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Little Italy Coffee Roasters, Belrose

Air Quality and Odour Assessment

Addressee(s):	Little Italy Coffee Roasters Pty Ltd
Site Address:	1/1 Minna Close, Belrose NSW
Report Reference:	25.1020.FR1V1
Date:	26 February 2025
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Quality Control

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Final Authority

This report must by regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below. A draft report is a working document, is issued without prejudice and is subject to change.

Martin Doyle **26 February 2025**

NON-TECHNICAL SUMMARY

Northstar was commissioned to perform an air quality assessment to assess the potential air quality impacts associated with a proposed coffee roasting facility located at 1/1 Minna Close, Belrose NSW.

A two staged approach was undertaken as follows:

- **Stage 1**: Perform an air quality risk assessment to identify proposed activities that have potential high risks of adverse air quality impacts at surrounding land uses without consideration of any emissions control measures.
- **Stage 2**: Perform a dispersion modelling assessment in accordance *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2022) and *Assessment and Management of Odour from Stationary Sources in NSW – Technical framework* (DECC, 2006) to provide an assessment of predicted off-site odour impacts resulting from the potential high risk activities identified in Stage 1.

The findings of the risk assessment undertaken for Stage 1 of the assessment indicates that all processes could be appropriately managed with exception of the proposed coffee roasting activities which were associated with *high* risks of adverse impact resulting in adverse odour impacts without appropriate emission control.

Dispersion modelling undertaken as part of Stage 2 of the assessment indicates that the implementation of the proposed emission control would act to minimise odour impacts being experienced at proximate residential dwellings. The dispersion modelling assessment has considered the afterburners proposed to be installed as part of emission control for coffee roasting.

Additionally, the dispersion modelling assessment predicts there to be no exceedances of the odour impact assessment criterion of 2 odour units at any location surrounding the Proposal site. Correspondingly, based upon the assumptions presented in the report, the Proposal is assessed as being capable to not give rise to significant odour impacts at surrounding land uses.

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

Northstar Air Quality Pty Ltd (Northstar) has been commissioned by Little Italy Coffee Roaster Pty Ltd (the Proponent), to perform an air quality assessment (AQA) to support a development application (DA) for a proposed coffee roasting facility (the Proposal) to be located at 1/1 Minna Close, Belrose NSW (the Proposal site).

This AQA has adopted a two-stage approach to assessing the potential for air quality impacts to be experienced at surrounding land uses resulting from the operation of the Proposal as follows:

- **Stage 1**: Perform an air quality risk assessment in accordance with ISO 31000 (International Organisation for Standardisation, 2018) to identify proposed activities that may have potential high risks of adverse air quality impacts at surrounding land uses without consideration of any emissions control measures.
- **Stage 2**: Perform a dispersion modelling assessment in accordance *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2022) and *Assessment and Management of Odour from Stationary Sources in NSW – Technical framework* (DECC, 2006) to provide an assessment of predicted off-site odour impacts resulting from the potential high risk activities identified in Stage 1.

1.1. Purpose of the Report

The purpose of this report is to identify and examine whether the impacts of the operation of the Proposal may adversely affect local air quality and where appropriate, provide recommendations to manage risks to acceptable levels.

The report presents data that summarise and characterise the existing environmental conditions, identifies the potential emissions to air associated with the operation of the Proposal, examines the potential for off-site impacts, and identifies appropriate mitigation measures that would be required to reduce those potential impacts.

This AQA has been performed in accordance with, and with due reference to:

- *Protection of the Environment Operations Act* 1997;
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2022);
- Assessment and Management of Odour from Stationary Sources in NSW – Technical framework (DECC, 2006); and
- ISO 31000 (International Organisation for Standardisation, 2018).

2. THE PROPOSAL

2.1. Environmental Setting

The Proposal site is located at 1/1 Minna Close, Belrose NSW, within the Local Government Area (LGA) of the Northern Beaches Council. A map showing the location of the Proposal site is presented in Figure 1.

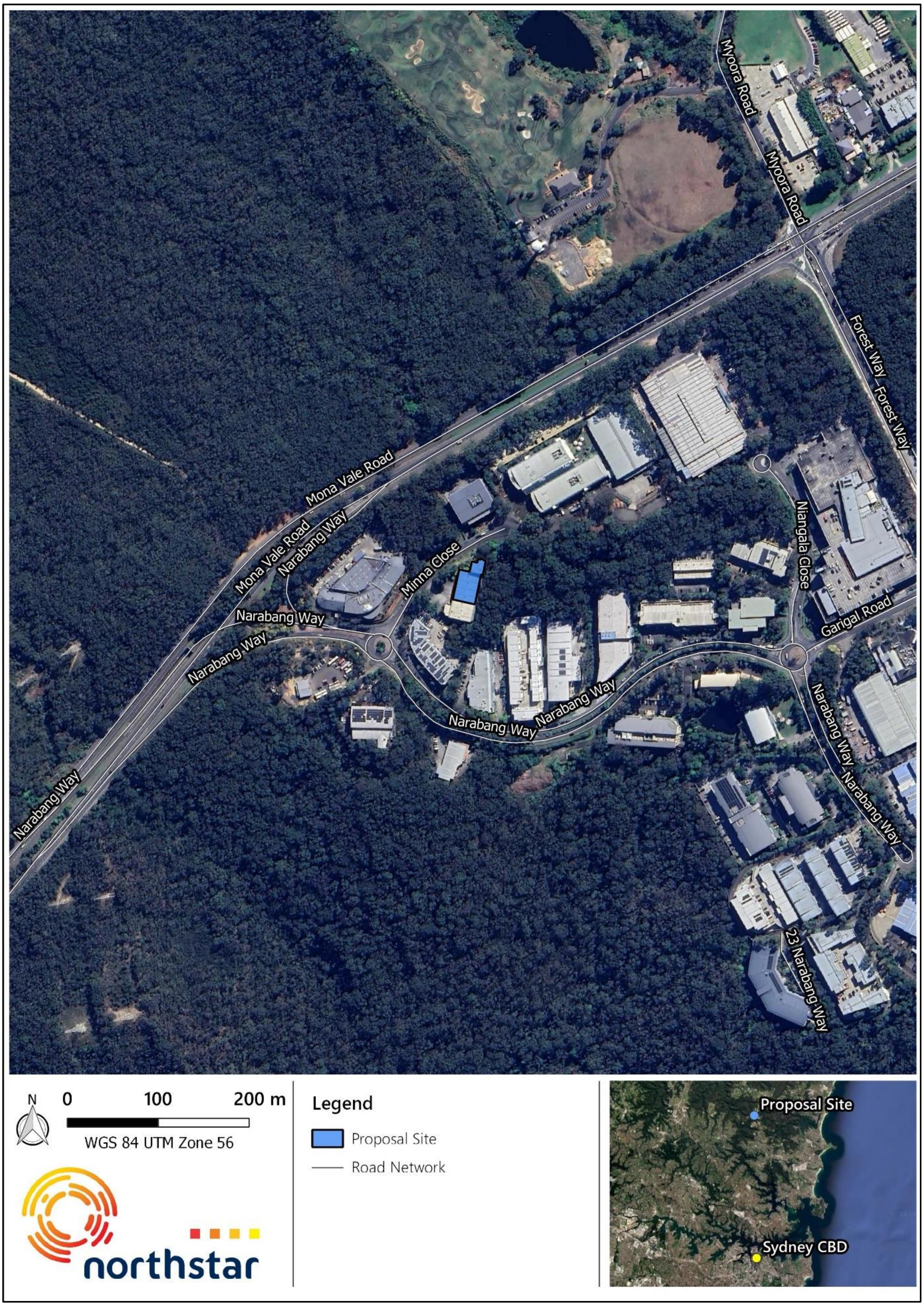
The Proposal site and immediate surrounds is currently zoned as SP4 – Enterprise, with a small portion of the northeastern area zoned as C2 – Environmental Conservation under the Warringah Local Environmental Plan (LEP) 2011.

