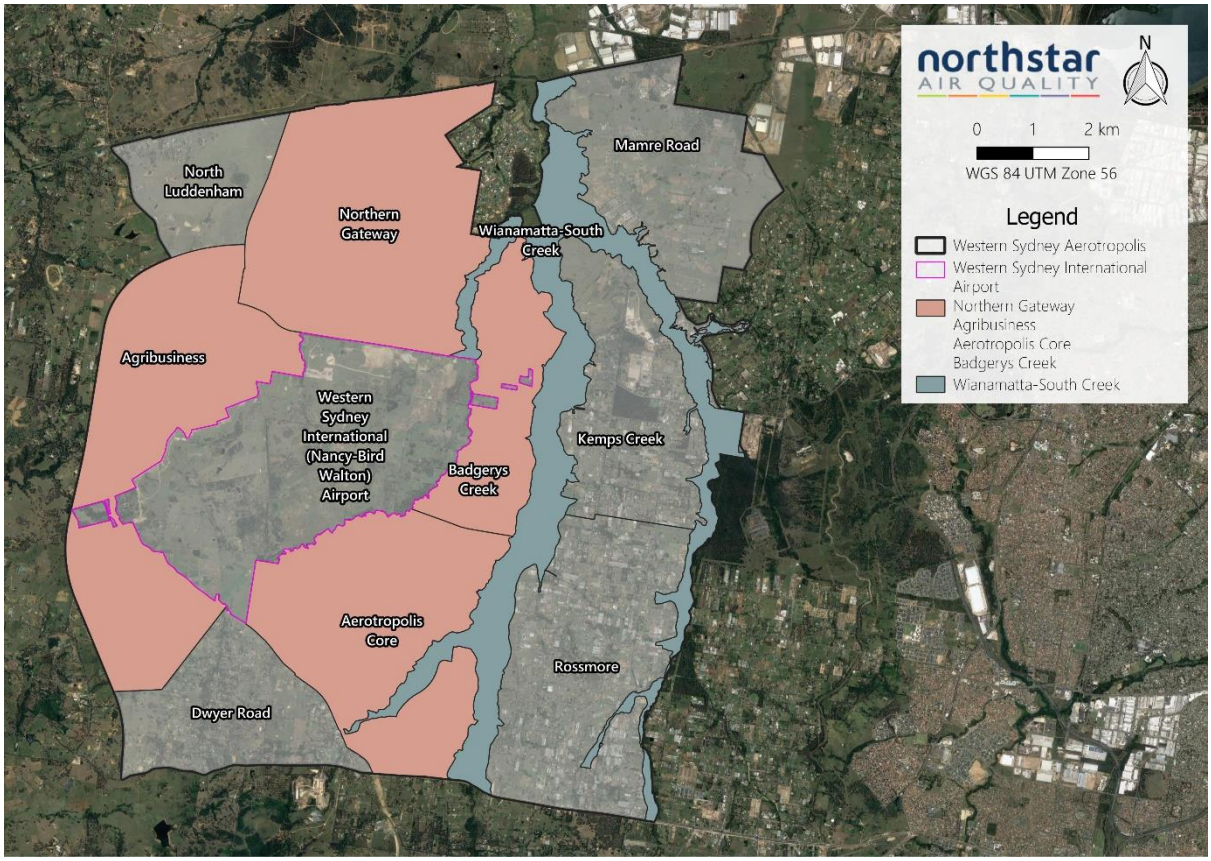
Source: Northstar Air Quality Pty Ltd

The Aerotropolis is part of the wider Metropolitan Cluster which includes Greater Penrith, Liverpool and Campbelltown-Macarthur, providing connectivity between the Aerotropolis and these centres. The Stage 1 Land Use and Infrastructure Implementation Plan (LUIIP) identified the Aerotropolis Core, Northern Gateway and Wianamatta-South Creek for initial precinct planning.

As planning for the Aerotropolis progressed, the WSAP has identified that, in addition to the above precincts, the Agribusiness, Badgerys Creek, and Mamre Road Precincts are suitable to be brought forward and be planned as initial precincts. Planning for Mamre Road is being led by the NSW Department of Planning, Infrastructure & Environment (DPIE) and therefore does not form part of the detailed planning of initial precincts to be undertaken as a part of this project.

A map showing the locations of these precincts and others within the study area is presented in **Figure 2**.

Figure 2 Precinct groups



Source: Northstar Air Quality Pty Ltd

For the purpose of detailed precinct planning, the initial precincts have been sorted into three groupings:

- Northern Gateway;
- Agribusiness; and,
- Aerotropolis Core, Badgerys Creek and adjoining areas of Wianamatta-South Creek (assessed as a single contiguous area in this study).

1.2 Scope of Air Quality and Odour Study

The Air Quality and Odour Study is delivered in two stages, with the requirement and scope of the second stage being informed by the findings of the first. A description of the scope of the Stage 1 and Stage 2 air quality and odour study is provided in the following sections.

1.2.1 Stage 1 Specification

The requirements of the Stage 1 air quality and odour study (the baseline assessment) are as follows. Please note that the Stage 1 Air Quality and Odour Study – Baseline Assessment (Northstar Air Quality, 2020) is provided as a separate report. This report is the Stage 2 Air Quality and Odour Study.

- Identify source(s) of air pollutants and odour on or in the vicinity of the subject land that may impact future development, including from any ongoing agricultural activities. These agricultural activities could be within or outside the Aerotropolis depending on how far the impacts extend;
- Develop an understanding of the nature of any air pollutant and odour producing activities identified;
- Consider the implications of any existing air pollutants and odours that may inform the staging of development;
- Complete a Level 1 Odour Impact Assessment as outlined in the former NSW Department of Environment and Conservation's Technical Framework: Assessment and management of odour from stationary sources in NSW (2006) and its Technical Notes. This assessment should identify the separation distance which would nominally be required between the odour producing activities and urban development (refer to the Technical Notes in the Policy). Separation distances associated with other activities with the potential for air emissions other than odour have also been considered;
- Recommend management strategies to maximise development opportunities both under the existing air pollutant and odour situation and into the future;
- Make recommendations for controlling impacts from air pollutant and odour generating activities. This includes adequate buffers or transition zones between areas identified for urban development (as identified in the WSAP) and sources of air pollutant and odour impacts;
- Prepare a report that outlines the findings of the assessment, including maps identifying areas where urban development (as generally identified in the WSAP) would encroach into the 'separation distance' required from any air pollutant and odour producing activities, and make recommendations for any Level 2 and/or 3 Assessments if required; and,
- Make specific recommendations to mitigate air pollutants and odour from development on areas identified for urban development or open space in the WSAP. The purpose of these recommendations to inform any acceptable solutions to be included in the Phase 2 Western Sydney Aerotropolis Development Control Plan (DCP) and/or inclusion in State Environmental Planning Policy (SEPP) maps.

1.2.2 Stage 1 Recommendations

As reported in Stage 1 of the Air Quality and Odour Study – Baseline Assessment, the following recommendations were identified.

> ***Recommendation 1***
>
> *It is recommended that the air quality and odour study should be updated as the precinct plans are developed and refined to provide revised evaluations of sensitivity and subsequently risk. With reference to Figure 39 (presented in Section 4.3.5) it may be identified that significant portions of land are assessed as being 'high risk'. The drivers for this identified risk are the aggregated sensitivity assumptions, and the substantial separation distances derived from agricultural land uses. These are discussed further below.*
>
> ***Recommendation 2***
>
> *It is recommended that the air quality and odour baseline study should be updated as the land use in the precinct plans are developed.*
>
> ***Recommendation 3***
>
> *It is recommended that the magnitude of impacts associated with the identified agricultural activities (poultry farming) are refined. The Level 1 assessment methodology is intended to provide a high-level screening assessment, and the study requires further refinement of that methodology as a Level 2/3 odour assessment. Of note, the magnitude of impacts from poultry farms numbers 13, 16, 17, 48, 49, 50, 57, 58 and 60 are recommended to be refined in Stage 2 studies.*
>
> ***Recommendation 4***
>
> *It is recommended that the magnitude of impacts associated with a number of identified waste management facilities should be refined in Stage 2, notably SUEZ Kemps Creek Advanced Resource Recovery Technology Facility, SUEZ Kemps Creek Landfill and Australian Native Landscapes.*

This Stage 2 Air Quality and Odour Study addresses the recommendations presented in Recommendation 3 and 4, specifically to reassess the magnitude of impacts associated with:

- Poultry farms numbers 13, 16, 17, 48, 49, 50, 57, 58 and 60;
- SUEZ Kemps Creek Advanced Resource Recovery Technology Facility;
- SUEZ Kemps Creek Landfill; and
- Australian Native Landscapes.

1.2.3 Stage 2 Specification

Based upon the findings and recommendations from Stage 1 in the Air Quality and Odour Study – Baseline Assessment, the consultant is to undertake a Level 2 and/or Level 3 Odour Assessment as outlined in the NSW Department of Environment and Conservation's *Technical Framework: Assessment and management of odour from stationary sources* (2006) and its *Technical Notes.*

The Stage 2 Air Quality and Odour Study report will:

- incorporate the results of the modelling and sets out any limitations to the data;
- highlights specific strategies for managing air pollutant odour impacts (including any appropriate management or structural changes to the odour generating operation);
- predicts air pollutant and odour impacts on the future development of the site in light of the management recommendations; and,
- make specific recommendations for controlling air pollutant and odour impact from 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.
- For clarity, this report specifically considers the requirements of **Stage 2**, comprising the requirements as outlined above).
- The methodology used for the Stage 2 Air Quality and Odour Study report will follow a parallel methodology as adopted for the Air Quality and Odour Study – Baseline Assessment report, which used a risk assessment methodology in accordance with the general requirements of ISO 31000 (International Organization for Standardisation (ISO) 31000:2018 'Risk management – Guidelines').
- The objective of the Stage 2 Air Quality and Odour Study report is to identify potential conflicting land uses that may influence the future development control plan and / or indicative layout plan, and not to perform an air quality impact assessment for the respective land uses.

Note: For clarity, the Stage 2 Air Quality and Odour Study report (this report) is required to focus on the higher-risk outcomes of the Stage 1 Baseline Study. The scope is therefore not to address all identified potential risks but escalates the higher-risk outcomes to a higher degree of scrutiny.

This report does not address air quality impacts or risks associated with the Western Sydney Airport. Aurecon has been advised by the Department of Planning, Industry and Environment that these are being established separately.

1.3 Legislation and Regulation

The purpose of this study is to identify existing land uses and their proximity to existing (and proposed) activities that have the potential to give rise to emissions to air. Through this process, opportunities and constraints within the WSAP can be identified.

An objective of the WSAP is to ensure a sustainable, low carbon Aerotropolis that embeds the circular economy, and therefore legislation relevant to this study includes the *Protection of the Environment Operations Act* (1997) (POEO Act) and the Protection of the Environment Operations (Clean Air) Regulation (2010) (under the *POEO Act*).

1.4 Data Sources

The study is reliant on the underlying sources of data which have been used to determine the potential constraints associated with existing and proposed land uses, when considering surrounding sources of air pollution and odour. The sources of data adopted in the performance of this study are outlined in **Table 1**.

Table 1 Data sources used in the Stage 2 study

Data	Data source
Precinct boundaries	• GIS files provided by email to Northstar via Aurecon on 30 September 2020 • NSW Government, Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020)
Land sensitivity	• Future preferred scenario provided by email in GIS format to Northstar via Aurecon on 30 September 2020
Magnitude	Based on data obtained from: • DPIE NSW Planning Portal – Major Projects[1] • NSW RMS - Infrastructure Projects[2] • Australian Government DAWE National Pollutant Inventory[3]; • NSW Environment Protection Licence register[4]; • Desk-top surveying, including use of Google Earth[5] and Six Maps[6]; • Northstar Air Quality site surveying (see the Stage 1 report and Appendix A).
Risk	• A product of **Sensitivity** and **Magnitude** as described in **Section 3.3**

Note: This Stage 2 Air Quality and Odour Study is based upon the Precinct boundaries provided in the Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020).

[1] https://www.planningportal.nsw.gov.au/major-projects

[2] https://www.rms.nsw.gov.au/projects/index.html

[3] www.npi.gov.au

[4] https://apps.epa.nsw.gov.au/prpoeoapp/

[5] https://www.google.com/earth/

[6] https://maps.six.nsw.gov.au/

2. EXISTING CONDITIONS

The information below provides a general description of the existing (background) conditions across the Aerotropolis study area. This information is not used in any significant way in the risk assessment process and is therefore provided for information purposes only.

2.1 Background Air Quality

The prevailing background (sometimes called 'baseline') air quality condition in the study area has been determined through review of air quality data collected by the DPIE at the Bringelly air quality monitoring station (AQMS). The AQMS is located on Badgerys Creek Road, within the study area, and provides a good approximation of air quality conditions across the study site. The air quality data collected at this site can be considered to be representative of conditions away from significant sources of emissions.

Data for particulate matter (PM_{10} and $PM_{2.5}$) are presented in **Table 2**, **Figure 3** and **Figure 4** respectively for the period 2010 to 2020 inclusive.

Concentrations of particulate matter (as TSP, PM_{10} and $PM_{2.5}$) have been measured to be in exceedance of the relevant 24-hour criteria at the Bringelly AQMS in the period 2010 to 2020, with some exceedances being significant. Exceedances are generally a result of regional dust storms, or bushfires, and the impact of the 2019 bushfire emergency is clearly seen in the monitoring record. Concentrations of particulate matter measured at the Bringelly AQMS are not atypical of the local area or wider Sydney region.

Table 2 Background air quality statistics, Bringelly AQMS 2010 - 2020

Pollutant	TSP (µg·m^{-3})	PM_{10} (µg·m^{-3})	$PM_{2.5}$ (µg·m^{-3})
Averaging Period	Annual	24-Hour	24-Hour
Data Points (number)	3 962	3 962	1 589
Mean	36.7	17.8	8.7
Standard Deviation	-	11.0	8.8
Skew[1]	-	5.1	8.2
Kurtosis[2]	-	61.2	115.0
Minimum	-	-0.2	0.4
Percentiles (µg·m^{-3})			
75	-	21.6	9.9
90	-	28.1	13.8
95	-	33.5	17.4
99	-	59.9	45.3
Maximum	36.7	241.8	178.0
Data Capture (%)	98.61%	98.61%	39.55%

Figure 3 Long-term 24-hour average PM_{10} concentrations – Bringelly AQMS – 2010 to 2020

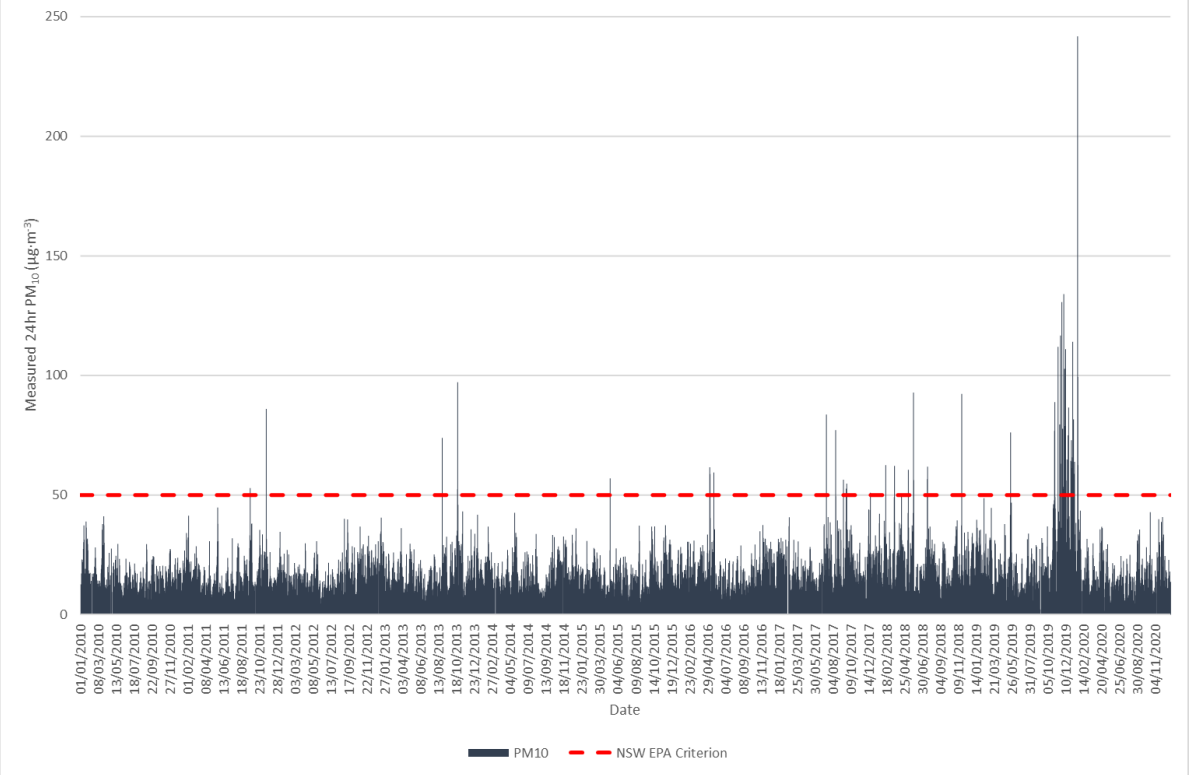
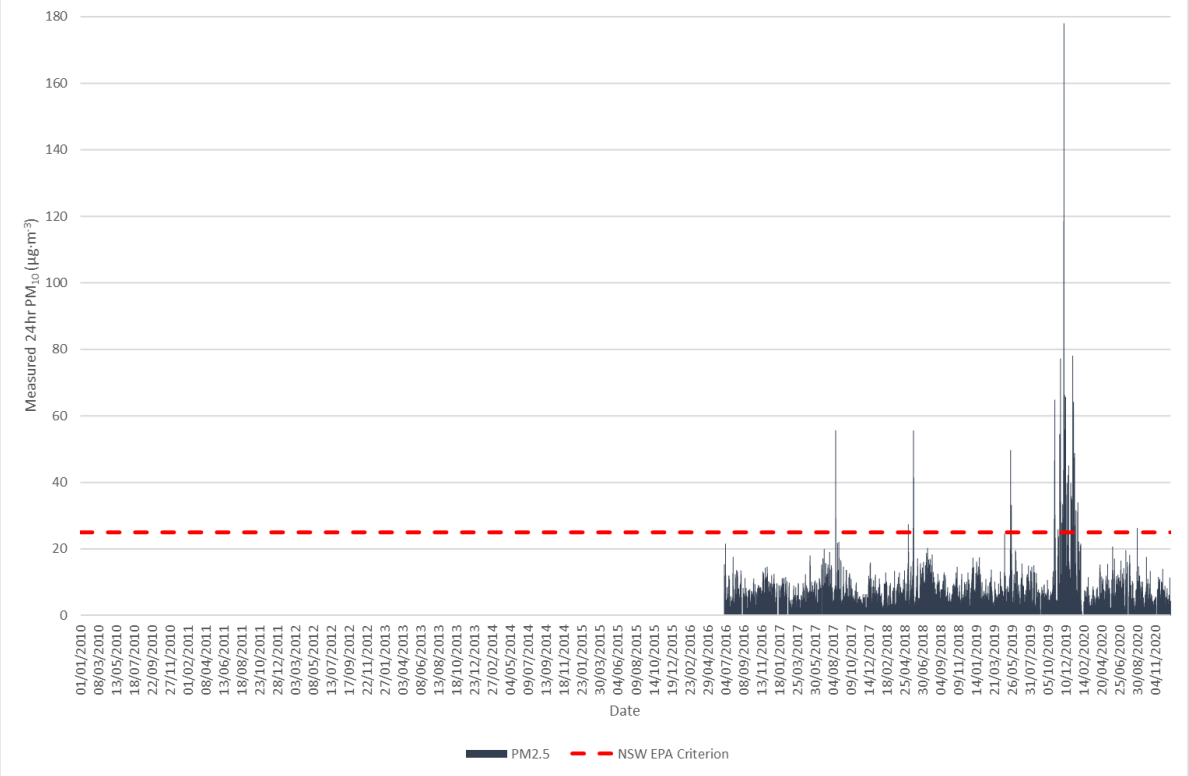


Figure 4 Long-term 24-hour average $PM_{2.5}$ concentrations – Bringelly AQMS – 2010 to 2020



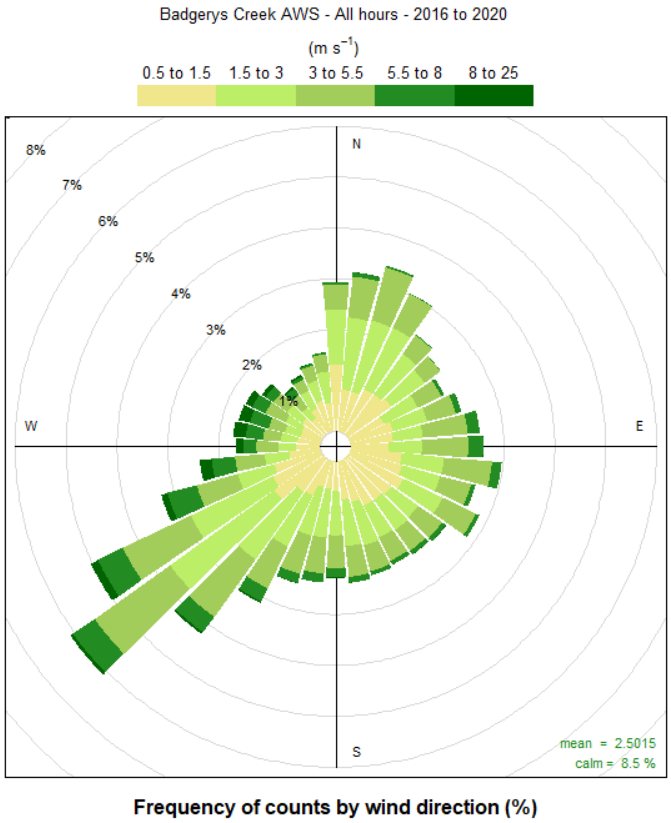
Given the fact that the study area is prone to the effects of bushfires and hazard reduction burns, consideration at the detailed design stage should include measures to reduce smoke exposure in buildings and public spaces. A summary of background air quality conditions is presented as **Appendix D** of this report.