Adjoining land uses include SP4 – Enterprise, E3 – Productivity Support to the east, C1 – National Parks and Nature Reserves and C2 – Environmental Conservation to the north and south, and RE1 – Public Recreation to the northeast.

The most proximate residential dwellings are located approximately 850 metres (m) to the southeast off Forest Way in the neighbouring suburb of Terrey Hills.

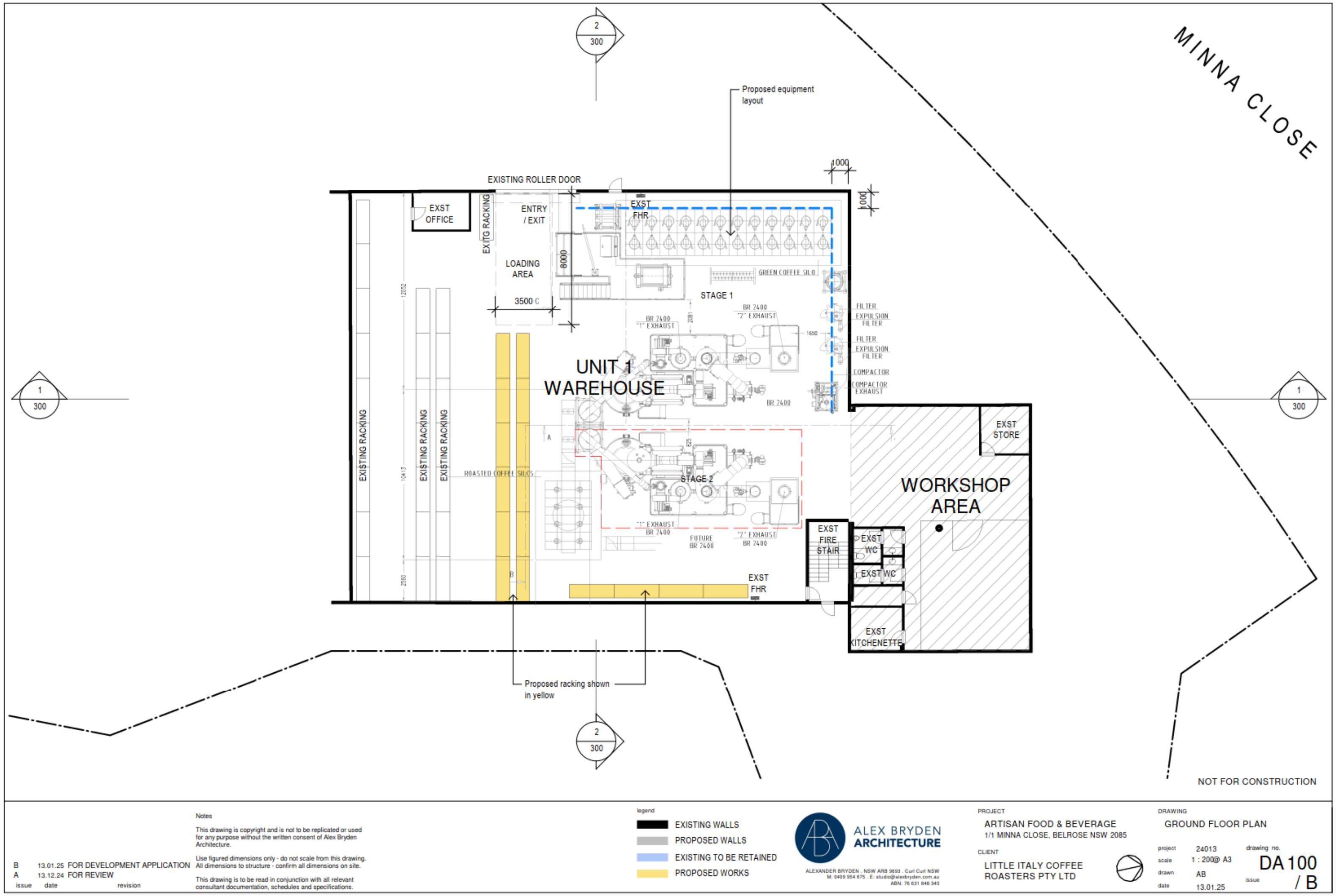
A layout of the Proposal site is provided in Figure 2.

Figure 1 Proposal site location



Source: Northstar

Figure 2 Proposal site layout



Source: Alex Bryden Architecture (13/01/25).

2.2. Proposal Overview

The Proponent is seeking consent for a proposed coffee roasting and production facility at the Proposal site. The Proposal will comprise the following components:

- 2 no. coffee roasters with silos and packing area;
- Office space;
- Enclosed offices & meeting rooms;
- Kitchen / lunch facilities; and
- Storage / racking.

The coffee roasting batch process typically involves a number of stages or processes, including the following:

- Cleaning;
- Roasting;
- Cooling;
- Grinding; and
- Packaging.

Whilst the coffee roasting process is relatively standardised, there are some variations between roasting processes in the composition of the coffee beans, residual moisture, roasting temperature and duration, decaffeination, type of roasting machine, roasting batch size, and the type of product intended.

Roasting typically occurs in rotating drums which tumble the coffee beans within a temperature-controlled environment.

The Proponent proposes to install and operate two batch coffee roasters at the Proposal site, namely:

- 2 no. Brambati 120 kilogram (kg) batch coffee roaster (BR 1200).

Each coffee roasting batch is assumed to take 15 minutes, including cooling time, with up to four batches possible each hour. Operating hours are assumed to be between 8 am and 4 pm, in line with other recent approvals for coffee roasters in the area (e.g. DA2016/0470).