2.2 Meteorology

General meteorological conditions for the study area have been derived from data collected by the Bureau of Meteorology (BoM) at the Automatic Weather Station (AWS) at Badgerys Creek (ID 67108), which is located within the boundary of the study area.

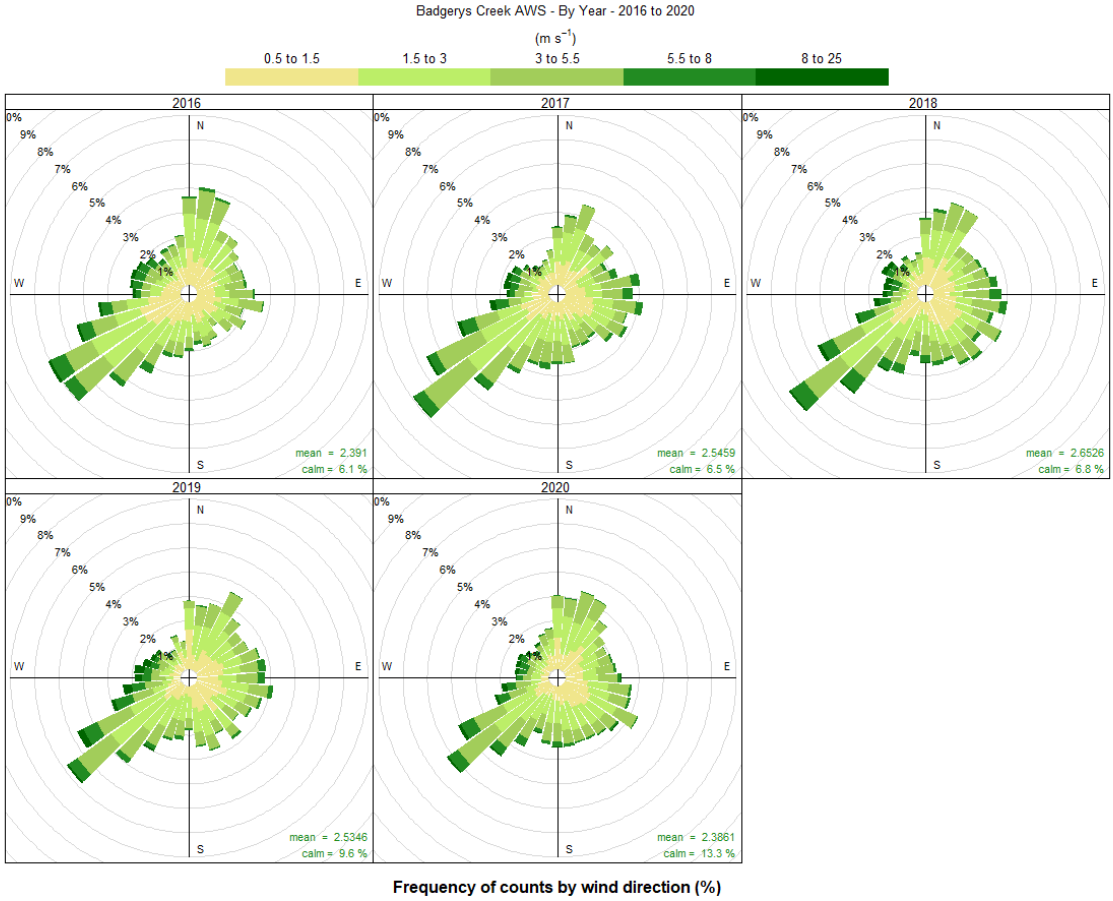
The prevailing wind conditions at Badgerys Creek AWS over the period from 2016 to 2020 are presented in **Figure 5**. **Figure 6** additionally presents the annual wind roses for the years 2016 to 2020.

Figure 5 Long-term wind rose – Badgerys Creek AWS – 2016 to 2020



Source: Northstar Air Quality Pty Ltd

Figure 6 Annual wind roses – Badgerys Creek AWS – 2016 to 2020



Source: Northstar Air Quality Pty Ltd

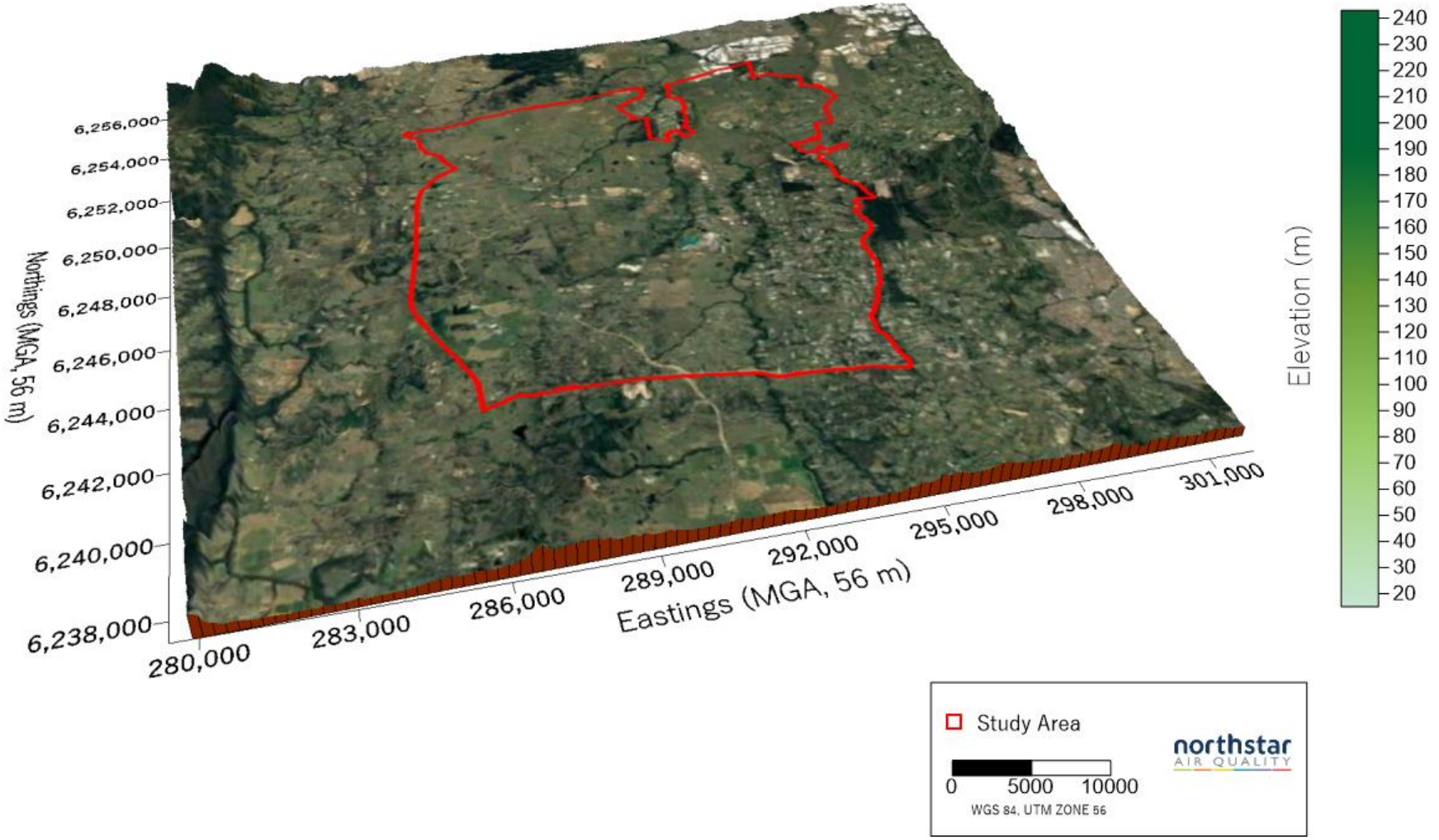
A summary of prevailing meteorological conditions is presented as **Appendix E** of this report.

2.3 Topography

The topography of the study area is illustrated in **Figure 7**.

The relief across the study area is generally flat, as may be expected for the site of an airfield. The height across the study area ranges from approximately 30 m Australian Height Datum (AHD) to 110 m AHD.

Figure 7 **Existing conditions – topography**



Source: Northstar Air Quality Pty Ltd

3. METHODOLOGY

This air quality and odour risk assessment has been performed using a risk assessment procedure, in accordance with the general requirements of ISO 31000 (International Organization for Standardisation (ISO) 31000:2018 'Risk management – Guidelines') and incorporating a methodology adopted from (NSW EPA, 2017).

For the purposes of this study, risk is evaluated as $risk = sensitivity \times magnitude$.

These terms are defined in the following sections, which also provide clarification on how this report has applied observed conditions of baseline sensitivity and impact magnitude to those definitions.

3.1 Definition of Sensitivity

Sensitivity terminology may vary depending upon the environmental effect, but generally this may be described in accordance with a scale from 'very high' to 'low', as defined in **Table 3**.

Table 3 Methodology - sensitivity of receptors

Sensitivity		Descriptions
4	Very high	• Receptors are highly sensitive to changes in the air quality / odour environment. • Areas may be typified by extended (day-long) exposure times and/or an expectation of high amenity values. • Typical examples may include residential areas, health care facilities, retirement homes
3	High	• Receptors have a high sensitivity to changes in the air quality / odour environment. • Areas may be typified by working-day exposure times and/or an expectation of high amenity values. • Typical examples may include commercial zones, recreation facilities, schools, high-end office space (banking etc).
2	Medium	• Receptors have a medium sensitivity to changes in the air quality / odour environment. • Areas may be typified by up to working-day exposure times and an expectation of reasonable amenity values commensurate with the land-uses. • Typical examples may include agricultural and environmental conservation spaces, industrial zones.
1	Low	• Receptors have a low sensitivity to changes in the air quality / odour environment. • Areas may be typified by short-term exposure times and a low expectation of amenity values. • Typical examples may include infrastructure land uses, open and undeveloped land.

Given that the definitions may be applied to air quality and odour pollutants with respective exposure standards ranging from 3-seconds, 1-hour to 24-hour, and annual average, the definitions need to be broad enough to be adaptable to a range of pollutants and the time over which a member of the community may reasonably be expected to be present at those locations. For example, it is reasonable to assume a member of the community would be at a place of residence for a 24-hour period, but not so at a place of employment, at which a person may be assumed to be located for around 8-hours over a typical working day.

The definition applied may also need to consider the level of amenity that may be reasonably expected at those locations, for example, the level of amenity at a place of residence would be higher than on agricultural land or at an industrial park.

The sensitivity of receptors has been applied with cognisance of the above factors and includes an element of interpretation and balance.

Table 4 Methodology – application of sensitivity

Sensitivity		Descriptions	
		Example existing land use	Example future land use
4	Very high	Land uses assessed include: • R2: Low density residential • R5: Large lot residential • RU5: Village	Land uses assessed include: • Mixed use • Luddenham Village • Plaza
3	High	Land uses assessed include: • B3: Neighborhood centre • E4: Environmental living • RE1: Public recreation	Land uses assessed include: • Education use • Development land • Specialised centre • Centres
2	Medium	Land uses assessed include: • E2: Environmental conservation • E3 Environmental management • IN1: General industrial • RU1: Primary production • RU2: Rural landscape • RU4: Primary production small lots • RU6: Transition	Land uses assessed include: • Light industrial use • Enterprise use • Productive land • Parks and open spaces • Environmental lands • Flexible employment
1	Low	Land uses assessed include: • SP1: Special activities • SPS2: Infrastructure	Land uses assessed include: • Special use (airport)(1) • Roads and streets

Note (1) This report does not address air quality impacts or risks associated with the Western Sydney Airport. Aurecon has been advised by the Department of Planning, Industry and Environment that this is being established separately.

In this study, sensitivity has been assessed using the following resources:

- Liverpool Local Environmental Plan (2008);
- Penrith Local Environmental Plan (2010); and,
- Scenarios for the initial Aerotropolis Precincts, as developed in September 2020.

Note: This Stage 2 Air Quality and Odour Study is based upon the Precinct boundaries provided in the Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020).

The application of land sensitivity 'classification' to the study area is presented in **Section 4.1**.

Descriptors of potential future land uses have been extracted from the precinct plans (see **Section 4.1** for further details on how these data have been applied).

3.2 Definition of Magnitude

Impact magnitude is a descriptor for the predicted scale of potential impact to the air quality / odour environment.

The identification of potential magnitude differs in the Stage 2 Air Quality and Odour Study than was applied in the Stage 1 baseline assessment (Northstar Air Quality, 2020). The Stage 1 baseline assessment used a methodology derived from a Level 1 screening assessment as published in the *Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW* (NSW DEC, 2006) and various separation distances ('buffer distances') as published in various State / Territory guidance including (ACT Government, 2018), (EPA SA, 2016), (EPA VIC, 2013) and (NSW DoP, 2008). Reference should be made to the Stage 1 baseline assessment for details of how this was derived and applied.

This Stage 2 Air Quality and Odour Study uses a methodology derived from a Level 2 assessment procedure, as outlined in (NSW DEC, 2006). A dispersion modelling assessment has been performed on emission estimates for the sources identified and discussed in **Section 1.2.2**. The dispersion modelling has been performed using the US EPA CALPUFF dispersion model, in "2-D" mode. Reference should be made to **Appendix F** for further information. The Level 2 procedure is specifically a methodology for odour emission modelling, but a parallel procedure to quantify the magnitude of particulate emissions has been adopted.

This study is not intended to be an impact assessment, and as such 'impact' is in reference to the graduated scale of potential impacts only, to enable the more significant hazards to be identified. However, as the basis of defining magnitude is the dispersion modelling of the assumed emissions, magnitude can be defined broadly by the predicted impacts.

3.2.1 Odour

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management but are generally not intended to achieve "no odour".

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU). An odour goal of less than 1 OU would theoretically result in no odour impact being experienced. In practice, the character of a particular odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions.

Based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU depending on a combination of the following factors:

- Odour Quality: whether an odour results from a pure compound or from a mixture of compounds. Pure compounds tend to have a higher threshold (lower offensiveness) than a mixture of compounds.
- Population sensitivity: any given population contains individuals with a range of sensitivities to odour. The larger a population, the greater the number of sensitive individuals it contains.
- Background level: whether a given odour source, because of its location, is likely to contribute to a cumulative odour impact. In areas with more closely located sources it may be necessary to apply a lower threshold to prevent offensive odour.
- Public expectation: whether a given community is tolerant of a particular type of odour and does not find it offensive, even at relatively high concentrations. For example, background agricultural odours may not be considered offensive until a higher threshold is reached than for odours from a landfill facility.
- Source characteristics: whether the odour is emitted from a stack (point source) or from an area (diffuse source). Generally, the components of point source emissions can be identified and treated more easily using control equipment than diffuse sources. Point sources tend to be located in urban areas, while diffuse sources are more prevalent in rural locations.
- Health Effects: whether a particular odour is likely to be associated with adverse health effects. In general, odours from agricultural activities are less likely to present a health risk than emissions from industrial facilities.

Experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which "offensive" odours should not occur (for an individual with a 'standard sensitivity' to odours). Therefore, in NSW the odour impact criterion (DECC, 2006a), (NSW EPA, 2017) recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU. This is expressed as the 99th percentile value, as a nose response time average (approximately one second).

Odour assessment criteria need to take into account the range in sensitivities to odours within the community in order to provide additional protection for individuals with a heightened response to odours. This is addressed in the Technical Framework (DECC, 2006a) by setting a population dependant odour assessment criterion.

In this study, consideration has been applied to 'sensitivity' which accounts for the value applied to the amenity expectations of various land uses (see **Section 3.1**) and therefore, odour concentration values of the following have been adopted to define the magnitude interval scale:

- Major: >7 OU
- Moderate: >5 OU
- Slight: > >2 OU
- Negligible: ≤2 OU

3.2.2 Particulate Matter

The potential magnitude of particulate emissions from the waste and resource management facilities has been assessed. The various limitations, assumptions and annualised estimates of particulate matter emissions are presented in **Appendix C**. Due to these limitations, the assessment of short-term magnitude of particulate matter is problematic and would be subject to a high degree of uncertainty. In the Stage 2 Air Quality and Odour Assessment, the magnitude of emissions of particulate matter has been assessed as PM_{10} and evaluated against the annual average criterion of 25 µg·m^{-3} as published in (NSW EPA, 2017).

To account for general prevailing conditions, the 10-year annual average PM_{10} concentration has been calculated from background data measured at Bringelly Air Quality Monitoring Station (AQMS). The AQMS is located on Badgerys Creek Road, within the study area, and provides a good approximation of air quality conditions across the study site. The air quality data collected at this site can be considered to be representative of conditions away from significant sources of emissions. The background 10-year annual average PM_{10} concentration is calculated as 17.8 µg·m^{-3}. Reference should be made to **Section 2.1** and **Appendix D**.

The available "headroom" between the measured 10-year annual average PM_{10} concentration and the criterion has been calculated as 7.2 µg·m^{-3}.

$$H = iac - \bar{x}$$

Where:

H = headroom (µg·m^{-3})

iac = annual average PM_{10} impact assessment criterion (25 µg·m^{-3})

$\dot{x}$ = measured 10-year annual average PM_{10} (17.8 µg·m^{-3})

In this study, magnitude has been assessed as fractions of H, at intervals of

- Major: >50 % H (>3.6 µg·m^{-3})
- Moderate: >30 % H (3.6 to 2.2 µg·m^{-3})
- Slight: >10 % H (2.2 to 0.7 µg·m^{-3})
- Negligible: ≤10 % H (<0.7 µg·m^{-3})

3.2.3 Summary

In summary, impact magnitude is evaluated on a scale from ''major' to 'negligible' as defined in **Table 5**.

Table 5 Methodology - impact magnitude

Magnitude		General Descriptions	Odour	Particulate
4	Major	Potential impact magnitude may cause statutory objectives / standards to be exceeded. Potential magnitude of impacts may generate nuisance complaints, resulting in regulatory action.	Odour impact >7 OU	Annual average PM_{10} >50 % H
3	Moderate	Potential impact may give rise to a perceivable health and/or amenity impact. Potential magnitude of impacts may generate nuisance complaints, likely to require management but not result in regulatory action.	Odour impact >5 OU	Annual average PM_{10} >30 % H
2	Slight	Potential impact may be tolerated. Potential magnitude of impacts is not likely to generate nuisance complaints.	Odour impact >2 OU	Annual average PM_{10} >10 % H
1	Negligible	Potential impact magnitude is unlikely to cause significant consequences. Potential magnitude of impacts is unlikely to generate nuisance complaints and is likely to only be perceptible within the site boundary.	Odour impact ≤2 OU	Annual average PM_{10} ≤10 % H

3.3 Definition of Risk

The risk matrix provided in **Table 6** is an adaption of the Stage 1 risk matrix, adapted to account for the magnitude derived from modelling outputs. The magnitude of odour impacts is defined by the odour impact assessment criterion (as discussed in **Section 3.2.1**), and the risk matrix has been devised to account for the concept of population density and amenity expectations, as presented in (DEC, 2006).