Each roaster is assumed to include an afterburner, which is considered to be best practice emission control for coffee roasting.

2.3. Identification of Potential Emissions to Atmosphere

Typically, the most significant potential emissions from coffee roasting operations are the emissions of various volatile organic compounds (VOCs) derived from the roasting process, experienced as odour. Additionally, minor odour emissions may also be generated as part of the cooling and grinding processes.

As reported by Gloess A.N, (2018) *On-line analysis of coffee roasting with ion mobility spectrometry-mass spectrometry (IMS-MS*) (Gloess A.N., 2018), the number of identified speciated VOCs is almost 1 000 and vary over time during the coffee bean roasting process. The VOCs include alkyl pyrazines (an important group of coffee aroma compounds), pyridines and a range of volatile fatty acids.

Emissions of particulate matter can also be associated with the coffee roasting process, which may typically be observed as smoke from roaster exhaust stacks.

Odour is a complex mix of solid particles, aerosols and liquid droplets, and odour is an aggregated proxy measure for the control of all contributing solid phase and liquid phase emissions. The emissions of smoke and odour are generally inter-related, and in some processes are so associated so that they can be regarded as symptomatic of a general lack of exhaust treatment and control. In this context, the control of particulates is considered to be an intrinsic component of effective odour control as exposure to emissions of smoke may illicit an olfactometric response as well as an exposure to gaseous phase emissions. Effective odour control therefore must provide adequate control of particulates.

3. LEGISLATION, REGULATION AND GUIDANCE

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", but manage odour impacts to an acceptable level.

3.1. Definitions of 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 detection threshold (ODT) and defines one odour unit (OU). An odour goal of less than 1 OU would (by definition) result in no odour impact being detectable in laboratory conditions. In practice, the character of an 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 (or greater) 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.

3.2. Odour Regulation and Control in NSW

The *Protection of the Environment (Operations) Act* 1997 (POEO) is applicable in relation to odour, which includes regulation regarding 'offensive' odour. 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, the Odour Technical Framework (DECC, 2006) recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU. In modelling and assessment terms, this is expressed as the 99th percentile value, as a nose response time average (approximately one second).

Odour assessment criteria need to consider the range in sensitivities to odours within the community to provide additional protection for individuals with a heightened response to odours. This is addressed in the Technical Framework (DECC, 2006) and the Approved Methods (NSW EPA, 2022) by setting a population dependant odour assessment criterion, and in this way, the odour assessment criterion allows for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity.

A summary of odour performance goals for various population sizes, as referenced in the Approved Methods (NSW EPA, 2022) is shown in Table 1. This table shows that in situations where the population of the affected community lies between 125 and 500 people, an odour assessment criterion of 4 OU at the nearest residence (existing or any likely future residences) is to be used. For isolated residences, an odour assessment criterion of 7 OU is appropriate.

Table 1 NSW EPA odour impact criterion

Population of affected community	Complex mixture of odours (OU)
Urban area (≥2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residence (≤2)	7.0

Source: The Odour Technical Notes, DECC 2006

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", but manage odour impacts to an acceptable level.

The term 'offensive odour' is defined within the POEO Act as:

> *an odour:*
>
> *(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:*

> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.*

Given the proximity of residential land uses around the Proposal site, the odour impact criteria adopted is 2 OU for all receptor locations.

4. EXISTING CONDITIONS

4.1. Sensitive Receptor Locations

Air quality assessments include a desktop mapping exercise to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed.

The Approved Methods (NSW EPA, 2022) defines a sensitive receptor location to be:

> *'A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area'.*

The focus of the AQA has been on discrete receptor locations, which are specified in consideration of the Approved Methods (NSW EPA, 2022) and are broadly representative of those areas or sites that may experience the greatest or most likely levels of exposure on account of the Proposal.

In addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location sensitive to changes in air quality does not render this assessment invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for this assessment are reflective of the locations in which the population of the area surrounding the Proposal site reside, population density data has been examined. Population density data based on the 2021 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2022).

Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

For clarity, the ABS use the following categories to analyse population density ($persons{\cdot}km^{-2}$):

- No population – Zero (0).
- Very low – < 500.
- Low – 500 to 2 000.
- Medium – 2 000 to 5 000.
- High – 5 000 and 8 000.
- Very high – > 8 000.

Analysis of the ABS data within a GIS indicates that the population density surrounding the Proposal site and its vicinity is very low i.e. within a range of between 0 to 500 persons·km^{-2}. The population density of the area surrounding the Proposal site is presented in Figure 3.

In accordance with the requirements of the NSW EPA Approved Methods document, several receptors have been identified and the receptors adopted for use within this AQA are presented in Table 2 and illustrated in Figure 3.

Table 2 Discrete sensitive receptor locations

Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
R1	Minna Close, Belrose	Commercial	333 981	6 269 275
R2	Minna Close, Belrose	Commercial	334 075	6 269 290
R3	Narabang Way, Belrose	Commercial	334 211	6 269 212
R4	Narabang Way, Belrose	Commercial	334 098	6 269 132
R5	Narabang Way, Belrose	Industrial	334 021	6 269 133
R6	Narabang Way, Belrose	Industrial	333 986	6 269 110
R7	Narabang Way, Belrose	Commercial	333 939	6 269 152
R8	Minna Close, Belrose	Industrial	333 900	6 269 203

Note: The requirements of this AQA may vary from the specific requirements of other studies, and as such the selection and naming of receptor locations, may vary between technical reports. This does not affect or reduce the validity of those assumptions.

Figure 3 Identified sensitive receptors and population density

Source: Northstar

4.2. Meteorology

The meteorology experienced within an area can govern the generation (in the case of wind-dependent emission sources), dispersion, transport, and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the Proposal site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at surrounding automatic weather stations (AWS).

Five meteorological stations operated by BoM were identified within an approximate 15 km radius of the Proposal site as summarised in Table 3.

Table 3 Meteorological monitoring stations surrounding the Proposal site

Site name	Source	Approximate location		Approximate distance (km)
		mE	mS	
Terrey Hills AWS – Station #066059	BoM	335 508	6 270 713	2.1
Sydney Harbour (Bombora) AWS – Station #066203	BoM	340 090	6 256 825	13.8
Sydney Harbour (Cannae Point) AWS – Station #066202	BoM	341 198	6 256 999	14.2
Middle Head AWS – Station #066199	BoM	339 316	6 255 526	14.7
Manly (North Head) AWS – Station #066197	BoM	342 531	6 257 032	14.9

Meteorological conditions measured at the Terrey Hills AWS are presented in Appendix B and are considered to be most representative of the Proposal site due to proximity. Data from 2019 to 2023 (the most recent five years of complete data) have been analysed for use in this assessment. The wind roses presented in Appendix B indicate that from 2019 to 2023, winds at Terrey Hills AWS show generally similar wind distribution patterns across the years assessed, with predominant west-north-westerly wind directions.

The majority of wind speeds experienced at the Terrey Hills AWS between 2019 and 2023 are generally in the range 1.5 metres per second ($m \cdot s^{-1}$) to 8 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring predominantly from north-westerly and south-easterly directions. Winds of this speed occur during 0.1 % of the observed hours during the years while calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 2.8 % of hours on average across the years between 2019 and 2023.

To provide a characterisation of the meteorology which would be expected at the Proposal site, a meteorological modelling exercise has also been performed. A summary of the inputs and outputs of the meteorological modelling assessment, including validation of those outputs is presented in Appendix B.

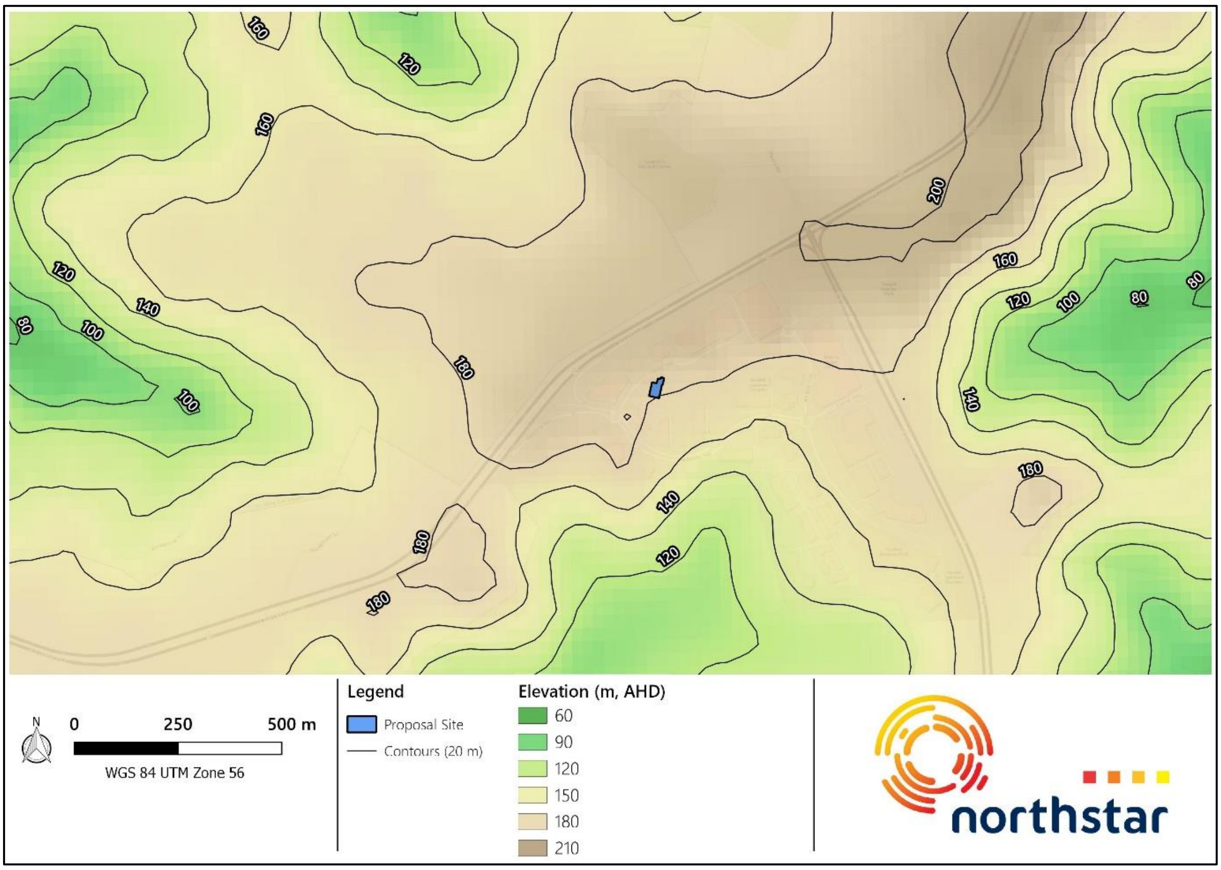
An analysis of the correlation coefficients between each year for wind speed, wind direction distribution was performed to select a representative year for the meteorological modelling (refer Appendix B). Following this analysis, the year 2021 was selected as the most representative year for further assessment.

4.3. Local Topography

The elevation at the Proposal site ranges between approximately 180 m and 185 m Australian Height Datum (AHD). The topography between the Proposal site and identified sensitive receptor locations is relatively consistent with elevation variances of less than 15 m within the immediate locality. In dispersion modelling terms, the topography is relatively uncomplicated, and does not need to be explicitly accounted for in the dispersion modelling exercise (i.e. Stage 2 of this AQA).

The topography surrounding the Proposal site is presented in Figure 4.

Figure 4 Topography surrounding the Proposal site



Source: Northstar

4.4. Potential for Cumulative Impacts

A desktop survey has been performed to identify proximate sources with a similar emissions profile to the Proposal that may result in cumulative impacts at sensitive receptor locations.

The survey search identified no facilities with potential to result in cumulative impacts with the Proposal. Corresponding, cumulative impacts from surrounding facilities have not been considered further in this assessment.

5. APPROACH TO ASSESSMENT

5.1. Stage 1 – Air Quality Risk Assessment

To perform Stage 1 of this study, a risk assessment approach based upon the specifications and definitions provided in ISO 31000 (International Organisation for Standardisation, 2018) has been adopted.

The risk assessment procedure adopted in this instance uses the definitions outlined in ISO 31000 regarding sensitivity of receptors and impact magnitude to derive risk.

The determined risk (significance) may be used to highlight the relative environmental risk and to determine the requirement for further assessment under Stage 2 of this assessment. For the purposes of this study, proposed activities that are associated with a *high* risk of potential adverse air quality (including odour) impacts will be further examined as part of a dispersion modelling assessment to better understand those potential impacts and identify the requirement for additional emissions control.

The full methodology and risk assessment are provided in Appendix C while a summary of the assessment is presented in Section 6.

5.2. Stage 2 – Dispersion Modelling Assessment

An atmospheric dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 2-dimensional (2D) mode, given the proximity of receptors and the uncomplicated nature of the topography surrounding the Proposal site.

The 2-D meteorological dataset has been developed using The Air Pollution Model (TAPM, v 4.0.5) (see Appendix C for further information).

An assessment of the impacts of the operation of activities at the Proposal has been performed which characterises the likely day-to-day operation of the Proposal, approximating the likely peak activities at the Proposal to allow comparison of potential impacts against short term (nose-response time) criterion for odour.