Table 6 Methodology - risk matrix (Stage 2)

Sensitivity \ Magnitude		Negligible (1)	Slight (2)	Moderate (3)	Major (4)
		[Defined by Table 5]			
Very High (4)	[Defined by Table 3]	Low (4)	Medium (8)	High (12)	High (16)
High (3)		Low (3)	Medium (6)	High (9)	High (12)
Medium (2)		Low (2)	Low (4)	Medium (6)	Medium (8)
Low (1)		Low (1)	Low (2)	Low (3)	Low (4)

'Risk' derived through this methodology is presented on a simplified three-point scale:

High	A high risk that requires management, through changes to impact magnitude (source) and sensitivity (receptor)
Medium	An intermediate risk, and recommendations are to reduce risk as low as practicable through changes to impact magnitude (source) and/or sensitivity (receptor)
Low	No further management required, although risks should be managed

3.4 Determination of Requirement for Mitigation and Management

It is noted that the determination of risk does not provide derogation or relief from the requirement to prevent or minimise air pollution under the Protection of the Environment Operations Act (1997), including Section 128:

> **128 Standards of air impurities not to be exceeded**
>
> (1) The occupier of any premises must not carry on any activity, or operate any plant, in or on the premises in such a manner as to cause or permit the emission at any point specified in or determined in accordance with the regulations of air impurities in excess of--
>
> (a) the standard of concentration and the rate, or

(b) the standard of concentration or the rate,

prescribed by the regulations in respect of any such activity or any such plant.

(1A) Subsection (1) applies only to emissions ("**point source emissions**") released from a chimney, stack, pipe, vent or other similar kind of opening or release point.

(2) The occupier of any premises must carry on any activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution if--

(a) in the case of point source emissions--neither a standard of concentration nor a rate has been prescribed for the emissions for the purposes of subsection (1), or

(b) the emissions are not point source emissions.

(3) A person who contravenes this section is guilty of an offence.

3.5 Assessment of Sensitivity

The relative risk is provided as a dimensionless product of the defined values attributed to receptor sensitivity and impact magnitude.

As outlined above in **Section 3.1**, this study has derived a scale of sensitivity from proposed land use classifications. With reference to the Stage 1 Air Quality and odour assessment – baseline study, this is called the "future baseline".

The map illustrating land sensitivity for the future baseline is illustrated in **Section 4.1**.

3.6 Assessment of Magnitude

In this study, impact magnitude has been assessed using the following resources (in no order):

- DPIE NSW Planning Portal – Major Projects[7]
- NSW RMS - Infrastructure Projects[8]
- Australian Government DAWE National Pollutant Inventory[9];
- NSW Environment Protection Licence register[10];
- Desk-top surveying, including use of Google Earth[11] and Six Maps[12];
- Northstar Air Quality site surveying (see the Stage 1 report, and Appendix A).

As discussed in **Section 1.2.3** the Stage 2 Air Quality and Odour Study report (this report) is required to focus on the higher-risk outcomes of the Stage 1 Baseline Study. The scope is therefore not to address all identified potential risks but escalates the higher-risk outcomes to a higher degree of scrutiny.

[7] https://www.planningportal.nsw.gov.au/major-projects

[8] https://www.rms.nsw.gov.au/projects/index.html

[9] www.npi.gov.au

[10] https://apps.epa.nsw.gov.au/prpoeoapp/

[11] https://www.google.com/earth/

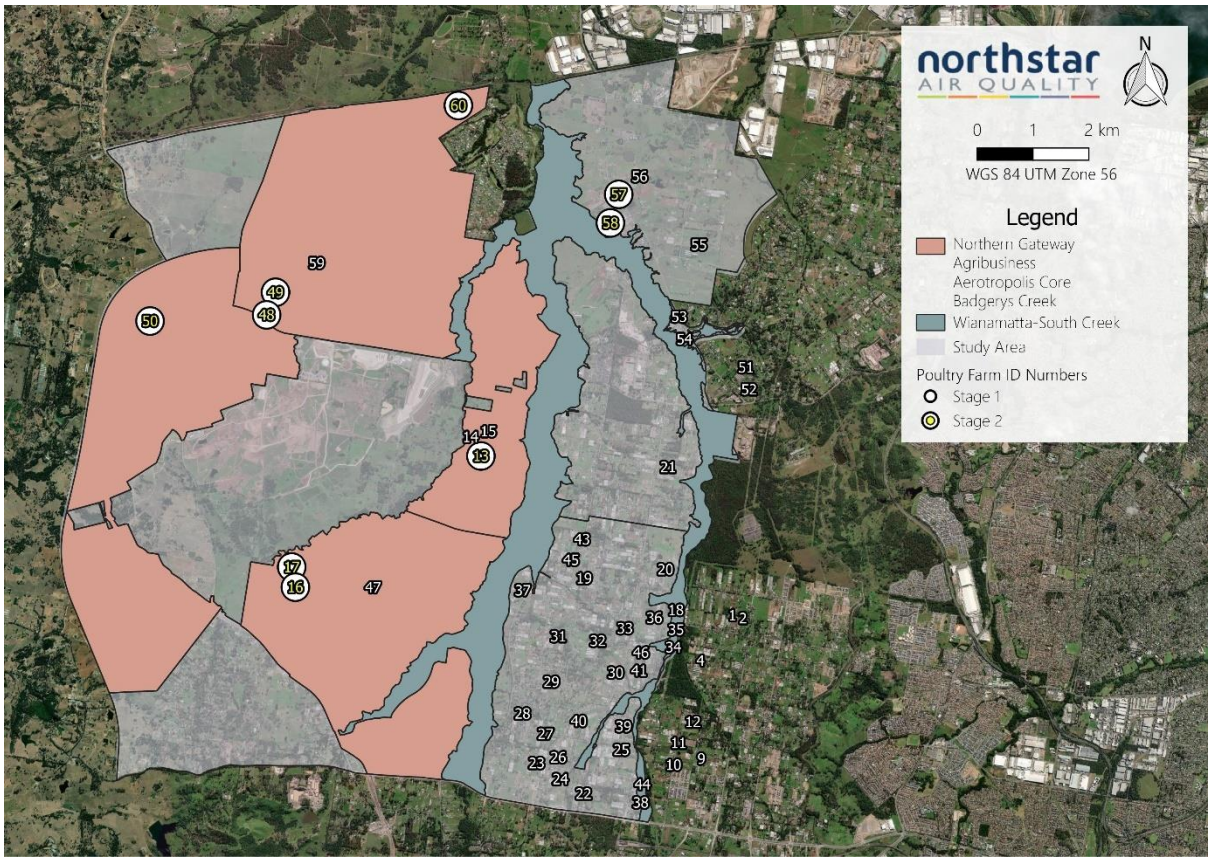
[12] https://maps.six.nsw.gov.au/

3.6.1 Assessment of Magnitude – Agriculture

The identified agricultural land uses with potential to impact upon air quality and odour are limited to poultry farming operations.

The identified locations of all identified poultry farming activities are illustrated in **Figure 8** and detailed in **Appendix A**.

Figure 8 Locations of identified poultry farm activities



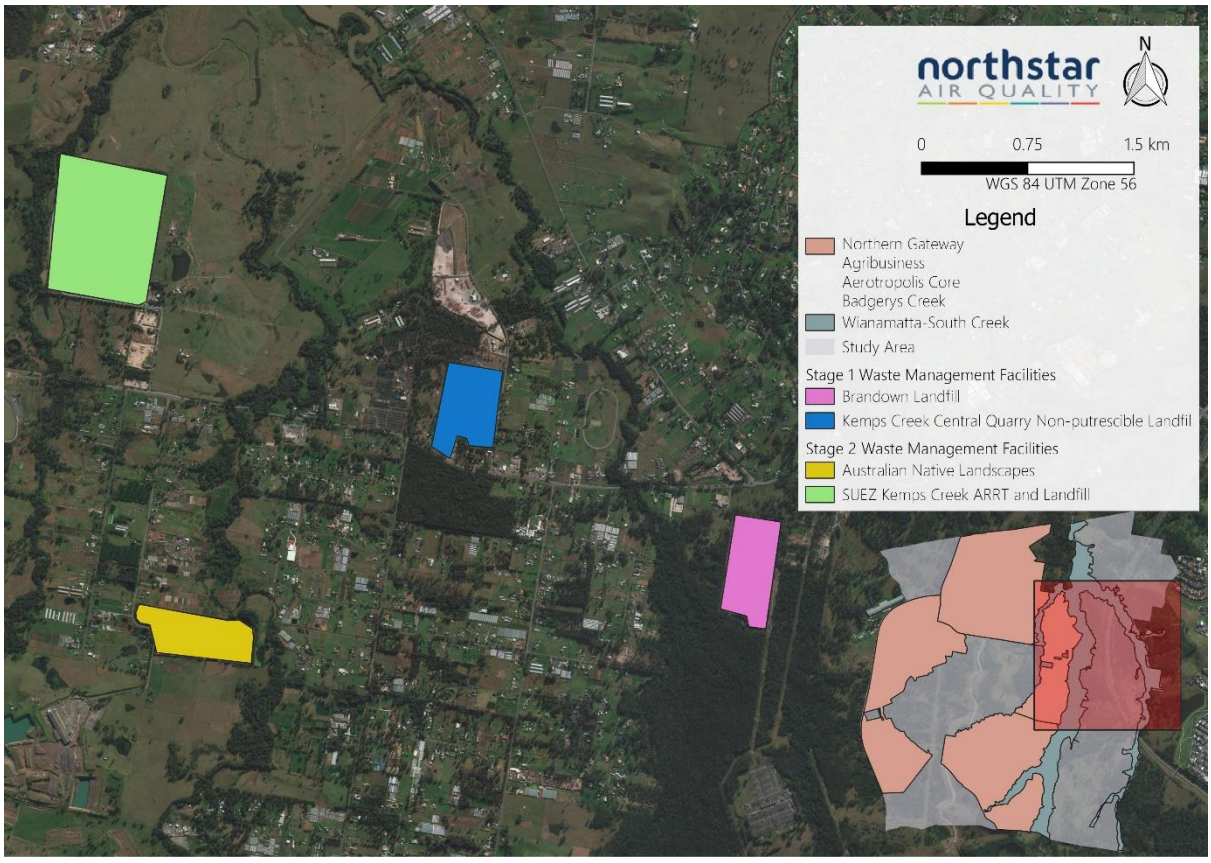
Source: Northstar Air Quality Pty Ltd

3.6.2 Assessment of Magnitude - Waste and Resource Management

The waste management activities identified within and surrounding the study area which are included in the Stage 2 assessment include:

- SUEZ Kemps Creek Advanced Resource Recovery Technology Facility, 1725 Elizabeth Drive, Kemps Creek;
- SUEZ Kemps Creek Landfill, 1725 Elizabeth Drive, Kemps Creek;
- Australian Native Landscapes, 210 Martin Road, Badgerys Creek.

Figure 9 Locations of identified waste and resource management activities



Source: Northstar Air Quality Pty Ltd

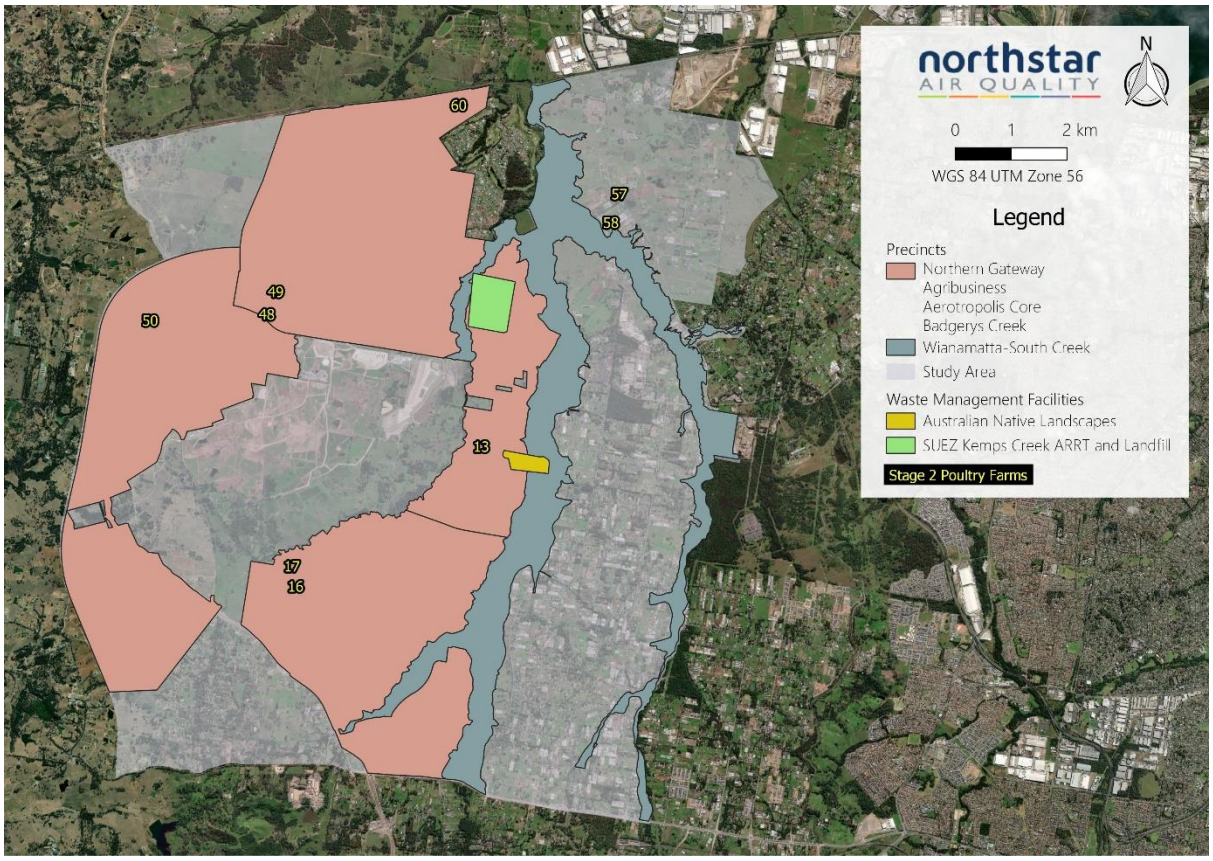
The locations of waste management activities are displayed above in **Figure 9**. Australian Native Landscapes (shown in yellow/mustard) is located on the border of the Badgerys Creek and Wianamatta-South Creek precincts. Both SUEZ activities (shown in green) are found in the Badgerys Creek precincts and the Kemps Creek Central Quarry (shown in blue) is located in the Kemps Creek precinct.

3.7 Dispersion Modelling

The potential magnitude of emissions associated with the sources assessed in Stage 2 have been assessed on land across Aerotropolis using a standard dispersion modelling technique. Modelling has been performed using the US EPA approved CALPUFF dispersion model, in accordance with the methodology specified in (NSW EPA, 2017) (see **Appendix F**).

The sources modelled in the Stage 2 Air Quality and Odour Study are illustrated in **Figure 10**.

Figure 10 Stage 2 source locations



Source: Northstar Air Quality Pty Ltd

3.8 Controls

As outlined in **Section 1.2.3**, this Stage 2 Air Quality and Odour Study will:

- *make specific recommendations for controlling air pollutant and odour impact from 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.*

Specific pollution controlling recommendations are identified and discussed in **Section 5**. The following methodology has been used to identify potential controls.

Options to reduce the risk of negative impacts associated with air pollution can be implemented through consideration of the source ➔ pathway ➔ receptor relationship. A stylised version of that relationship is presented in **Figure 11**.

Figure 11 Source-pathway-receptor relationship

Source: Northstar Air Quality Pty Ltd

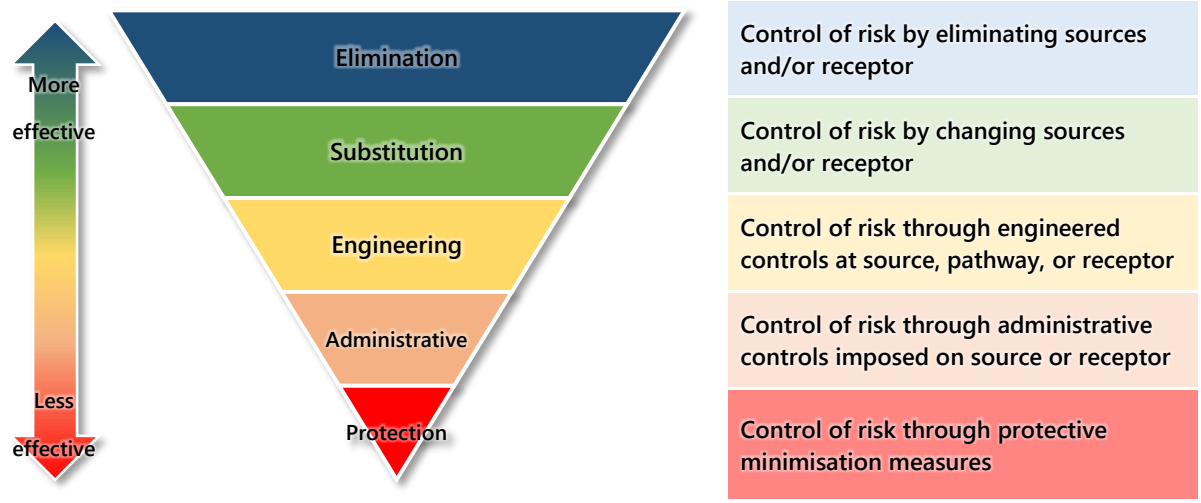
In this study, consideration of the "source" is provided as the magnitude of activities performed. The atmospheric dispersion modelling evaluates the influence of "pathway", and the "receptor" is evaluated and considered as sensitivity.

Implementation of options to reduce risk (discussed further below) can be applied at any stage of the source ➔ pathway ➔ receptor relationship.

Generally, it is more effective to control high risk at point of emission (i.e., at the source) than at the point of effect (i.e., at the receptor). For low-risk activities, it may be effective to control (i.e., minimise) the risk at any stage in the source ➔ pathway ➔ receptor relationship. However, that does not preclude the implementation of strategies at all stages of the process to manage any level of risk.

The concept of pollution prevention hierarchy is well understood for the waste management industry, where the most preferable option is prevention and reduction, then reuse, recycling, recovery, with the least preferable option being disposal. A similar hierarchy of controls can be applied to the management of other environmental issues with the accepted hierarchy and terminology presented in **Figure 12**.

Figure 12 Adapted hierarchy of controls



Source: Northstar Air Quality Pty Ltd

Presented in **Table 7** are a number of potential measures which may be applied to manage risks through the source ➔ pathway ➔ receptor relationship, taking into consideration the hierarchy of controls.

Table 7 Hierarchy of controls

Controls Imposed	Hierarchy of Control (examples)				
	Elimination	Substitution	Engineering	Administrative	Protection
Source (Magnitude)	Removal of significant sources Reduction in poultry farm stocking density Reduction in waste and resource facility activity rates	Relocation of sources and operations to increase distance to high-risk land uses	Engineered discharge conditions to improve dispersion efficiency Addition of ventilation fan stacks on forced ventilation sheds Use of odour neutralisers at sources	Review of DA approvals / conditions	Use of odour 'masking agents' at sources
Pathway			Addition of fan wall barriers on forced ventilation sheds Inclusion of vegetative buffers/screens/earth mounds around farms		
Receptor (Sensitivity)	Removal of sensitive land uses	Relocation of sensitive land uses Change in land use sensitivity from higher to lower sensitivity land uses	Inclusion of vegetative buffers/screens/earth mounds around sensitive land uses		Addition of mechanical air ventilation (e.g. air conditioning) at sensitive land uses

3.9 Limitations

The methodology adopted and approved by WSPP for both the Stage 1 Air Quality and Odour Study – Baseline Assessment (Northstar Air Quality, 2020) and this Stage 2 Air Quality and Odour Study report is based upon a risk assessment procedure derived from ISO 31000 (International Organization for Standardisation (ISO) 31000:2018 'Risk management – Guidelines'). The methodology adopted is documented in **Section 3**, and the report objectives are presented in **Section 1.2**.

Notably, the following limitations are acknowledged.

3.9.1 Assessing Sensitivity

This Stage 2 Air Quality and Odour Study is based upon the Precinct boundaries provided in the Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020) as outlined in **Figure 14**. Some level of judgement is required and has been applied to enable the appropriate allocation of sensitivity to each land use type.

3.9.2 Assessing Magnitude from Poultry Farming

In relation to poultry farming activities, the Stage 2 assessment has been based upon an estimate of total shed area, an assumed stocking density for bird type, and published odour emission rates to derive a fixed odour emission rate, which is subsequently ventilated using standardised ventilation assumptions for natural and tunnel-ventilated sheds. The assessment of magnitude is therefore sensitive to the above factors.

Given the number of sheds to be modelled concurrently, no consideration has been applied in the modelling to the growth cycle of the stocked poultry. Reference should be made to **Appendix A** and **Appendix B** for the applied assumptions.

It is further noted that the risk assessment methodology uses the metrics of land sensitivity (derived from land use classification) and impact magnitude (derived from a modelled odour concentration). This differs from the methodology adopted in the NSW Approved Methods (NSW EPA, 2017) which uses a function of population size rather than land use classification.

This risk assessment is not intended to represent an impact assessment and should not be misinterpreted as such.

3.9.3 Assessing Magnitude from Waste and Resource Management Facilities

Impact magnitudes associated with waste and resource management facilities have been based on information that could be determined from publicly available data resources, such as contained within the Environmental Protection Licences for the facilities. These are often noted to be "upper-limiting" annual thresholds and may not represent the typical annual activity rates for those facilities. Reference should be made to **Appendix C** for the applied assumptions.

Given that these data are typically limitations on annual throughputs and activity rates, the data available cannot be realistically applied to determine short-term impact magnitudes (i.e., consideration of the published 24-hour PM_{10} impact assessment criterion). Experience has shown that the relationship between annual average daily throughput / activity rates to the corresponding peak throughput / activity rates are highly variable, and to apply an arbitrary scaling factor to estimate peak activity rates would introduce further and unwarranted uncertainty into the assessment.

By assuming annual throughputs, the impact magnitude is acknowledged to represent upper-threshold average day activity, rather than peak activity rates which may, from time to time, be multiple times higher than the average and conversely, from time-to-time actual activity rates would also be lower than the average activity rates. The prediction of odour and particulate impacts from those facilities is therefore made on average activity rates, estimated from the upper-threshold of annual activity rates determined from published resources.

This risk assessment is not intended to represent an impact assessment and should not be misinterpreted as such.

3.9.4 Assessing Risk

The determined risk (sometimes termed 'significance') may be used to highlight the relative environmental risk and to highlight the general requirement for the application of controls and mitigation. It is noted that the adopted approach is designed to provide an overall impact risk and is not intended to represent the defining determination for the requirement for mitigation and control.

It is important to note that the risk methodology is not designed to exclude impacts with a lower determined significance from receiving mitigation and control treatments, in accordance with the principle of reducing environmental impacts to the maximum extent practicable.

In regard to the management of odour impacts, reference is made to the odour impact criterion, as specified in the Approved Methods (NSW EPA, 2017). The NSW odour impact assessment criterion, and its dependance upon population density, is discussed in **Section 3.2.1**. The methodology used in this risk assessment uses land use to determine sensitivity rather than population density, but a general parallel may be drawn between the two approaches.

A determined 'slight' odour impact from an assessed agricultural facility of between 2 OU and 5 OU at a 'very high' sensitivity location (such as residential areas) would equate to a 'medium' risk (see **Table 6**). It is noted that the magnitude of odour impact is above the 2 OU odour impact assessment criterion that would determine additional mitigation / controls would be required (NSW EPA, 2017) and correspondingly, the assessment of a medium risk under the adopted methodology would require controls, as outlined in **Section 5.4**.

Clearly the level of control would be lower than required to manage a corresponding 'high' risk at the same location, but determination of 'medium' risk does not negate the requirement for additional controls, which are discussed in **Section 5.4**.

4. RISK ASSESSMENT

4.1 Sensitivity

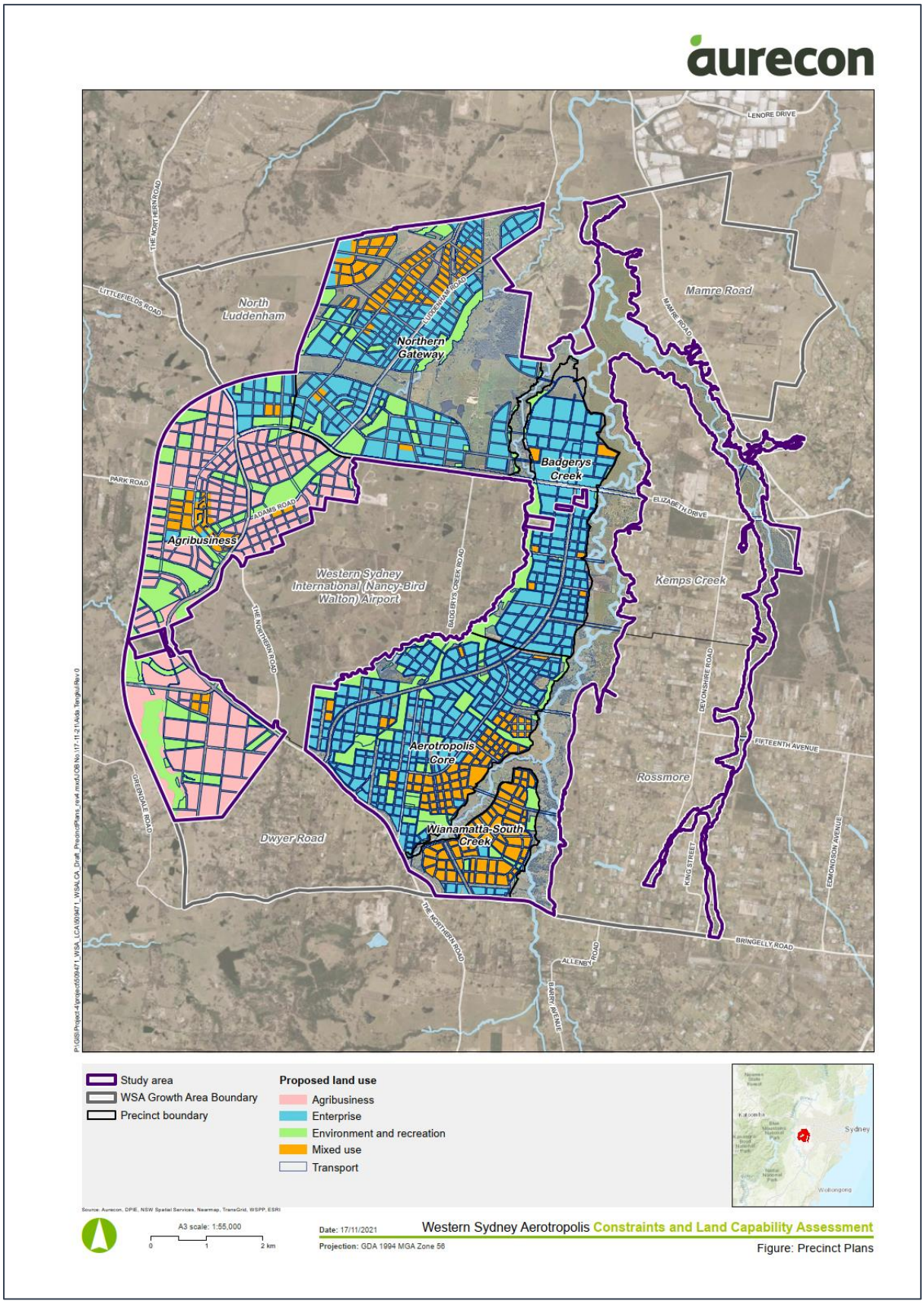
The land use sensitivity is assessed in the following section. The methodology is discussed in **Section 3.1** and **Section 3.4**, and using that methodology land sensitivity has been evaluated as presented in **Figure 14**.

The precinct plan, presented in **Figure 13**, shows the Agribusiness precinct is disaggregated by various proposed land uses, and these land uses have been assigned a sensitivity as presented in **Table 3**.

Figure 14 presents the sensitivity of the relevant land uses under potential future conditions with areas associated with each land sensitivity presented in **Table 8**.

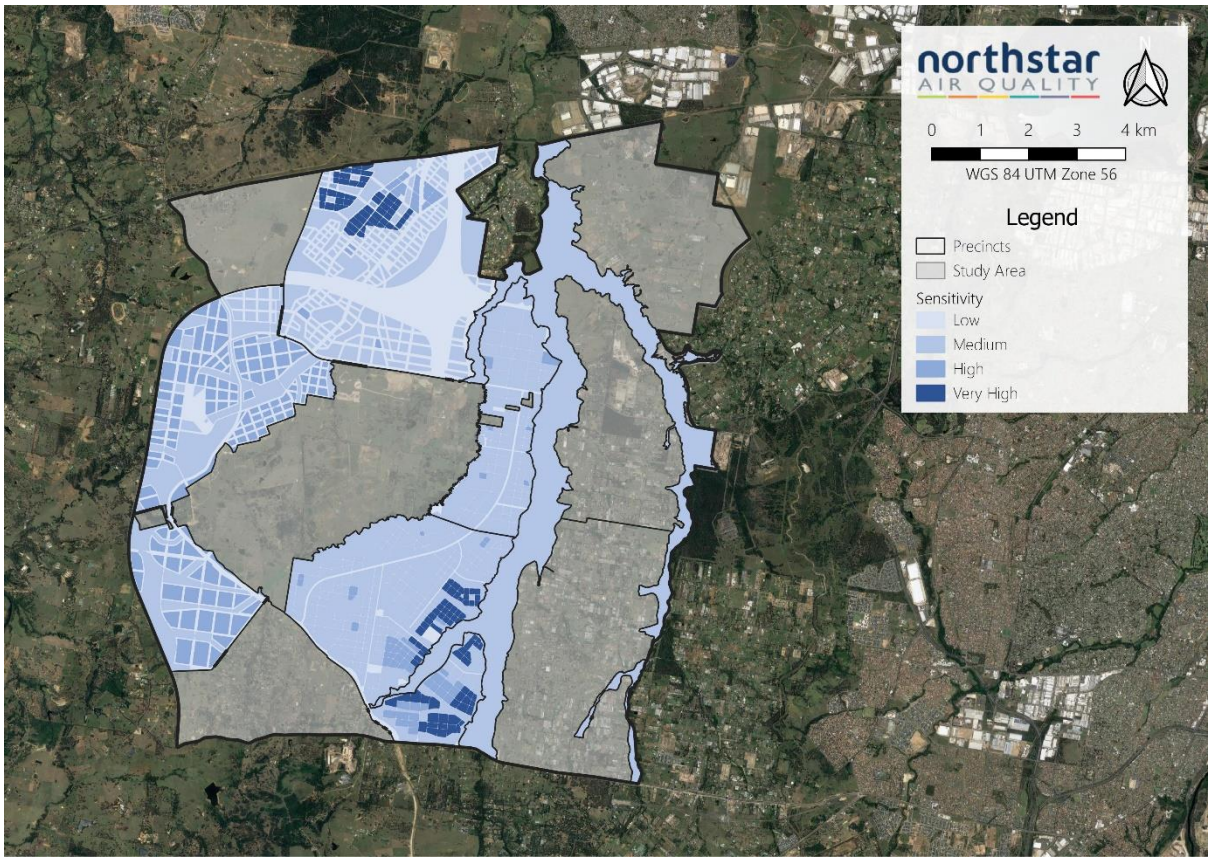
Note: This Stage 2 Air Quality and Odour Study is based upon the Precinct boundaries provided in the Western Sydney Aerotropolis Plan, September 2020 (NSW Government, 2020).

Figure 13 Future baseline – precinct plans



Source: Aurecon, 2021

Figure 14 Sensitivity



Source: Northstar Air Quality Pty Ltd

The distribution of sensitivity across the precincts is summarised in **Table 8**.

Table 8 Distribution of land sensitivity

Precinct	Total area (ha)[B]	Sensitivity							
		Low		Medium		High		Very high	
		Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total
Northern Gateway	1 616	742.8	46%	761.9	47%	38.6	2%	72.3	4%
Agribusiness	1 560	364.3	23%	500.9	32%	695.7	45%	0.0	0%
Aerotropolis Core, Badgerys Creek and Wianamatta-South Creek [A]	3 349	535.0	16%	2 599.8	78%	98.8	3%	113.0	3%

Note (A) Assessed as a single contiguous area in this study.
(B) Precinct areas derived from (NSW Government, 2020).

4.2 Magnitude

The magnitude of existing (and approved) activities is assessed in the following sections. The methodologies to determine magnitude are discussed in **Section 3.2** and **Section 3.6**.

4.2.1 Stage 1: Aggregated Activities

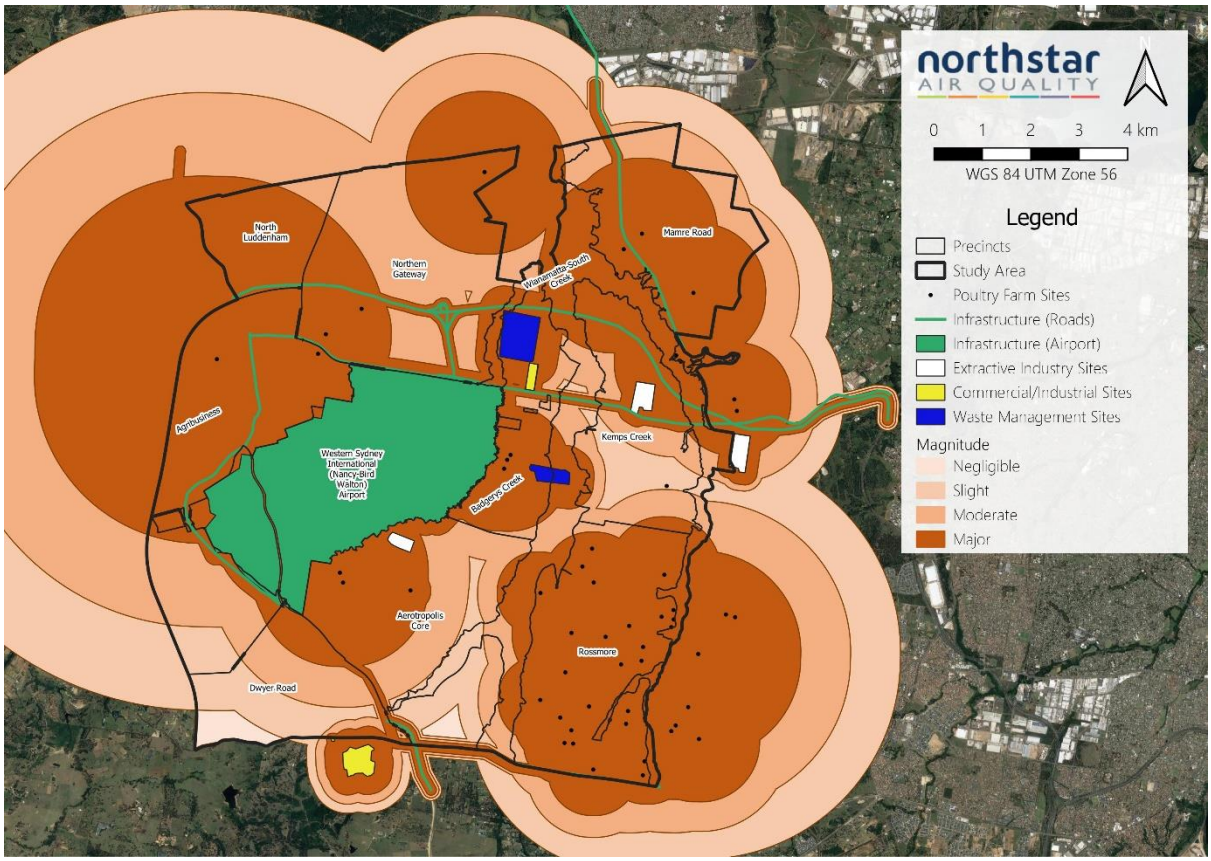
The Stage 1 Air Quality and Odour Study – Baseline Study documented the aggregated magnitude of all activities across the study area. The conclusions of the Stage 1 Air Quality and Odour Study – Baseline Study remain unchanged and provided below is a replication of that information.

Table 9 Distribution of magnitude (Stage 1)

Precinct	Total area (ha)[B]	Magnitude							
		Negligible		Slight		Moderate		Major	
		Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total
Northern Gateway	1 616	0.0	0%	1.5	0%	696.1	43%	919.4	57%
Agribusiness	1 560	0.0	0%	107.2	7%	325.7	21%	1 126.3	72%
Aerotropolis Core, Badgerys Creek and Wianamatta-South Creek [A]	3 349	33.4	1%	313.1	9%	893.7	27%	2 105.9	63%

Note (A) Assessed as a single contiguous area in this study.
(B) Precinct areas derived from (NSW Government, 2020).

Figure 15 Magnitude – aggregated activities (Stage 1)



Source: Northstar Air Quality Pty Ltd

4.2.2 Stage 2: Aggregated Activities

As discussed in **Section 1.2.3** the Stage 2 Air Quality and Odour Study report (this report) is required to focus on the higher-risk outcomes of the Stage 1 Baseline Study. The scope is therefore not to address all identified potential risks but escalates the higher-risk outcomes to a higher degree of scrutiny. Correspondingly, the Stage 2 Air Quality and Odour Study report has provided a detailed assessment of the higher-risk generating sources identified in Stage 1 and identified in **Section 1.2.2**, namely:

- Agricultural facilities – farm nos. 13, 16, 17, 48, 49, 50, 57, 58 and 60
- Waste and resource management facilities - SUEZ Advanced Waste Treatment Facility, SUEZ Elizabeth Drive Landfill, and Australian Native Landscapes

The magnitude of operations provided in Stage 1 (using screening-level assessment techniques) have been overwritten with the more detailed approach adopted in Stage 2 (using dispersion modelling techniques). Other activities not updated by the Stage 2 scope are retained from the Stage 1 assessment.

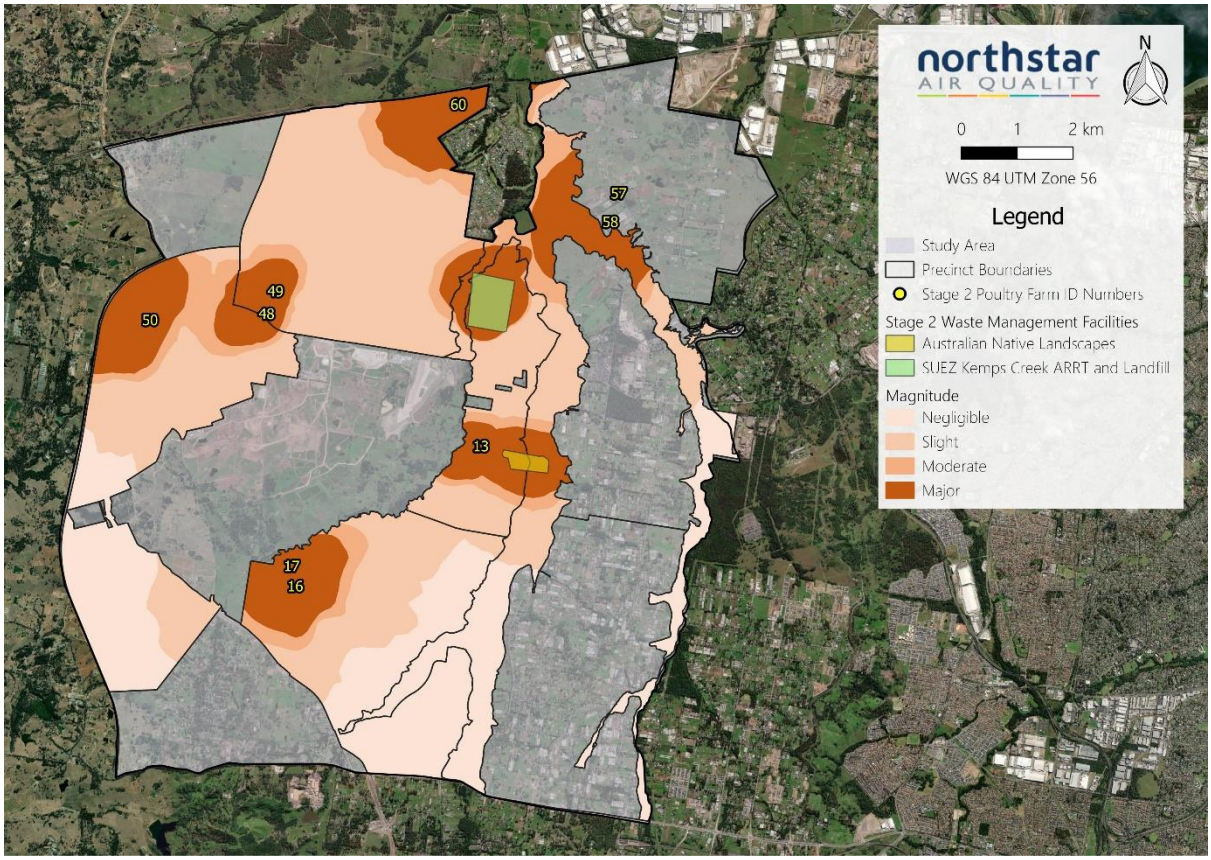
The assessed aggregated levels of magnitude are presented in **Table 10** and illustrated in **Figure 16**.