The modelling scenario provides an indication of the air quality impacts of the operation of activities at the Proposal site. Based on the assessment of potential cumulative impact sources (refer Section 4.4), the background odour environment has been considered to be negligible.

5.2.1. Emission Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. In the absence of specific odour emission factors/rates for the roasters proposed, this assessment has adopted odour emission concentrations from comparable coffee roasting equipment (i.e. Loring S35 and Probat U22) as $OU \cdot m^{-3}$. For the purpose of performing a conservative assessment, the highest of these available values has been adopted.

Exhaust gas flow rates ($m^3 \cdot s^{-1}$) have also been adopted from the available information, and these have been scaled *pro-rata* according to the batch size. The two values ($OU \cdot m^{-3}$ and $m^3 \cdot s^{-1}$) have been multiplied together to provide the odour emission rate ($OU \cdot s^{-1}$). The odour control efficiency of an afterburner (90 %) on each roaster has also been applied. It is noted that a typical afterburner would be anticipated to result in between 90 % and 95 % odour control efficiency, although to provide an additional level of conservatism, a control efficiency of 90 % has been adopted. A summary of the assumptions adopted in the performance of this assessment is presented in Table 4.

Table 4 Adopted emissions data

Parameter	Units	BR1200 #1	BR1200 #2	Notes
Batch roast size	kg	120	120	Provided
Batch cycle time	mins	15	15	Provided
Batches per hour	number	4	4	Calculated
Hours roasting per day	number	8	8	Based on other development approvals
Exhaust gas flow rate from roaster	$m^3 s^{-1}$	1.68	1.68	Average of Loring S35 and Probat UG22 roasters, scaled to batch size (120 kg)
Odour emissions from roaster - high	$OU \cdot m^{-3}$	11 159	11 159	Loring S35 (unabated)
Emission stack height (above roof level)	m	2.5	2.5	Assumed
Emission stack diameter	mm ID	400	400	Assumed
Exhaust gas velocity	$m \cdot s^{-1}$	13.4	13.4	Calculated
Emission control	-	Afterburner	Afterburner	Provided
Emission control efficiency	%	90	90	Literature review
Emission rate	$OU \cdot s^{-1}$	1 880	1 880	Calculated
Exhaust gas temp	K	473.1	473.1	Assumed
Building height	m AGL	7.3	7.3	Based on plans
Easting	mE	333 978	333 980	Assumed
Northing	mS	6 269 214	6 269 213	Assumed

5.2.2. Peak to Mean

The odour concentration predictions have been multiplied by a peak to mean factor (P/M60) of 2.3, as per the requirements of (NSW EPA, 2022), to allow hourly concentrations to be converted to nose-response time averages.

6. STAGE 1 – AIR QUALITY RISK ASSESSMENT

To determine which proposed activities require a quantitative assessment under Stage 2 of this study, a risk assessment exercise has been performed to identify the major risks to offsite odour impacts.

6.1. Risk Assessment (No Mitigation)

The full risk assessment is included in Appendix C, which describes the metrics of sensitivity and consequence that are used to derive risk. This risk assessment would be updated by management should any of the identified processes change, or it should become apparent that the magnitude of the risk associated with any process should be updated (following complaints, for example).

Using the methodology outlined in Appendix C derives an assessment of risk (as expressed on a scale: high – medium – low), as summarised in Table 3.

Table 5 Risk assessment summary (No Mitigation)

Sensitivity of receptors		Impact magnitude		Risk Assessment
Location	Assessment	Process	Assessment	
Various locations at and beyond site boundary	High sensitivity	Cleaning	Negligible	Medium
		Roasting	Major	High
		Cooling	Slight	Medium
		Grinding	Slight	Medium
		Packaging	Negligible	Medium

The findings of the risk assessment indicate that emissions associated with roasting activities have *high* risks of odour impacts with no emissions control measures considered, while all other assessed activities are associated with *medium* risks, primarily due to the very high sensitivity of receptors.

Given the above, a dispersion modelling assessment has been performed to further assess emissions associated with coffee roasting at the Proposal site as presented in Section 7.

7. STAGE 2 – DISPERSION MODELLING ASSESSMENT

The 99th percentile 1-second nose response time odour concentrations predicted at the surrounding receptor locations resulting from the Proposal are presented in Table 6.

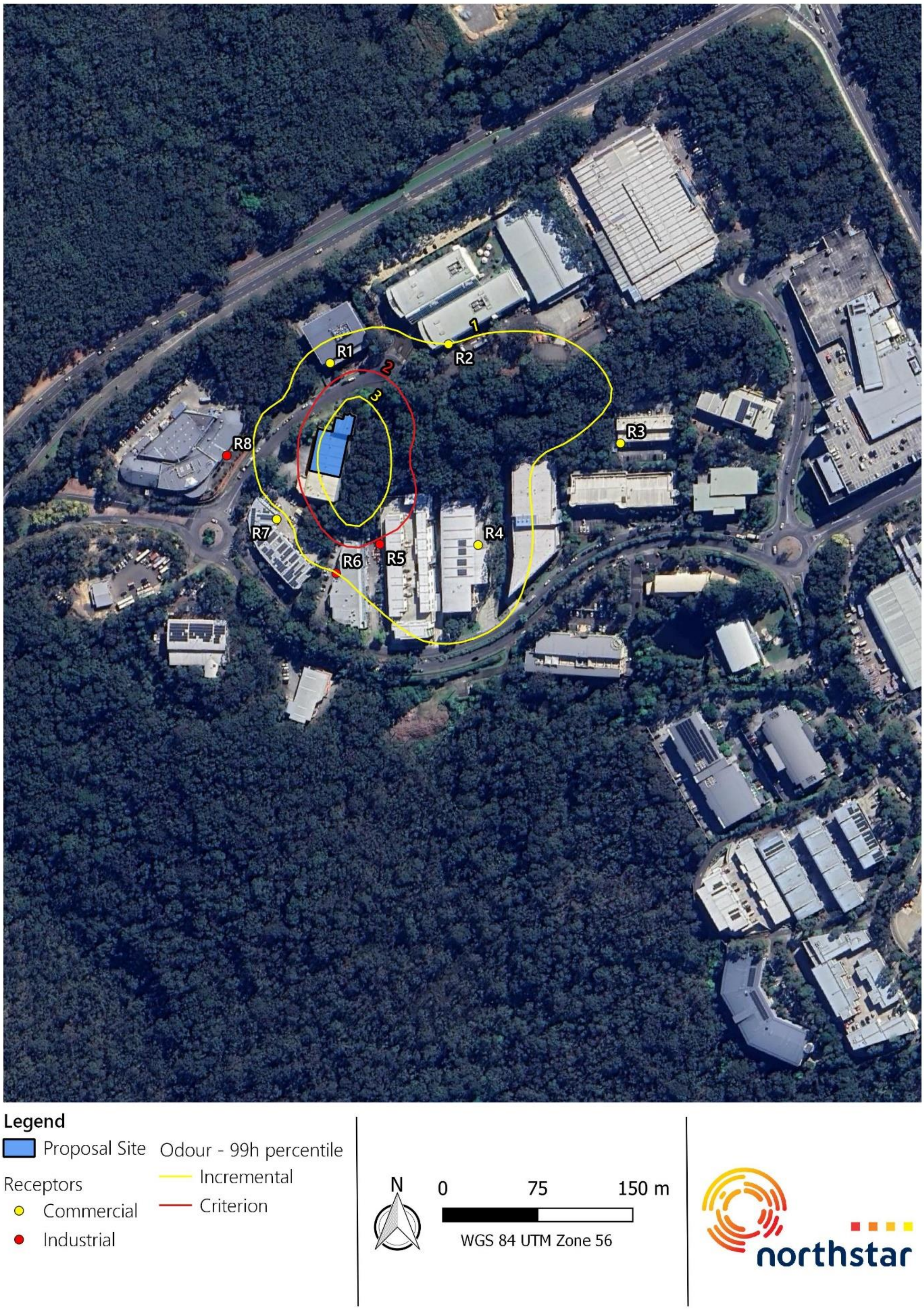
Table 6 Predicted 99th percentile 1-second odour concentrations

Receptor	Maximum predicted 1-second odour concentration (at any height)
Criterion	2
Max. % of criterion	80.7
R1	1.1
R2	0.8
R3	0.9
R4	1.3
R5	1.8
R6	1.0
R7	0.9
R8	0.8

As shown in Table 6, the maximum predicted odour concentration at all receptor locations is 1.8 OU as a 1-second nose response time averaging period. This maximum was predicted at R5. Consequently, no odour concentrations are predicted to exceed the odour impact assessment criterion of 2 OU at any location.

A contour plot displaying the spatial distribution of predicted odour impacts resulting from the Proposal is presented in Figure 5.

Figure 5 Predicted 99th percentile odour concentration



Source: Northstar

8. DISCUSSION AND CONCLUSION

8.1. Mitigation and Monitoring

As discussed in Section 5.2.1, an afterburner is proposed to be installed to control emissions resulting from each of the two coffee roasting activities. The efficiency of each afterburner to control emissions has been conservatively assumed to be 90 % which has been considered as part of the dispersion modelling assessment, and is considered to represent Best Available Technology (BAT) for the control of coffee roaster emissions.

The results presented in Section 7 indicate that the afterburners would appropriately control emissions generated from coffee roasting activities to not result in adverse odour impacts experienced at land uses surrounding the Proposal site. Given the above, it is important that the afterburner is maintained and managed in accordance with the manufacturer's specifications.

8.2. Conclusion

Northstar was commissioned to perform an air quality assessment to assess the potential air quality impacts associated with a proposed coffee roasting facility located at 1/1 Minna Close Belrose NSW.

A two staged approach was undertaken as follows:

- **Stage 1**: Perform an air quality risk assessment to identify proposed activities that have potential high risks of adverse air quality impacts at surrounding land uses without consideration of any emissions control measures.
- **Stage 2**: Perform a dispersion modelling assessment in accordance *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2022) and *Assessment and Management of Odour from Stationary Sources in NSW – Technical framework* (DECC, 2006) to provide an assessment of predicted off-site odour impacts resulting from the potential high risk activities identified in Stage 1.

The findings of the risk assessment undertaken for Stage 1 of the assessment indicates that all processes could be appropriately managed with exception of the proposed coffee roasting activities which was associated with *high* risks of adverse impact resulting in adverse odour impacts without appropriate emission control.

Subsequent dispersion modelling undertaken as part of Stage 2 of the assessment indicates that the implementation of the proposed emission control would act to minimise odour impacts being experienced at proximate residential dwellings. The dispersion modelling assessment has considered the afterburners proposed to be installed as part of emission control for coffee roasting.

The dispersion modelling assessment predicts there to be no exceedances of the odour impact assessment criterion of 2 OU at any location surrounding the Proposal site. Correspondingly, based upon the assumptions presented in the report, the Proposal is assessed as being capable to not give rise to significant odour impacts at surrounding land uses.

Although odour complaints would not be anticipated based on the results of this assessment, if odour complaints are received, an odour complaint form should be used to collect data to inform the nature and scale of any impacts, to target further management measures (refer Appendix D).

9. REFERENCES

ABS. (2022). *Australian Bureau of Statistics*. Retrieved from https://www.abs.gov.au/statistics/people/population/regional-population/2021#interactive-maps

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APPENDIX A

Commonly used units and abbreviations

Units Used in the Report

Units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units.

Commonly used SI units

The following units are commonly used in Northstar reports.

Symbol	Name	Quantity
SI base units		
K	Kelvin	thermodynamic temperature
kg	kilogram	mass
m	metre	length
mol	mole	amount of substance
s	seconds	time
Non-SI units mentioned in the SI or accepted for use		
°	degree	plane angle
d	day	time
h	hour	time
ha	hectare	area
J	joule	energy
L	litre	volume
min	minute	time
N	newton	force or weight
t	tonne	mass
V	volt	electrical potential
W	watt	power

Multiples of SI and non-SI units

The following prefixes are added to unit names to produce multiples and sub-multiples of units:

Prefix	Symbol	Factor
T	tera-	10^{12}
G	giga-	10^{9}
M	mega-	10^{6}
k	kilo-	10^{3}
h	hector-	10^{2}
da	deca-	10^{1}

Prefix	Symbol	Factor
p	pico-	10^{-12}
n	nano-	10^{-9}
µ	micro-	10^{-6}
m	milli-	10^{-3}
c	centi-	10^{-2}
d	deci-	10^{-1}

In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre would be presented as 50 $\mu g \cdot m^{-3}$ and not 50 $\mu g/m^3$; and,

- 0.2 kilograms per hectare per hour would be presented as 0.2 $kg \cdot ha^{-1} \cdot hr^{-1}$ and not 0.2 kg/ha/hr.