Table 10 Distribution of magnitude (Stage 2)

Precinct	Total area (ha)[B]	Magnitude							
		Negligible		Slight		Moderate		Major	
		Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total
Northern Gateway	1 615	0	0%	1151	71%	157	10%	307	19%
Agribusiness	1 559	519	33%	592	38%	157	10%	291	19%
Aerotropolis Core, Badgerys Creek and Wianamatta-South Creek [A]	3 344	1 119	33%	1125	34%	301	9%	799	24%

Note (A) Assessed as a single contiguous area in this study.
(B) Precinct areas derived from (NSW Government, 2020).

Figure 16 Magnitude – aggregated activities (Stage 2)

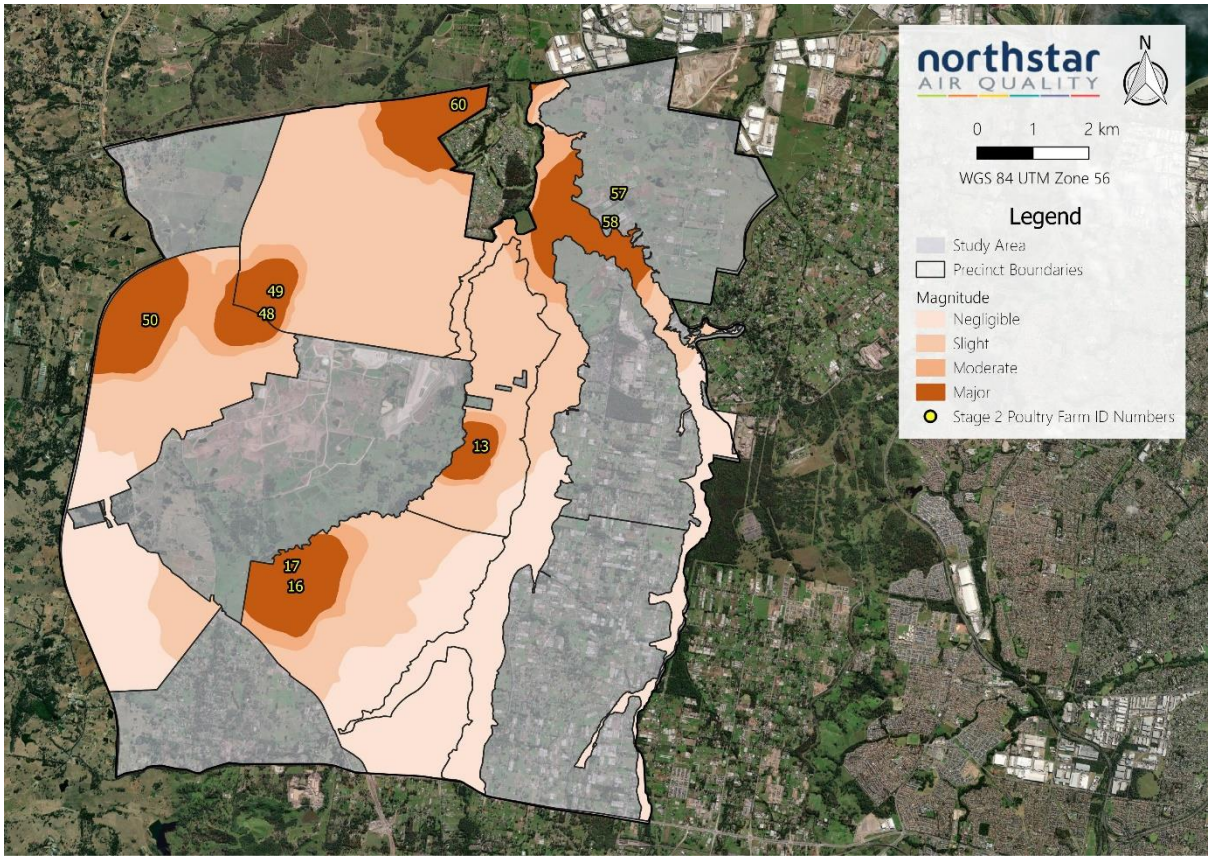


Source: Northstar Air Quality Pty Ltd

4.2.3 Stage 2: Agriculture

The assessed levels of magnitude associated with intensive agricultural activities (i.e., poultry farms) are illustrated in **Figure 17**. For clarity, this is the original magnitude assessed as part of Stage 1, updated with the Stage 2 magnitude for poultry farms nos 13, 16, 17, 48, 49, 50, 57, 58 and 60.

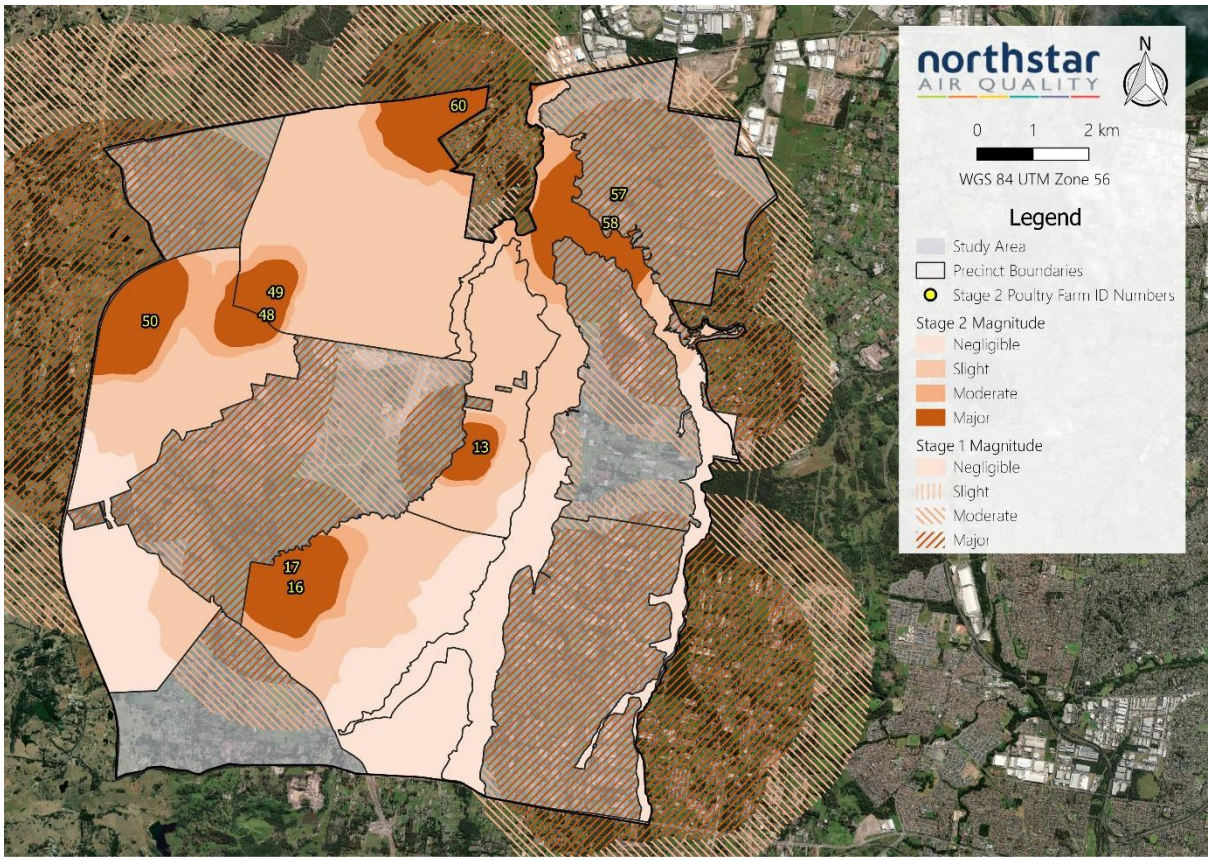
Figure 17 Magnitude – agriculture (Stage 2)



Source: Northstar Air Quality Pty Ltd

To understand the implication of the update from Stage 1 to Stage 2, the magnitude of operations from poultry farms nos 13, 16, 17, 48, 49, 50, 57, 58 and 60 has been isolated and compared side-by-side. This is provided for comparative purposes only.

Figure 18 Magnitude – agriculture (comparison of Stage 1 and Stage 2)

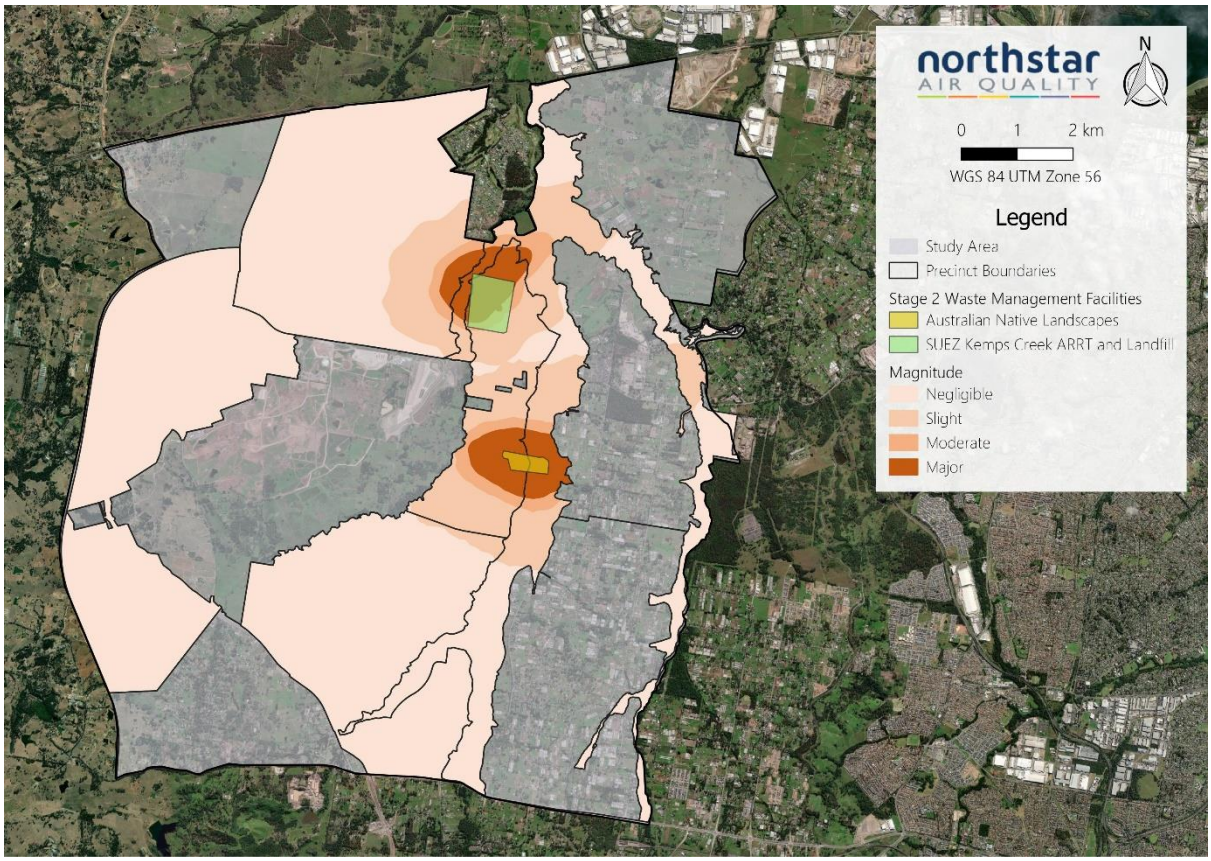


Source: Northstar Air Quality Pty Ltd

4.2.4 Stage 2: Waste and Resource Management

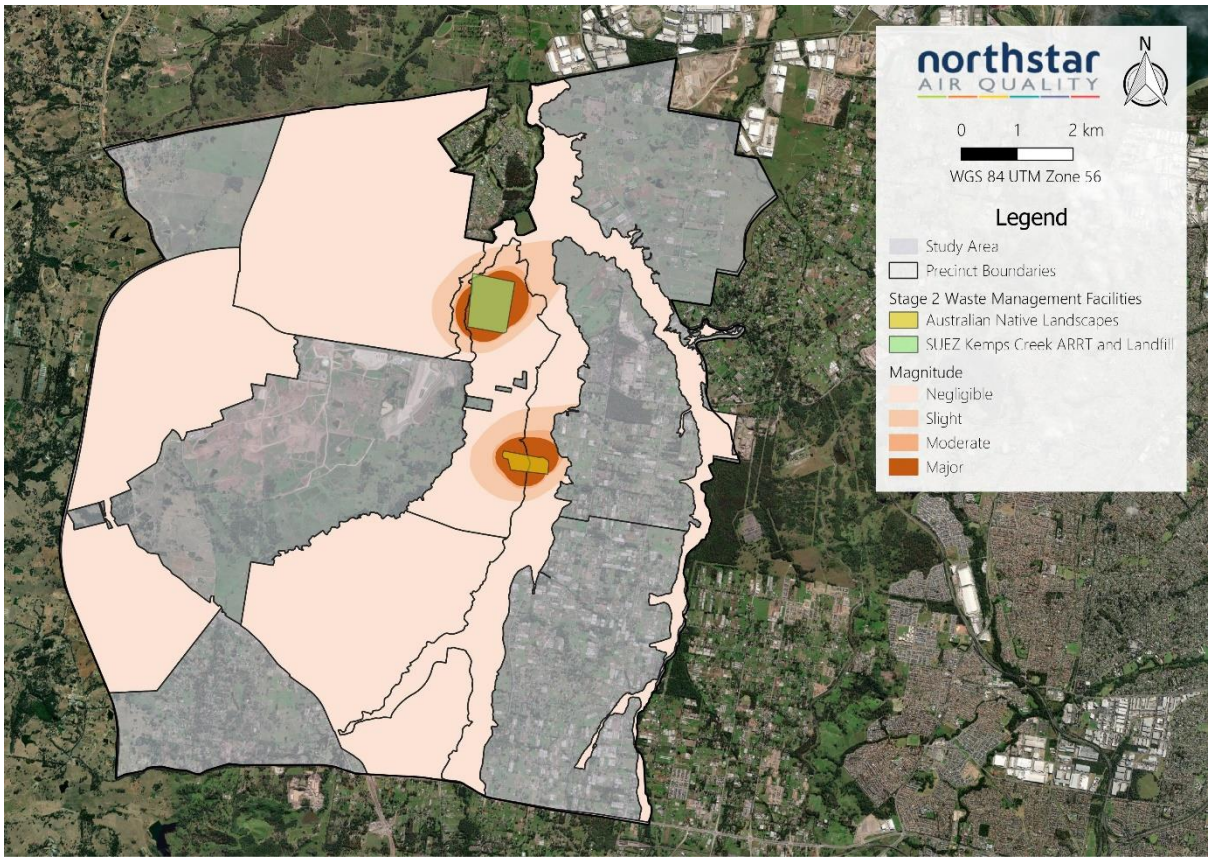
The assessed levels of magnitude associated with odour from waste and resource management activities are illustrated in **Figure 19** and particulates (as PM_{10}) in **Figure 20**.

Figure 19 Magnitude – waste and resource management facilities (odour)



Source: Northstar Air Quality Pty Ltd

Figure 20 Magnitude – waste and resource management facilities (particulates as PM_{10})



Source: Northstar Air Quality Pty Ltd

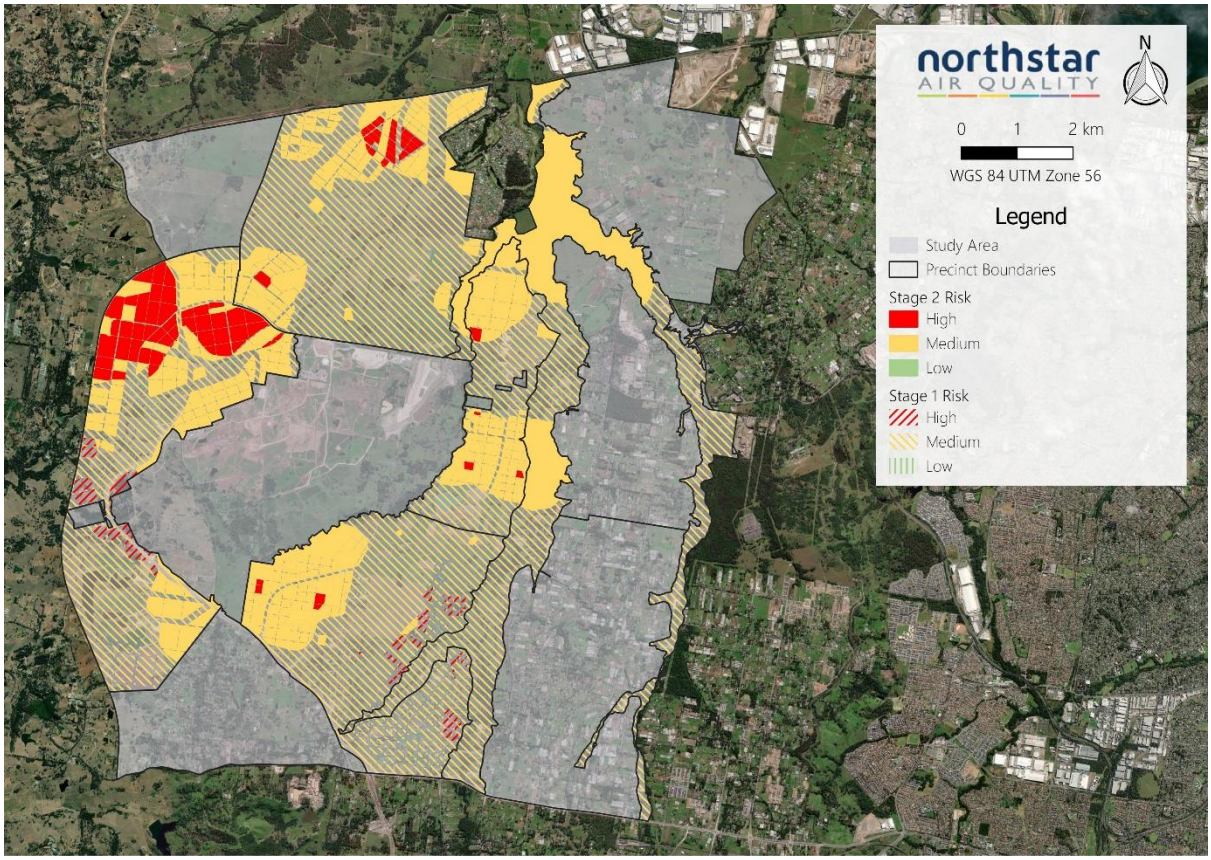
4.3 Risk

The risk assessment is outlined in the following section.

Risk is the product of sensitivity and magnitude.

The assessed levels of risk associated with all activities across all Precincts are illustrated in **Figure 21**. **Figure 21** also presents the Stage 2 risk underlaid with the Stage 1 risk, for comparative purposes.

Figure 21 Risk



Source: Northstar Air Quality Pty Ltd

5. DISCUSSION

Based upon the assumptions outlined in the report, the following discussion is provided.

5.1 Sensitivity

The baseline assessment summarises air quality and odour land use sensitivity over the study area as follows.

Section 4.1 presents the summary of the area assessed by sensitivity classification, with the corresponding percentage of the total, as derived using the method outlined in **Section 3.1**.

This assessment shows that based upon the precinct plan land use designations the distribution of sensitivity varies by precinct. The majority of land in Northern Gateway (46%) is low sensitivity, the majority of land in Agribusiness is of medium (32 %) and high sensitivity (45 %) and the majority of land in Aerotropolis Core, Badgerys Creek and Wianamatta-South Creek is of medium sensitivity (78 %).

This is consistent with the conclusion of the Stage 1 Air Quality and Odour Study – Baseline Study.

5.2 Magnitude

Section 4.2.2 presents the summary of the area assessed by magnitude classification, with the corresponding percentage of the total, as derived using the method outlined in **Section 3.2**.

This assessment shows that the majority (34 % to 71 %) of land is classified as 'slight' magnitude across all precincts, as affected by the sources considered as part of the Stage 2 Air Quality and Odour Study.

5.3 Risk

Section 4.3 presents the summary of the area assessed by risk as derived using the method outlined in **Section 3.3**.

Due to the necessary change in the methodology used to derive risk (see **Section 3.3** and **Table 6**), the integration of aggregated risk contours from the Stage 1 baseline assessment and the Stage 2 assessment is not possible. The principal driver for this is to account for the odour impact assessment criterion (DEC, 2006) (NSW EPA, 2017) and how that is adapted to account for land sensitivity. Correspondingly, the estimation of risk by land area is also not possible as an aggregation between Stage 1 and Stage 2.

To provide an interpretation of the inter-relation of risk between all sources considered in Stage 1, and the selected sources considered in Stage 2, **Section 4.3**, **Figure 21** provides a multi-layered risk map. The risks identified by Stage 2 are provided in bolder coloration (see figure legend) and overlay the risks identified in Stage 1, which are layered beneath in a shaded coloration. In this way, the two risk contours can be visualised, with Stage 1 overwritten by Stage 2. In this way high risk areas identified in Stage 1 (red dashed coloration) are retained.

5.4 Management Strategies

As required by the brief (and discussed in **Section 1.2.3**), this study is required to identify management strategies for controlling air quality and odour risks from the identified sources. The definition of controls is outlined in **Section 3.7**, **Figure 12** and **Table 7**.

In accordance with the risk assessment methodology adopted, high risks should be managed through changes to either sensitivity or magnitude components of the risk. Medium risks should be managed as low as possible.

5.4.1 Elimination

The most effective measure presented on the 'hierarchy of controls' is that of elimination (i.e., the control of risks by eliminating sources and/or receptor).

In practice, this would require the removal of sources and/or reprovision of land to remove the sensitivity so that the corresponding risks are 'managed out'.

This would require decisions at State or Council level, and implementation through policy such as through the Local Environment Plan.

It is beyond the scope of this report to provide any commentary on whether that is acceptable, feasible or desirable, but it offers the most effective risk management option.

5.4.2 Substitution

Alternatively, the measure of 'substitution' may be considered to relocate (rather than remove) the sources and/or sensitive land uses to increase the distance between the two locations.

This is a commonly adopted risk management strategy, implemented through 'separation distances' (i.e., buffers) between sources and sensitive land uses (ACT Government, 2018) (EPA SA, 2016) (EPA VIC, 2013) (NSW DoP, 2008). This is also implemented through land use zoning policy through the Local Environment Plans and Development Control Plans.

5.4.3 Engineering

Engineered controls are typically applied at source to manage the impact magnitude but may also be considered in the pathway and at receptor.

Examples of engineered controls at source may include a program to optimise the ventilation and discharge conditions on poultry farms to enhance dispersion and minimise the footprint of impact magnitude. For more modern farms this may already have been considered as part of the approvals at the development approval process. However, for older farms this may require a degree of assessment and retrofitting which may be commercially unfeasible in some circumstances.

In terms of waste and resource management facilities, engineered controls may include programs to reduce the rate of emission generation and propagation, possibly including (but not limited to):

- Performing activities and process within enclosures, e.g. performing composting operations within atmospherically sealed buildings, or providing wind shielding for open-air stockpiles;
- active mechanical air extraction and ventilation programs to reduce fugitive emissions;
- operation of air pollution control devices on controlled discharges to reduce emissions;
- provision of emission controls on open-air sources, e.g. water sprays of dust—generating processes or improving road surfaces to minimise wheel-generated dust;
- design of discharge points on controlled emissions to optimise dilution through dispersion;
- reducing waste or resource handling frequency;
- improved landfill gas capture systems.

Typically, the imposition of engineered controls would "draw in" the footprint of those operations (magnitude) towards the source, such that magnitude reduces to background levels over less distance.

Engineered controls in the pathway and at receptor may involve passive 'barrier' systems to increase near-ground turbulence and vertical mixing of air, which improves the rate of dilution and dispersion. As air travels towards such barriers, it will tend to rise due to the marginal increase in pressure ahead of the barrier, or otherwise mix as the air passes through the barrier. Examples of such would include:

- Fan wall barriers on forced ventilation poultry sheds;
- Creating of multi-layered vegetated (planted) barriers at the boundary of sources, within the pathway between the source and receptor, and/or at the receptor.
- Creating screens and earth mounds at the boundary of sources, within the pathway between the source and receptor, and/or at the receptor.

5.4.4 Administrative

Administrative measures may be imposed through regulatory controls, which may be enforced by the EPA or Councils. This would essentially be the imposition of performance improvement programs (e.g. Pollution Reduction Program, compliance programs or improvement notices) to identify and manage (reduce) odour and/or particulate generation and propagation to acceptable levels.

In regard to facilities regulated under the *Protection of Environmental Operations Act* (1997), reference should be made to the provisions provided in Section 129:

> ***129 Emission of odours from premises licensed for scheduled activities***
> ***(1) The occupier of any premises at which scheduled activities are carried on under the authority conferred by a licence must not cause or permit the emission of any offensive odour from the premises to which the licence applies.***
> ***(2) It is a defence in proceedings against a person for an offence against this section if the person establishes that—***
> ***(a) the emission is identified in the relevant environment protection licence as a potentially offensive odour and the odour was emitted in accordance with the conditions of the licence directed at minimising the odour, or***
> ***(b) the only persons affected by the odour were persons engaged in the management or operation of the premises.***
> ***(3) A person who contravenes this section is guilty of an offence.***

In regard to poultry farms which are not regulated under the POEO Act, reference should be made to the provisions provided in the Local Environment Plan of the relevant Council.

Reference should also be made to the NSW *Right to Farm* policy and the NSW DPI guidance provided through the *Handbook for managing land use conflict issues on the NSW North Coast*[13] which provides an example framework for such considerations.

5.4.5 Protection

The least effective control measure is that of 'protection', which is applied at the receptor. The equivalence of this is the use of personal protective equipment (PPE) and is considered to be the lowest form of risk management and would generally be applied when alternative control options have been exhausted.

In this regard, protection measures would be the provision of mechanical air ventilation systems (i.e., air conditioning) at sensitive land uses.

[13] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/234001/Living-and-working-in-rural-areas-complete.pdf

5.5 Recommendations

Recommendations relating to odour and air quality control for inclusion in the Development Control Plan are provided in Section 4.4 and 4.6 (respectively) of WSPP (2020) Western Sydney Aerotropolis – Development Control Plan 2020 – Phase 1 (NSW DPIE, 2020), as reproduced below in **Figure 22** and **Figure 23**.

Figure 22 Draft DCP (2020) Condition 4.4

4.4 Odour

4.4.1 Objectives

a) Manage and mitigate the impacts of development in relation to odour.

4.4.2 Performance Outcomes

PO1	Development does not unreasonably affect the amenity and environmental quality of the locality, nearby residential premises, sensitive uses or public spaces due to odour impacts.
PO2	Residential development and other sensitive land uses do not encroach upon existing or approved uses that may impact upon the amenity of those proposed uses in terms of odour nuisance.
PO3	Putrescibles waste generated as a result of the development does not cause odour nuisance issues for adjoining land uses.
PO4	Construction work is undertaken in a manner which does not cause unacceptable impacts on surrounding areas as a result of odour.
PO5	Development is to be in accordance with *Technical framework: Assessment and management of odour from stationary sources in NSW*.

Figure 23 Draft DCP (2020) Condition 4.6

4.6 Air Quality

4.6.1 Objectives

a) Manage and mitigate the impacts of development in relation to air quality.

b) To protect air quality for sensitive uses, including adjoining busy roads and rail corridors.

c) For development located in or adjacent to road corridors and intersections, to incorporate site layout and building design features that address higher level of air emissions generally found in transport corridors.

4.6.2 Performance Outcomes

PO1	Air emissions resulting from development, including the siting of vents and stacks, do not cause environmental harm or nuisance, and surrounding land uses are not exposed to concentrated levels of air contaminants.
PO2	Proposed sensitive land uses are adequately separated from existing lawful land uses that produce air emissions.
PO3	Development is to be in accordance with *Protection of the Environment Operations Act 1997* and other Environmental Protection Authority guidelines for air quality.

Based upon the outcomes of this Air Quality and Odour Study, the controls and mitigation requirements are generally consistent with the performance outcomes contained within the Development Control Plan.

The suggested amendments to section 4.4 of WSPP (2020) Western Sydney Aerotropolis – Development Control Plan 2020 – Phase 1 (NSW DPIE, 2020) are proposed and presented in **Table 11**.

Table 11 Recommended amendments to section 4.4 of the Development Control Plan

Development Control Plan Section 4.4 Provisions for Odour	
PO1	Development (including construction) does not unreasonably affect the amenity and environmental quality of the locality, nearby residential premises, sensitive uses or public spaces due to odour impacts.
PO2	Residential development and other sensitive land uses do not encroach upon existing or approved uses that may impact upon the amenity of those proposed uses in terms of odour nuisance.
PO3	Waste materials generated as a result of the development do not cause odour nuisance issues for adjoining land uses.
PO4	Development is to be in accordance with *Protection of the Environment Operations Act* 1997 and other Environmental Protection Authority guidelines for odour management.

The suggested amendments to section 4.6 of (NSW DPIE, 2020) are proposed and presented in **Table 12**.

Table 12 Recommended amendments to section 4.6 of the Development Control Plan

Development Control Plan Section 4.6 Provisions for Air Quality	
PO1	Development (including construction) does not unreasonably affect the amenity and environmental quality of the locality, nearby residential premises, sensitive uses or public spaces due to air quality impacts.
PO2	Air emissions resulting from development, do not cause environmental harm or nuisance, and surrounding land uses are not exposed to unacceptable levels of air pollutants
PO3	Proposed sensitive land uses are adequately separated from existing lawful land uses that produce air emissions.
PO4	Development is to be in accordance with the *Protection of the Environment Operations Act* 1997 and other Environmental Protection Authority guidelines for air quality.

With regard to performance outcomes PO1 and PO2 presented in section 4.4 and section 4.6 of (NSW DPIE, 2020), reference is made to the evaluation of odour and air quality risk (respectively) and the identified drivers for mitigation through the risk assessment process. As discussed in **Section 3.3**, the assessment of land as 'high' risk requires prioritised additional controls and mitigation, applied through the hierarchy of controls as outlined in **Section 5.4**. However, land assessed as a 'medium' risk also requires the application of appropriate controls (including but not limited to a higher degree of environment assessment, different design or land use, transitional strategy and/or reverse sensitivity, for example) to manage the risks of air pollutants (including odour) as low as reasonably achievable, and to demonstrate compliance with the requirements of the POEO Act (1997) (see **Section 3.4**) and the NSW impact assessment criteria (NSW EPA, 2017), if relevant.

6. REFERENCES

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EPA SA. (2016). *Evaluation Distances for Effective Air Quality and Noise Management.*

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SLR. (2018). *Odour Impact Assessment (Level 3), Lowes Creek Maryland Project, NSW Department of Planning and Environment, September 2018.*

APPENDIX A – STAGE 2 SOURCE IDENTIFICATION

Poultry Farms

Table A1 below provides a summary of the poultry farms assessed as part of the scope of work for the Stage 2 Air Quality and Odour Study. The identified poultry farms are summarised by location, address, estimated number of sheds, and model groups. The table also identifies the assumed ventilation scheme (naturally ventilated sheds or tunnel fan ventilation).

Photographs taken during the site visit performed by Northstar Air Quality on 18th March 2021 are presented in **Appendix B**.

The estimated emission inventories for these sources are presented in **Appendix B**. For some poultry farms, a number of sheds have been aggregated, as indicated.

Table A1 Agriculture (poultry farm) activities identified for Stage 2 assessment

Site Identification on Map	Number of Sheds	Address	Sheds Observed	Ventilation	Operational
13	8	225 Lawson Rd, Badgerys Creek	13.01	Natural	Yes
			13.02	Natural	Yes
			13.03	Natural	Yes
			13.04	Natural	Yes
			13.05	Natural	Yes
			13.06	Natural	Yes
			13.07	Natural	Yes
			13.08	Natural	Yes
16	5	115 Mersey Road, Bringelly	16.01	Fan	Yes
			16.02	Fan	Yes
			16.03	Fan	Yes
			16.04	Fan	Yes
			16.05	Fan	Yes
17	8	135 Mersey Road, Bringelly	17.01	Fan	Yes
			17.02	Fan	Yes
			17.03	Fan	Yes
			17.04	Fan	Yes
			17.05	Fan	Yes
			17.06	Fan	Yes
			17.07	Fan	Yes
			17.08	Fan	Yes
48	5		48.01	Natural	Yes

Site Identification on Map	Number of Sheds	Address	Sheds Observed	Ventilation	Operational
		2550 Elizabeth Dr, Luddenham	48.02	Natural	Yes
			48.03	Natural	Yes
			48.04	Natural	Yes
			48.05	Natural	Yes
49	6	2179 Elizabeth Dr, Luddenham	49.01	Natural	Yes
			49.02	Natural	Yes
			49.03	Natural	Yes
			49.04	Natural	Yes
			49.05	Natural	Yes
			49.06	Natural	Yes
50	18	2903 The Northern Rd, Luddenham	50.01	Natural	Yes
			50.02	Natural	Yes
			50.03	Natural	Yes
			50.04	Natural	Yes
			50.05	Natural	Yes
			50.06	Natural	Yes
			50.07	Natural	Yes
			50.08	Natural	Yes
			50.09	Natural	Yes
			50.10	Natural	Yes
			50.11	Natural	Yes
			50.12	Natural	Yes
			50.13	Natural	Yes
			50.14	Natural	Yes
			50.15	Natural	Yes
			50.16	Natural	Yes
			50.17	Natural	Yes
			50.18	Natural	Yes
57	3	885 Mamre Rd, Kemps Creek	57.01	Fan	Yes
			57.02	Fan	Yes
			57.03	Fan	Yes
58	3	917 Mamre Rd, Kemps Creek	58.01	Fan	Yes
			58.02	Fan	Yes
			58.03	Fan	Yes
60	5	425 Luddenham Rd, Luddenham	60.01	Fan	Yes
			60.02	Fan	Yes
			60.03	Fan	Yes
			60.04	Fan	Yes
			60.05	Fan	Yes

The identification numbers assigned to the sites in **Table A1** correspond to the numbers observed in **Section 3.6**. It should be noted that for poultry farm sheds that could not be confirmed as being fan-ventilated or naturally ventilated, have been for the purposes of this report labelled as fan-ventilated to account for a greater odour risk potential.

Waste and Resource Management Facilities

The waste and resource management facilities assessed as part of the scope of work for the Stage 2 Air Quality and Odour Study are summarised in **Table A2**.

Table A2 Waste management activities identified for Stage 2 assessment

Identified Activity	Address
SUEZ Kemps Creek Advanced Resource Recovery Technology Facility	1725 Elizabeth Drive, Kemps Creek
SUEZ Kemps Creek Landfill	1725 Elizabeth Drive, Kemps Creek
Australian Native Landscapes	210 Martin Road, Badgerys Creek

APPENDIX B – POULTRY FARM EMISSION ASSUMPTIONS AND ESTIMATES

Emission Estimates and Assumptions – poultry farming activities

The information used to characterise the processes and potential emissions from the identified poultry farming activities is presented in **Table B1** and **Table B2**.

Table B1 Summary of poultry farm locations and operational status

ID	Address	Operational	Farm Type	Ventilation Type	# Sheds	# Birds
13	225 Lawson Rd, Badgerys Creek	Yes	Duck	Natural	3	71 061
16	115 Mersey Road, Bringelly	Yes	Turkey	Fan	5	44 400
17	135 Mersey Road, Bringelly	Yes	Duck	Fan	8	78 105
48	2550 Elizabeth Dr, Luddenham	Yes	Duck	Natural	9	45 350
49	2179 Elizabeth Dr, Luddenham	Yes	Duck	Natural	2	79 137
50	2903 The Northern Rd, Luddenham	Yes	Broiler	Natural	7	238 484
57	885 Mamre Rd, Kemps Crek	Yes	Broiler	Fan	3	99 818
58	917 Mamre Rd, Kemps Creep	Yes	Broiler	Fan	3	109 818
60	425 Luddenham Rd, Luddenham	Yes	Broiler	Fan	5	163 782

Table B2 General calculations – poultry farming activities

General Calculations – poultry farming activities	
Stocking density [14]	Naturally ventilated sheds - 28 kg·m^{-2} Mechanically ventilated sheds - 40 kg·m^{-2}
Area of sheds	Calculated from length and width of shed as identified through Google Earth Imagery
Ventilation rate (mechanically ventilated sheds)	10 m^{3}·hr^{-1}·bird^{-1} [15]

[14] https://www.publish.csiro.au/ebook/download/pdf/3451

[15] https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/60358/Poultry-Modelling-Guidance-Report-2.pdf

APPENDIX C – WASTE AND RESOURCE MANAGEMENT EMISSION ASSUMPTIONS AND ESTIMATES

Emission Estimates and Assumptions - SUEZ Advanced Waste Treatment Facility

The information used to characterise the processes and potential emissions from the SUEZ Advanced Waste Treatment facility is presented in **Table C1** and **Table C2**.

Table C1 General information – SUEZ Advanced Waste Treatment (SAWT) Facility

General Information – SUEZ Advanced Waste Treatment Facility		
Name	SUEZ Recycling & Recovery Pty Ltd	
Address	1725 Elizabeth Drive, Kemps Creek NSW 2178	
EPL #	12889 [16]	
Scheduled Activity	Composting Resource recovery Waste storage	>50 000 t annual capacity to receive organics Any general waste recovered Any other types of waste stored
Specific relevant EPL conditions		
L3.1 Waste	Specific wastes permitted to be received at the premises	General solid waste (putrescible) General solid waste (non putrescible) Biosolids categorised as restricted use 1, 2 or 3, in accordance with the criteria set out in the biosolids guidelines
L3.3 Waste	The authorised amount of waste permitted on the premises cannot exceed 32,100 tonnes at any one time.	
L6.1 Hours of operation	Waste Receipt, outdoor operations & product dispatch	Mon to Fri 6am to 6pm Sat 8am to 5pm Sun 8am to 4pm
	Outdoor operations	Mon to Fri 6pm to 10pm Public holidays 7am to 4pm
	Indoor operations	Mon to Sat 7am to 11pm
	In case of emergency	Anytime

[16] https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=163388&SYSUID=1&LICID=12889

General Information – SUEZ Advanced Waste Treatment Facility		
	Completely cover waste derived organic material, stored outside with impervious sheeting	Everyday 4.30pm to 8am
	Turning, processing and refining of waste derived organic material stored outside	Mon to Sat 8am to 4.30pm Sun 8am to 4pm Public holidays 8am to 4pm
O5.2 Odour management	The licensee must ensure the facility is built and operated to minimise odours. This must include: a) all composting must be undertaken within enclosed tunnels; b) composting must be undertaken for set periods of time and at certain temperatures, oxygen and moisture levels so that the composted material has been fermented properly and is adequately stabilized prior to any outdoor storage of the composted material (parameters to be agreed with the EPA); c) all exhaust air from the Receival Hall, Composting Tunnels and Drying Tunnels (also known as the Biocell Building) must pass through biofilters; d) the biofilters attached to the Receival Hall and Composting Tunnels must be of a deep bed design and have vented roofs; e) a system of three leachate ponds must be used on site, to minimise the surface area of odorous leachate. f) all composting is undertaken in accordance with "The organic outputs derived from mixed waste order 2014." g) All emissions generated by the pre-refinery trommel must be diverted back into the SAWT Receival Hall and pass through the biofilters	
O5.5 Odour management	A maximum of 8 complete windrows and 2 partially formed windrows containing maturing organic material produced from Food and Garden Organics ("FGO") is permitted to be stored outside at any one time.	
O6.3 Waste management	The total outdoor surface area used for maturation, processing and storage of waste derived organic material must be less than 10,000m^2.	

Table C2 Available information to support quantitative assessment– SUEZ Advanced Waste Treatment Facility

Emission Assumptions and Estimates - SUEZ Advanced Waste Treatment Facility			
Any publicly available information relating to emissions?	Odour:	YES ☒	NO ☐
	Particulates:	YES ☒	NO ☐

Emission Assumptions and Estimates - SUEZ Advanced Waste Treatment Facility		
Data source(s)	AQIA for the "Expansion of the Advanced Waste Treatment Facility, Kemps Creek Resource Recovery Precinct" (AECOM, 2013) – now withdrawn	
Assumptions (Particulate matter)	As presented in (AECOM, 2013) for the existing (at that time) facility – assumed to be reflective of current operations.	
Assumptions (Odour)	Activity data Taken from (AECOM, 2013) SSO Leachate pond: 1 000 m^2 MSW Leachate pond: 700 m^2 Compost storage pad (MSW): 10 017 m^2 Compost storage pad (SSO): 3 360 m^2 Biofilter section 1: unknown Biofilter section 2: unknown Biofilter section 3: unknown Biofilter section 4: unknown Emission rates Taken from (AECOM, 2013) – site specific measurements SSO Leachate pond: 0.41 $OU \cdot m^{-2} \cdot s^{-1}$ MSW Leachate pond: 0.69 $OU \cdot m^{-2} \cdot s^{-1}$ Compost storage pad (MSW): 0.41 $OU \cdot m^{-2} \cdot s^{-1}$ Compost storage pad (SSO): 0.55 $OU \cdot m^{-2} \cdot s^{-1}$ Biofilter section 1: 16 898 $OU \cdot s^{-1}$ Biofilter section 2: 16 898 $OU \cdot s^{-1}$ Biofilter section 3: 16 898 $OU \cdot s^{-1}$ Biofilter section 4: 16 898 $OU \cdot s^{-}$ Emission controls No additional controls applied – included in emissions inventory	
Emissions	Odour (aggregated to total site) 74 440 $OU \cdot s^{-1}$ (daytime) 6 848 $OU \cdot s^{-1}$ (nighttime)	Particulates (PM_{10}) (aggregated to total site) 0.04 $g \cdot s^{-1}$ (daytime) 8E-07 $g \cdot s^{-1}$ (nighttime)

Emission Estimates and Assumptions - SUEZ Elizabeth Drive Landfill

The information used to characterise the processes and potential emissions from the SUEZ Elizabeth Drive landfill is presented in **Table C3** and **Table C4**.