Commonly used SI-derived and non-SI units

$g \cdot m^{-2} \cdot s^{-1}$	gram per square metre per second	rate of mass deposition per unit area
$g \cdot s^{-1}$	gram per second	rate of mass emission
$kg \cdot ha^{-1} \cdot hr^{-1}$	kilogram per hectare per hour	rate of mass deposition per unit area
$kg \cdot m^{-3}$	kilogram per cubic metre	density
$L \cdot s^{-1}$	litres per second	volumetric rate
m^2	square metre	area
m^3	cubic metre	volume
$m \cdot s^{-1}$	metre per second	speed and velocity
$mg \cdot m^{-3}$	milligram per cubic metre	mass concentration per unit volume
$mg \cdot Nm^{-3}$	milligram per normalised cubic metre (of air)	mass concentration per unit volume
$\mu g \cdot m^{-3}$	microgram per cubic metre	mass concentration per unit volume
$mg \cdot m^{-3}$	milligram per cubic metre	mass concentration per unit volume
Pa	pascal	pressure
ppb	parts per billion ($1x10^{-9}$)	volumetric concentration
pphm	parts per hundred million (1×10^{-5})	volumetric concentration
ppm	parts per million ($1x10^{-6}$)	volumetric concentration

Commonly used abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
ACT	Australian Commonwealth Territory
AGL	above ground level
AHD	Australian height datum
APC	air pollution control
AQI	air quality index
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AQRA	air quality risk assessment
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS/NZS	Australian Standard / New Zealand Standard
AWS	automatic weather station
BCA	Building Code of Australia
BGL	below ground level
BOM	Bureau of Meteorology
CEMP	construction environment management plan
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation

Abbreviation	Term
DEM	digital elevation model
EETM	emission estimation technique manual
EPA VIC	Environmental Protection Authority Victoria
EPBC	Environment Protection and Biodiversity Conservation Act
FIBC	flexible intermediate bulk container
GIS	geographical information system
IAQM	UK Institute of Air Quality Management
IBC	intermediate bulk container
ID	internal diameter
LLV	low level waste
LoM	life of mine
MSDS	Material Safety Data Sheet
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NH_3	ammonia
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
NORM	naturally occurring radioactive material
NSW	New South Wales
NSW DCCEEW	New South Wales Department of Climate Change, Energy, the Environment and Water
NSW EPA	New South Wales Environment Protection Authority
NT	Northern Territory
OEMP	operational environmental management plan
O_3	ozone
OU	odour unit
$OU{\cdot}m^3{\cdot}s^{-1}$	odour units times metres cubed per second
$OU{\cdot}s^{-1}$	odour units per second
Pb	lead
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
ROM	run of mine
SA	South Australia
SEPP	State Environmental Protection Policy
SO_X	oxides of sulphur
SO_2	sulphur dioxide
SRTM3	Shuttle Radar Topography Mission
SVOC	semi-volatile organic compound
TAPM	The Air Pollution Model
TAS	Tasmania

Abbreviation	Term
TEU	twenty-foot equivalent unit
TSP	total suspended particulates
TVOC	total volatile organic compounds
TWA	time weighted average
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VIC	Victoria
VLLW	very low level waste
VOC	volatile organic compound

APPENDIX B

Meteorology

Meteorological Stations

Five meteorological stations operated by BoM were identified within an approximate 15 km radius of the Proposal site. A summary of identified BoM AWS relative to the Proposal site is provided in Table B1 (listed by proximity).

Table B1 Identified BoM AWS within 15 km of Proposal site

Site name	Source	Approximate location		Approximate distance (km)
		mE	mS	
Terrey Hills AWS – Station #066059	BoM	335 508	6 270 713	2.1
Sydney Harbour (Bombora) AWS – Station #066203	BoM	340 090	6 256 825	13.8
Sydney Harbour (Cannae Point) AWS – Station #066202	BoM	341 198	6 256 999	14.2
Middle Head AWS – Station #066199	BoM	339 316	6 255 526	14.7
Manly (North Head) AWS – Station #066197	BoM	342 531	6 257 032	14.9

Meteorological conditions measured at the Terrey Hills AWS are considered to be most representative of the Proposal site due to proximity. Correspondingly, meteorological data collected at Terrey Hills AWS has been adopted for use in this study.

Meteorological conditions at the Terrey Hills AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2019 to 2023) are presented in Figure B1. The annual wind speed frequency distribution for the five-year period is presented in Figure B2.

Figure B1 Annual wind roses – Terrey Hills AWS (2019 to 2023)

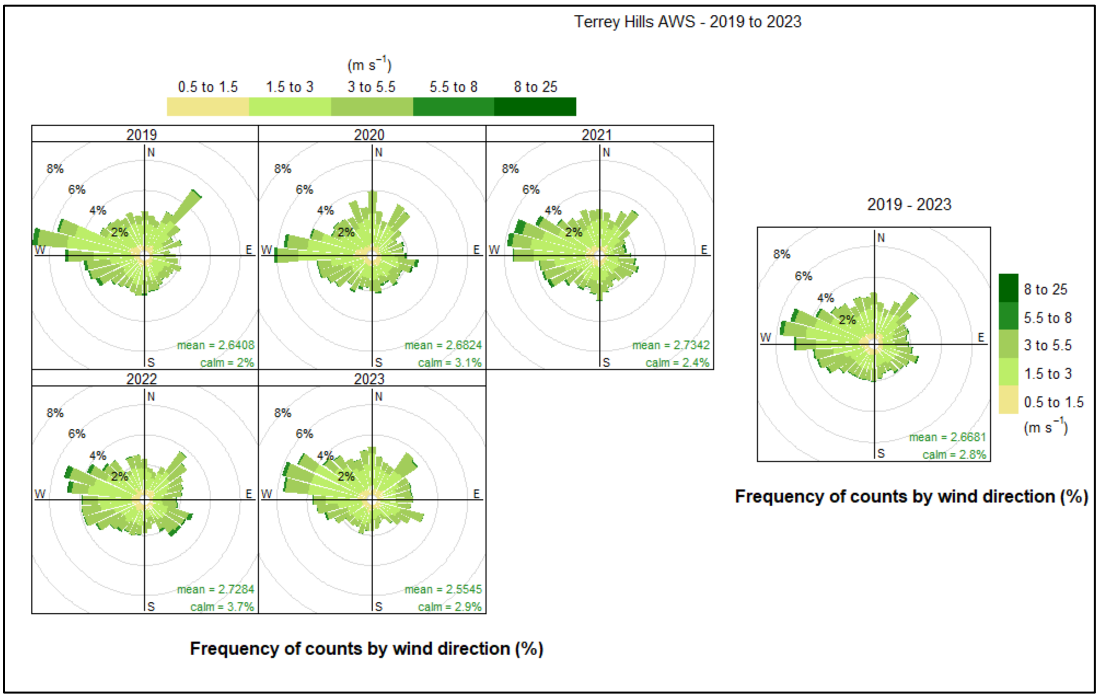
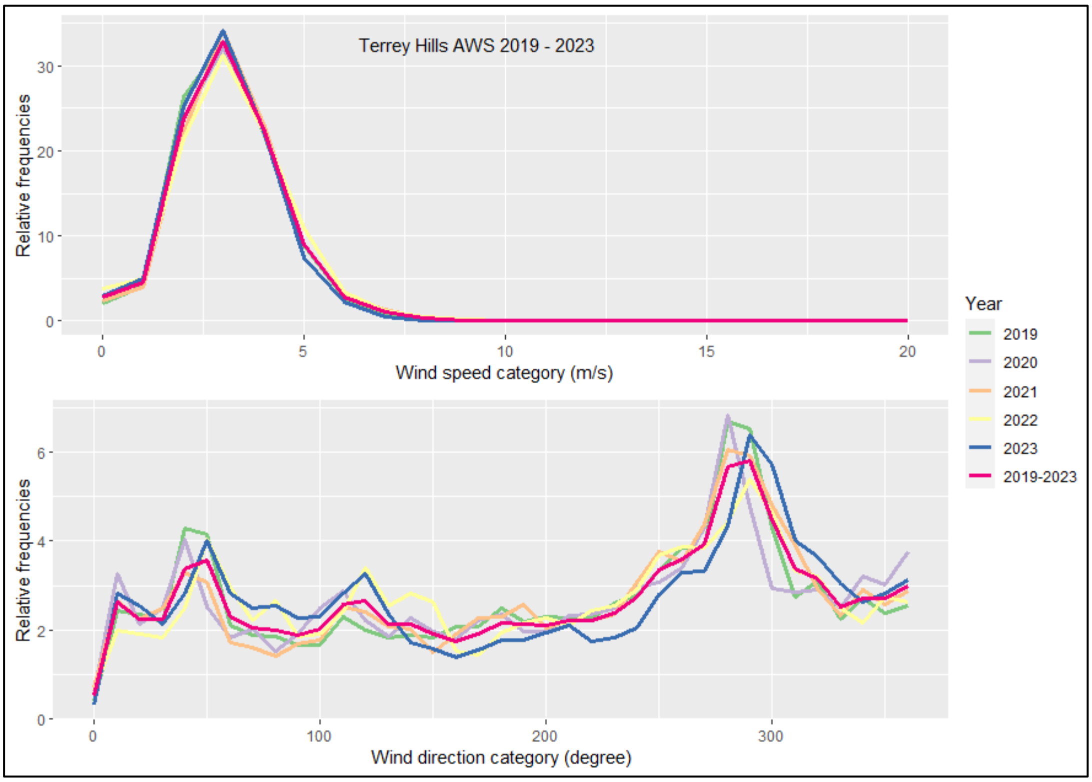