Table C3 General information – SUEZ Elizabeth Drive Landfill

General Information – SUEZ Elizabeth Drive Landfill		
Name	SUEZ Recycling & Recovery Pty Ltd	
Address	1725 Elizabeth Drive, Kemps Creek NSW 2178	
EPL #	4068 [17]	
Scheduled Activity	Electricity generation Waste disposal (application to land) Waste storage	0 – 250 GWh annual generating capacity Any capacity Any other types of waste stored
Specific relevant EPL conditions		
L3 Waste	Specific wastes permitted to be received at the premises	General solid waste (non-putrescible) Asbestos waste Waste tyres Restricted solid waste NOTE Only food and garden waste permitted to be processed (non-thermal treatment)
L3.5 Stockpiles	The volume of unshredded and shredded garden waste and wood waste stockpiled at the Premises must not exceed 2,000 cubic metres (m_3) at any one time.	
L3.6 Stockpiles	The volume of demolition material, concrete, broken tiles, blast furnace slag, and bricks stored or stockpiled for the purpose of landfill operations must not exceed 2,000 cubic metres (m^3) at any one time.	
L6.1 Hours of operation	All quarrying and waste compaction activities at the premises must only be conducted between the following hours: 7.00am to 6.00pm Monday to Friday; 7.00am to 5.00pm Saturdays; and 8.00am to 5.00pm Sundays and Public Holidays.	
L6.2 Hours of operation	All waste receipt activities at the premises must only be conducted between the following hours: 6.00am to 6.00pm Monday to Friday; 7.00am to 5.00pm Saturdays; and 8.00am to 5.00pm Sundays and Public Holidays.	
O6.1 Waste management	General solid waste which is to be landfilled at the premises must be deposited within landfill cells D1, E3, E4, F2A, F1A, F3A, F1B, F2B, F3B, F4, F5 and F6 only.	
O6.6 Covering of waste	a) Daily cover Daily cover material must be either: i) virgin excavated natural material (VENM); or ii) approved alternative daily cover (ADC).	

[17] https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=208362&SYSUID=1&LICID=4068

General Information – SUEZ Elizabeth Drive Landfill	
	Daily cover material must be applied to a minimum depth of 15 centimetres over all exposed and filled waste prior to ceasing operations at the end of each day. b) Intermediate cover Virgin excavated natural material (VENM) must be applied to a depth of 30 centimetres over surfaces of the landfilled waste at the premises which are to be exposed for more than 90 days. c) Cover material stockpile At least two weeks cover material must be available at the premises under all weather conditions. This material may be won on site, or alternatively a cover stockpile must be maintained adjacent to the tip face.
O6.7 Covering of waste	For the purposes of condition O6.6 (a) (ii) the approved ADC is either: 1. ConCover that achieves the performance criteria specified in Section 8 Covering of Waste of NSW EPA Environmental Guidelines Solid Waste Landfills Second Edition, 2016; or 2. a tarpaulin system (Tarpomatic or similar). ADC is not approved for use on the Restricted Solid Waste Landfill Cells.

Table C4 Available information to support quantitative assessment– SUEZ Elizabeth Drive landfill

Emission Assumptions and Estimates – SUEZ Elizabeth Drive Landfill			
Any publicly available information relating to emissions?	Odour:	YES ☒	NO ☐
	Particulates:	YES ☐	NO ☒
(Alternative) data source(s)	AQIA for the "Expansion of the Advanced Waste Treatment Facility, Kemps Creek Resource Recovery Precinct" (AECOM, 2013) – now withdrawn Google Earth imagery – site layout Assumptions		
Assumptions (Particulate matter)	<u>Activity data</u> Site throughput – 500 000 tpa Quantity of material handling – 1 000 000 tpa (i.e., assumed materials handled 2 times) Capacity of vehicles for delivery– 30 t Number of delivery vehicles – 16 667 per annum (500 000 t / 30 t) Distance travelled by each vehicle whilst on site – 1 500 m (round trip) Total vehicle kilometres travelled – 25 000 VKT per annum (16 667 × 1.5 km) Area of site subject to wind erosion – 28 ha <u>Emission controls</u> Watering of haul roads (50 % control)		

Emission Assumptions and Estimates – SUEZ Elizabeth Drive Landfill		
	Watering of stockpiles (50 % control)	
Assumptions (Odour)	<u>Activity data</u> Taken from (AECOM, 2013) General waste - active tip face (daytime) 700 m^2 General waste - daily cover (night time) 1 500 m^2 General waste - intermediate cover 113 000 m^2 Restricted waste - active tip face (daytime) 100 m^2 Restricted waste - daily cover (night time) 100 m^2 Restricted waste - intermediate cover 57 000 m^2 Capped area (Cells C1, C2 and D1) 120 000 m^2 Capped area (Cells E1 and D1) 40 000 m^2 Capped area (Cells A1 - A3) 20 000 m^2 <u>Emission rates</u> Taken from (AECOM, 2013) – site specific measurements General waste - active tip face (daytime) 22.99 $OU \cdot m^{-2} \cdot s^{-1}$ General waste - daily cover (night time) 2.24 $OU \cdot m^{-2} \cdot s^{-1}$ General waste - intermediate cover 0.03 $OU \cdot m^{-2} \cdot s^{-1}$ Restricted waste - active tip face (daytime) 0.39 $OU \cdot m^{-2} \cdot s^{-1}$ Restricted waste - daily cover (night time) 0.22 $OU \cdot m^{-2} \cdot s^{-1}$ Restricted waste - intermediate cover 0.1 $OU \cdot m^{-2} \cdot s^{-1}$ Capped area (Cells C1, C2 and D1) 0.01 $OU \cdot m^{-2} \cdot s^{-1}$ Capped area (Cells E1 and D1) 0.01 $OU \cdot m^{-2} \cdot s^{-1}$ Capped area (Cells A1 - A3) 0.01 $OU \cdot m^{-2} \cdot s^{-1}$ <u>Emission controls</u> No additional controls applied – included in emissions inventory (e.g. cover, capping etc.)	
Emissions	Odour (aggregated to total site) 27 022 $OU \cdot s^{-1}$ (daytime) 14 272 $OU \cdot s^{-1}$ (nighttime)	Particulates (PM_{10}) (aggregated to total site) 0.54 $g \cdot s^{-1}$ (daytime) 0.19 $g \cdot s^{-1}$ (nighttime)

Emission Estimates and Assumptions – Australian Native Landscapes

The information used to characterise the processes and potential emissions from the Australian Native Landscapes facility is presented in **Table C5** and **Table C6**.

Table C5 General information – Australian Native Landscapes

General Information – Australian Native Landscapes		
Name	Australian Native Landscapes Pty Ltd	
Address	210 Martin Road, Badgerys Creek NSW 2555	
EPL #	4625 [18]	
Scheduled Activity	Composting Waste processing (non-thermal treatment) Waste storage	>50 000 t annual capacity to receive organics Any annual processing capacity Any other types of waste stored
Specific relevant EPL conditions		
L2 Waste	Specific wastes permitted to be received at the premises	Food waste Foundry sands Wood waste VENM Biosolids Garden waste Boiler flyash Waste coffee grounds Spent mushroom compost Tobacco waste Organic non-odorous DAF sludges Spent filter sand medium Spent biofilter medium NOTE Only food and garden waste permitted to be processed (non-thermal treatment)
L2.2 Food and Organic drying shed	The amount of Food Organics and Garden Organics to be received at the premises per day must not exceed 200 tonnes.	
L2.3 Food and Organic drying shed	Food Organics and Garden Organics received at the premises must only be unloaded, loaded, stored, processed and transferred within the enclosed drying shed.	
L4 Hours of operation	0700 to 1700 Monday to Saturday	

[18] https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=138341&SYSUID=1&LICID=4625

Table C6 Available information to support quantitative assessment– Australian Native Landscapes

Emission Assumptions and Estimates – Australian Native Landscapes			
Any publicly available information relating to emissions?	Odour:	YES ☐	NO ☒
	Particulates:	YES ☐	NO ☒
Alternative data source(s)	Google Earth imagery – site layout Assumptions		
Assumptions (Particulate matter)	<u>Activity data</u> Site throughput – 200 000 tpa Processing (screening) – 100 000 tpa Quantity of material handling – 1 000 000 tpa (i.e., assumed materials handled 5 times) Capacity of vehicles for delivery and dispatch – 30 t Number of delivery vehicles – 6 667 per annum (200 000 t / 30 t) Number of dispatch vehicles – 6 667 per annum (200 000 t / 30 t) Distance travelled by each vehicle whilst on site – 850 m (round trip) Total vehicle kilometres travelled – 11 333 VKT per annum ((6 667 + 6 667) × 0.85 km) Area of site subject to wind erosion – 33 ha <u>Emission controls</u> Watering of haul roads (50 % control) Watering of stockpiles (50 % control)		
Assumptions (Odour)	<u>Activity data</u> 'Active' site area – 33 ha Fresh waste material storage – 20 % of site – 6.6 ha Maturation windrows – 40 % of site – 13.2 ha Final product storage – 20 % of site – 6.6 ha Screening area / storage - 17 % of site – 5.6 ha Fresh waste material (FOGO building) – 3 % of site – 0.2 ha <u>Emission rates</u> Based on literature review presented in (SLR, 2018) (performed on behalf of NSW DPE) Fresh waste material storage – 0.25 $OU \cdot m^{-2} \cdot s^{-1}$ (green waste stockpile, Myocum Landfill (KMH, 2011)) Maturation windrows – 0.46 $OU \cdot m^{-2} \cdot s^{-1}$ (green waste maturation area, Woy Woy AWT (URS, 2007)) Final product storage – 0.46 $OU \cdot m^{-2} \cdot s^{-1}$ (final product, Woy Woy AWT (URS, 2007)) Screening area / storage – assumed no odour Based on data presented in (EAQ Consulting, 2020) Fresh waste material (FOGO building) – 8 $OU \cdot m^{-2} \cdot s^{-1}$ (FOGO stockpiling)		

Emission Assumptions and Estimates – Australian Native Landscapes		
	Emission controls Enclosure of FOGO building (80 % control)	
Emissions	Odour (aggregated to total site) 123 748 $OU \cdot s^{-1}$ (daytime) 123 748 $OU \cdot s^{-1}$ (nighttime)	Particulates (PM_{10}) (aggregated to total site) 0.54 $g \cdot s^{-1}$ (daytime) 0.19 $g \cdot s^{-1}$ (nighttime)

APPENDIX D – BACKGROUND AIR QUALITY CONDITIONS

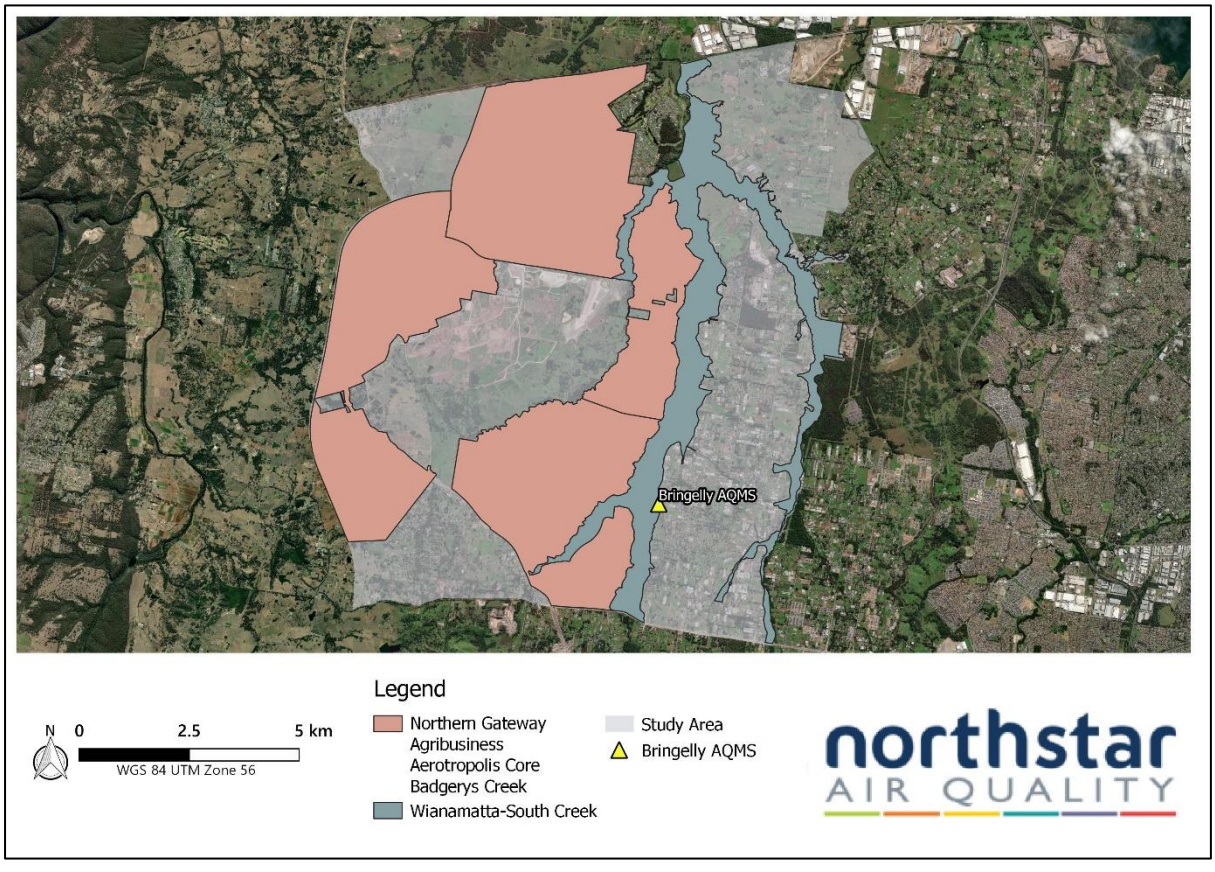
Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment (DPIE) at Bringelly air quality monitoring station (AQMS) located on Badgerys Creek Road within the study area. Details of the monitoring performed at Bringelly AQMS is presented in **Table D1** and **Figure D1**.

Although the background air quality is not being used for a quantitative analysis in this assessment, data for PM_{10} and $PM_{2.5}$ at Bringelly AQMS for the period 2010 to 2020 has been detailed to provide a characterisation of the air quality conditions experienced in the study area.

Table D1 Details of Bringelly AQMS

AQMS Location	Data Availability	Screening Parameters		
		Measurements		
		PM_{10}	$PM_{2.5}$	TSP
Bringelly	1992 -2020	✓	✓	×

Figure D2 Location of Bringelly AQMS



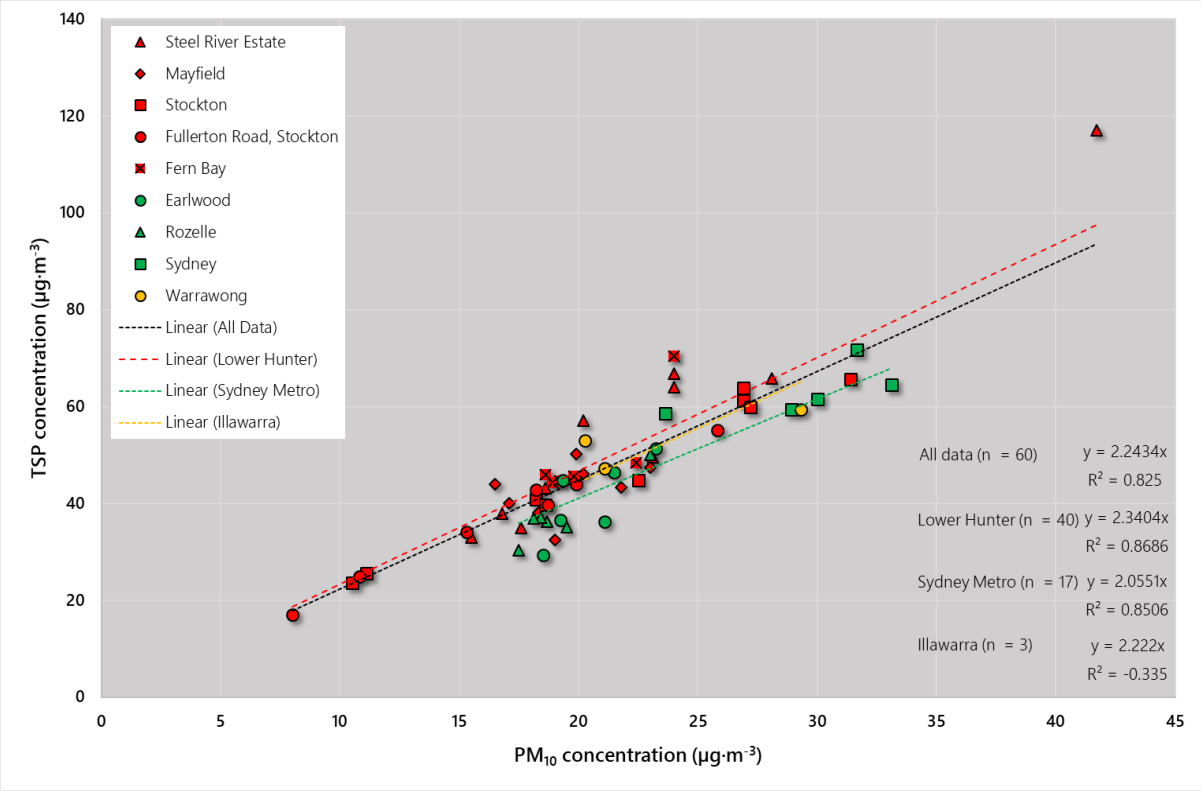
Summary statistics for PM_{10} and $PM_{2.5}$ data are presented in **Table D2**.

Concentrations of TSP are not measured by the NSW DPIE at Bringelly AQMS. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure D2**.

The analysis concludes that, on the basis of the measurements collected across NSW between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.0551 : 1 (i.e., PM_{10} represents ~48 % of TSP) is appropriate to be applied to measurements in the Sydney Metro area.

In the absence of any more specific information, this ratio has been adopted for the purposes of this background assessment. These estimates have not been adjusted for background exceedances.

Figure D1 Co-located TSP and PM_{10} measurements, Lower Hunter, Sydney Metro and Illawarra



Graphs presenting the daily varying PM_{10} and $PM_{2.5}$ data recorded at Bringelly for the period 2010 to 2020 are presented in **Figure D3** and **Figure D4**, respectively.

Table D2 Summary of background air quality data (Bringelly 2010 to 2020)

Pollutant	TSP (µg·m^{-3})	PM_{10} (µg·m^{-3})	$PM_{2.5}$ (µg·m^{-3})
Averaging Period	Annual	24-Hour	24-Hour
Data Points (number)	3962	3962	1589
Mean	36.7	17.8	8.7
Standard Deviation	-	11.0	8.8
Skew[1]	-	5.1	8.2
Kurtosis[2]	-	61.2	115.0
Minimum	-	-0.2	0.4
Percentiles (µg·m^{-3})			
1	-	4.5	1.7
5	-	7.0	2.7
10	-	8.4	3.4
25	-	11.6	4.8
50	-	15.8	7.0
75	-	21.6	9.9
90	-	28.1	13.8
95	-	33.5	17.4
97	-	37.4	23.7
98	-	42.5	31.7
99	-	59.9	45.3
Maximum	36.7	241.8	178.0
Data Capture (%)	98.61%	98.61%	39.55%

Notes: **1:** Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure D3 Long-term 24-hour average PM_{10} concentrations – Bringelly AQMS – 2010 to 2020

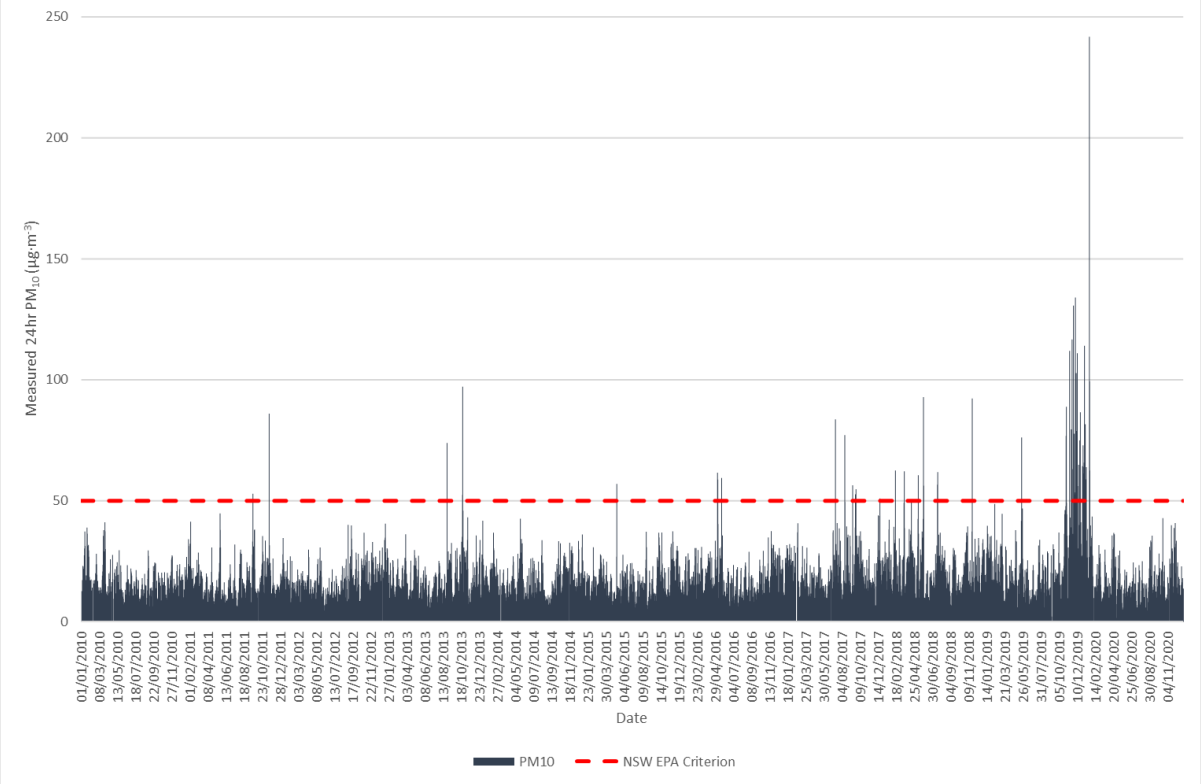
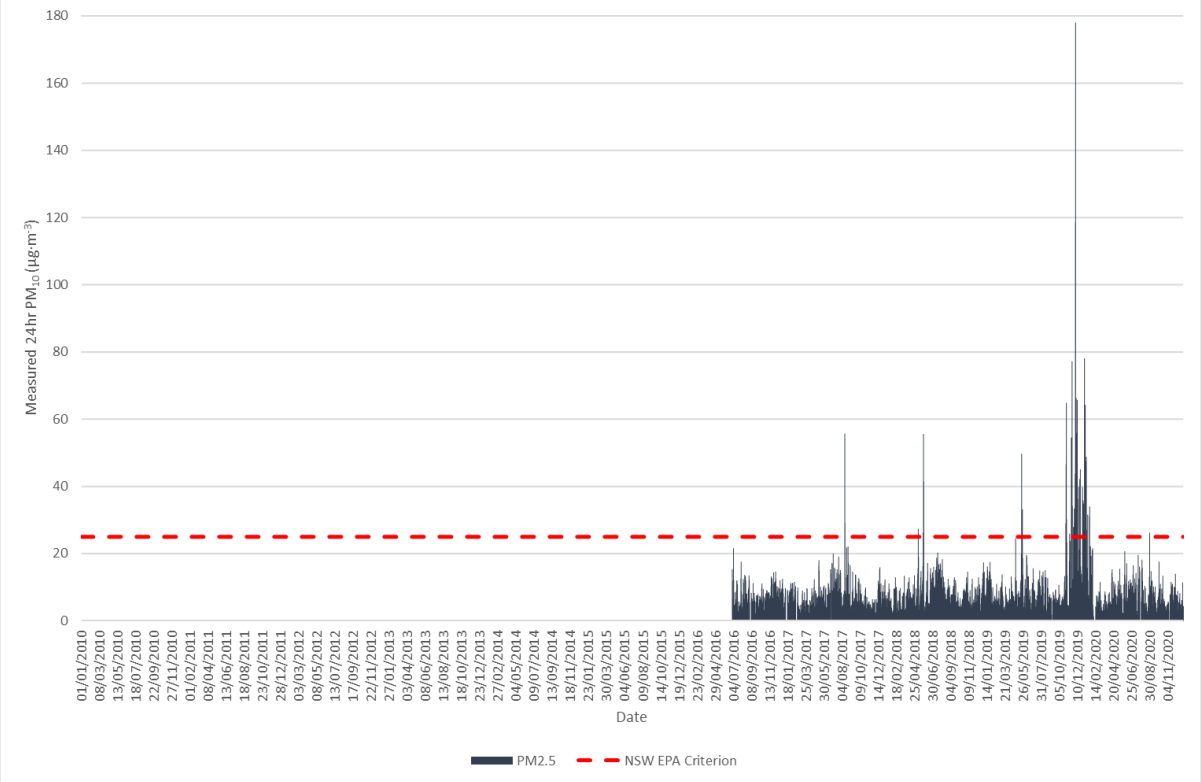


Figure D4 Long-term 24-hour average $PM_{2.5}$ concentrations – Bringelly AQMS – 2010 to 2020



APPENDIX E – METEOROLOGY

As discussed in **Section 2.2** meteorological data has been analysed to characterise the meteorology of the study area. The meteorological monitoring has been based on measurements taken Badgerys Creek automatic weather stations (AWS) operated by the Bureau of Meteorology (BoM) due to its location within the study area.

A summary of Badgerys Creek AWS is provided in **Table E1** and its location is also illustrated in **Figure E1**.

Table E1 Details of Badgerys Creek AWS

Site Name	Data Availability	Approximate Location (UTM)	
		mE	mS
Badgerys Creek AWS – Station # 67108	1998-2020	289,907	6,246,949

Figure E1 Location of Badgerys Creek AWS

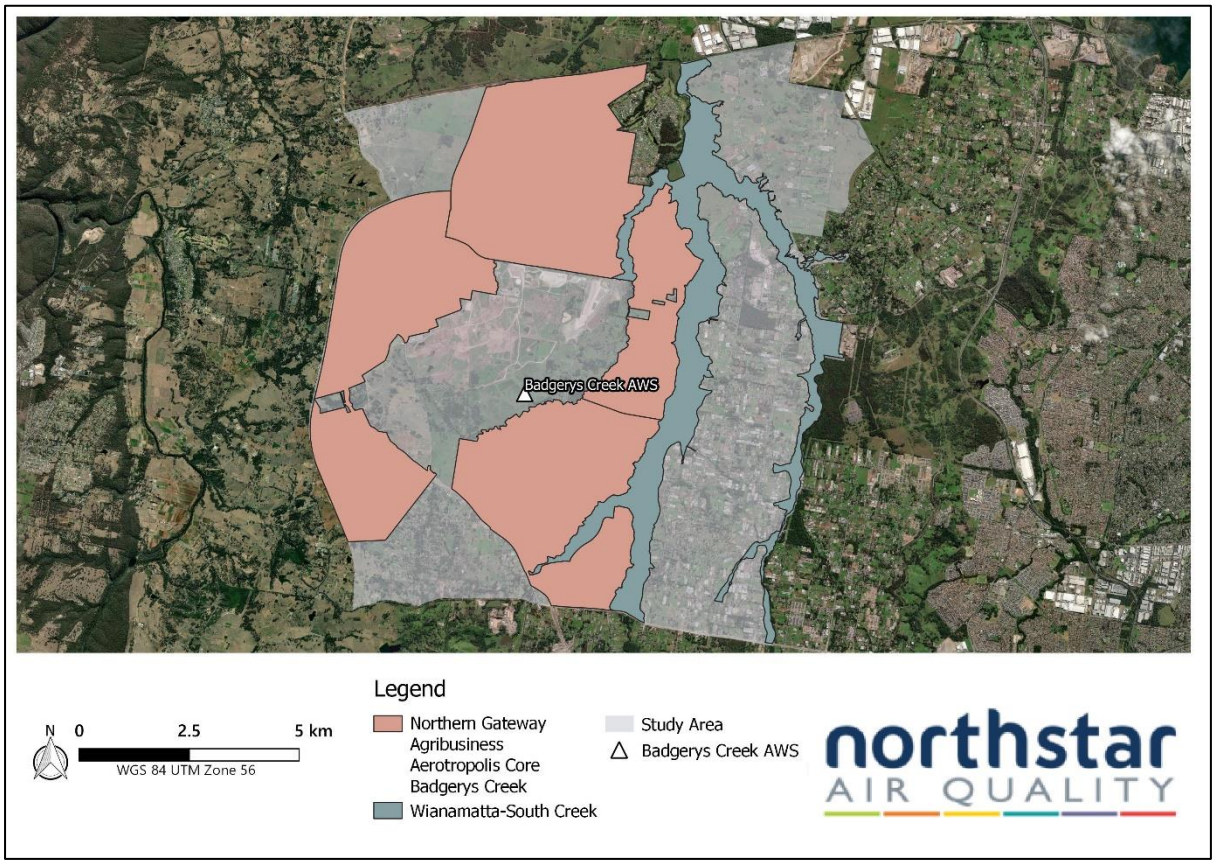


Image courtesy of Google Earth, adapted by Northstar Air Quality

Meteorological conditions at Badgerys Creek AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Presented in **Figure E2** are the annual wind roses for the most recent years of data (2016 to 2020) and in **Figure E3** the annual wind speed distribution.

The wind roses indicate that from 2016 to 2020, winds at Badgerys creek AWS are predominantly experienced from the southwest with north-easterly components also evident.

The majority of wind speeds experienced at the Badgerys Creek AWS between 2016 and 2020 are generally in the range 0.5 metres per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from south-westerly and westerly directions. Winds of this speed are rare and occur during 1.7 % of the observed hours during the years. Calm winds (<0.5 $m \cdot s^{-1}$) occur more than 8.1 % of hours across the years.

Figure E2 Annual wind roses 2016 to 2020, Badgerys Creek AWS

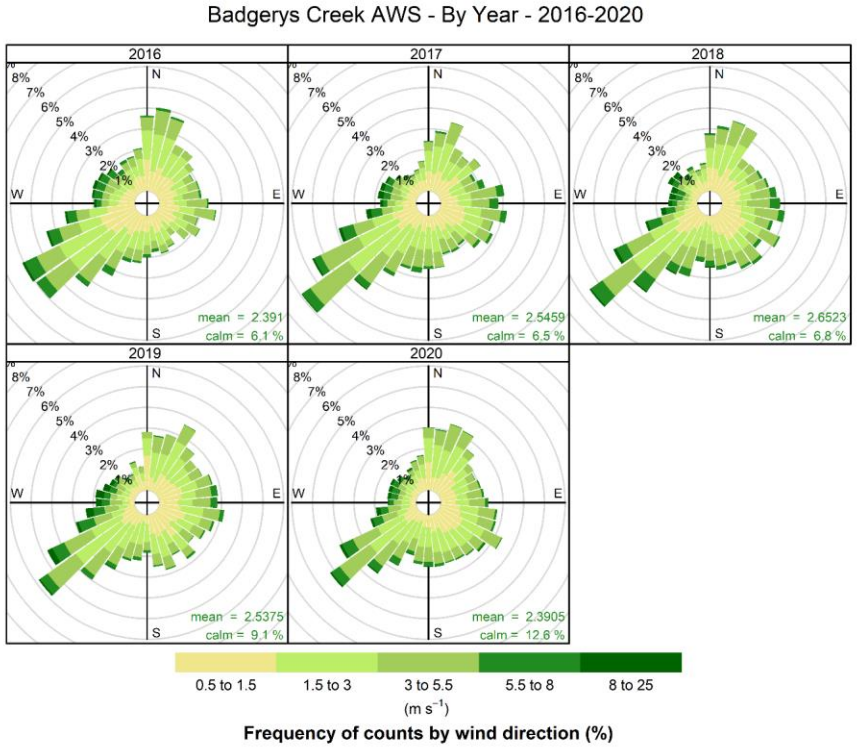
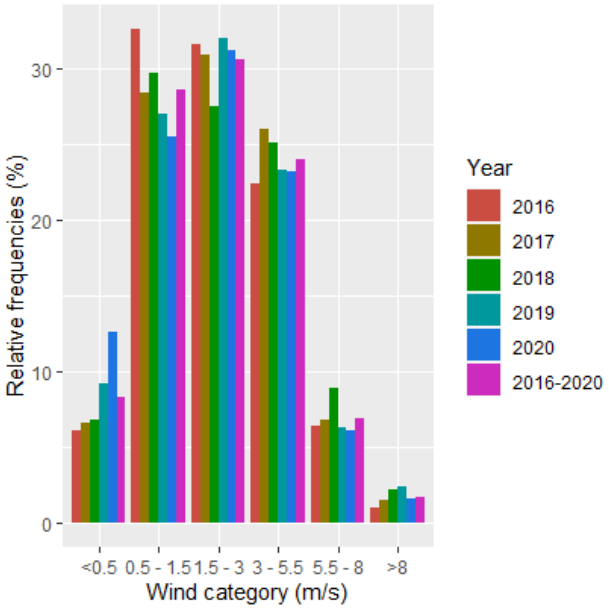


Figure E3 Annual wind speed distribution 2016 to 2020, Badgerys Creek AWS



APPENDIX F – DISPERSION MODELLING

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF Atmospheric Dispersion Model. CALPUFF is a multi-layer, multi-species, non-steady-state Gaussian puff dispersion model that is able to simulate the effects of time- and space-varying meteorological conditions on pollutant transport.

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the study area. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

Meteorological conditions representative of the study area was generated using The Air Pollution Model (TAPM, v 4.0.5). TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere in a format suitable for using in the CALPUFF dispersion model.

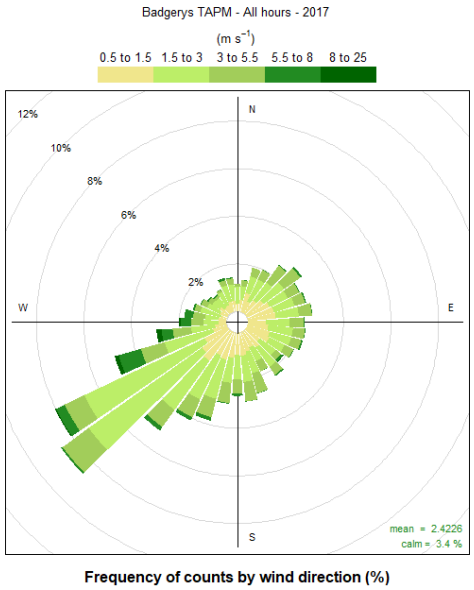
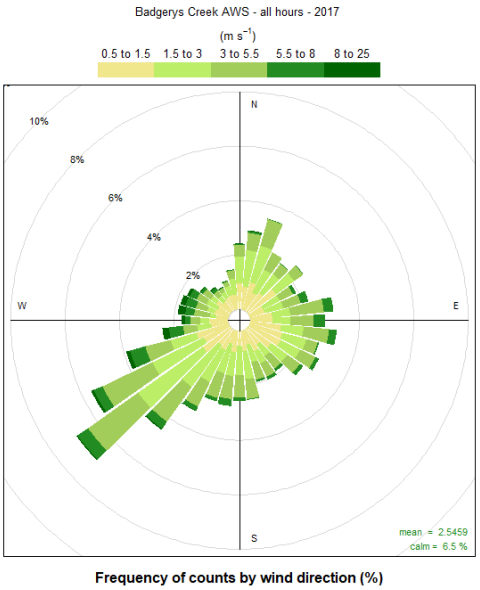
The parameters used in TAPM modelling are presented in **Table F1**.

Table F1 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2017 to 31 December 2017
Centre of analysis	291 142 mE, 6 248 484 mN (UTM Coordinates)
Number of grid points	25 × 25 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	-

A comparison of the TAPM generated meteorological data, and that observed at the Badgerys creek AWS, is presented in **Figure F1**. These data compare well which provides confidence that the meteorological conditions modelled as part of this assessment are appropriate.

Figure F1 Modelled and observed meteorological data – Badgerys Creek 2017

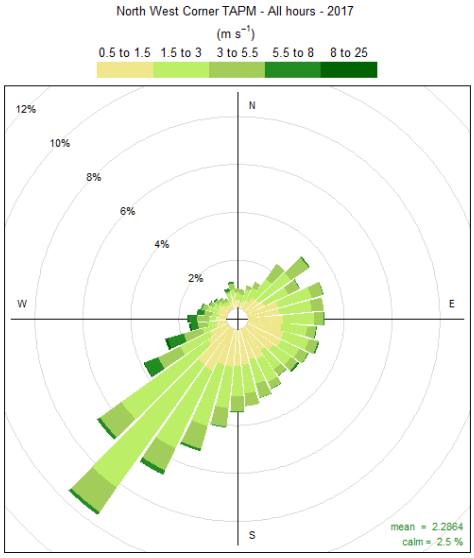
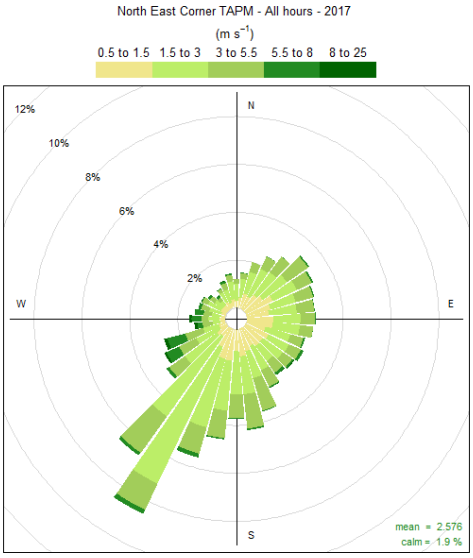
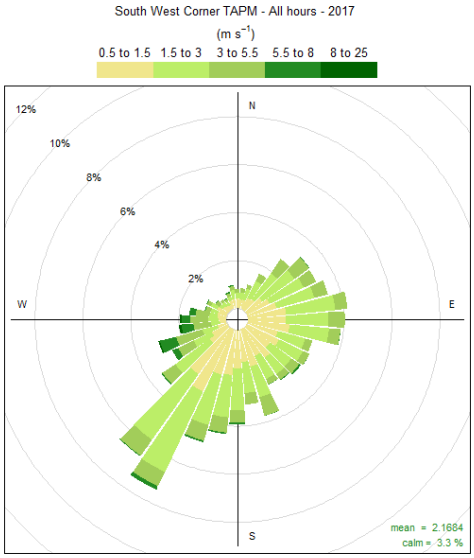
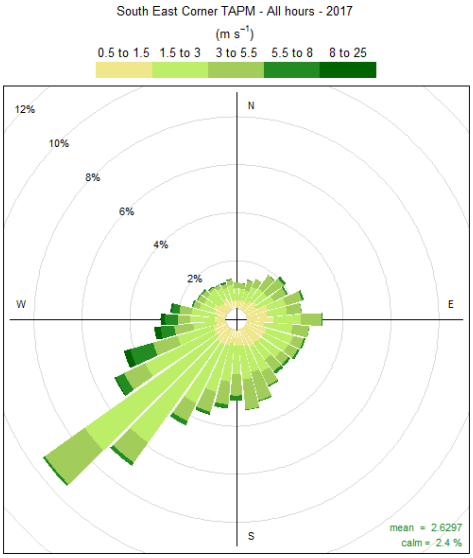
TAPM generated windrose	Observations at Badgerys creek AWS
	

The modelled meteorological data have been extracted at 4 locations of the study area (corners) in order to analyse their spatial variability. **Table F2** present the coordinates of the locations and **Figure F2** displays the modelled meteorological data at these locations.

Table F2 TAPM extraction locations (study area corners)

UTM zone 56H	Easting (mE)	Northing (mS)
North west	28 5142	6 253 484
South west	285 142	6 241 484
North east	298 142	6 255 484
South east	296 142	6 240 484

Figure F2 Modelled meteorological data extracted at the corners of the study area

TAPM North West	TAPM North East
	
Frequency of counts by wind direction (%)	**Frequency of counts by wind direction (%)**
TAPM South West	**TAPM South East**
	
Frequency of counts by wind direction (%)	**Frequency of counts by wind direction (%)**

The wind roses indicate that at the corners of the study area, winds are generally comparable and predominantly generated from the southwest with north-easterly components also apparent. The winds extracted at these locations are also similar in distribution to those modelled at Badgerys Creek.

Given the similarity of the wind roses across the study area a detailed assessment using a 3-D meteorological dataset is not warranted. The modelling has been performed in CALPUFF 2-dimensional (2-D) mode using the meteorological dataset generated at Badgerys Creek.