Figure B2 Annual wind direction & speed distribution – Terrey Hills AWS (2019 to 2023)



The wind roses indicate that from 2019 to 2023, winds at Terrey Hills AWS show generally similar wind distribution patterns across the years assessed, with predominant west-north-westerly wind directions.

The majority of wind speeds experienced at the Terrey Hills AWS between 2019 and 2023 are generally in the range 1.5 metres per second ($m \cdot s^{-1}$) to 8 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring predominantly from north-westerly and south-easterly directions. Winds of this speed occur during 0.1 % of the observed hours during the years while calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 2.8 % of hours on average across the years between 2019 and 2023.

The correlation coefficient between each year and the five-year period for the distribution of wind speed and wind direction summarised in Table B2. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table B2.

Table B2 Correlation coefficient analysis – Terrey Hills AWS (2019 – 2023)

Parameter	Wind speed		Wind direction		Aggregated rank
	Corr.	Rank	Corr.	Rank	
2019	0.9981	4	0.9632	2	3
2020	0.9998	1	0.8787	5	3
2021	0.9986	3	0.9696	1	1
2022	0.9974	5	0.9008	3	5
2023	0.9986	2	0.8957	4	3
2019-2023	1	-	1	-	-

Note: Corr. = correlation

Wind speed observations for each year correlated well against the wind speed over the five-year period, with each year having a correlation coefficient greater than 0.99. The year 2020 is the highest ranked for correlation against the wind speed over the five-year period.

Wind direction observations for each year are reasonably well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than of 0.87. The year 2021 is the highest ranked for correlation against the wind direction over the five-year period.

The correlation coefficient analysis indicates that 2021 is the most appropriate representative year for meteorological modelling.

Meteorological Modelling

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

In absence of any measured onsite meteorological data, site representative meteorological data for this Proposal was generated using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.2).

Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for CALPUFF. 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, precipitation, 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.

To validate model outputs, a comparison of the TAPM generated meteorological data, and that observed at the Terrey Hills AWS has been performed and is presented in Figure B3. These data generally compare well which provides confidence that the meteorological conditions modelled as part of this assessment are appropriate.

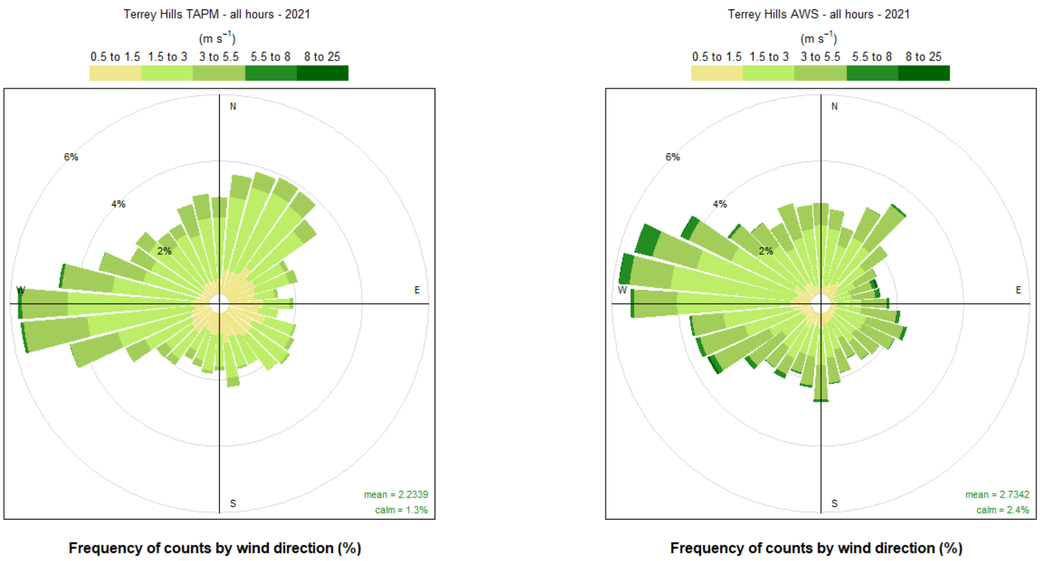
The parameters used in TAPM modelling are presented in Table B3.

Table B1 TAPM meteorological parameters

TAPM v 4.0.5	
Modelling period	1 January 2021 to 31 December 2021
Centre of analysis	333 970 mE, 6 268 742 mS
Number of grid points	25 x 25 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	No data assimilation

Figure B3 Modelled and observed meteorological data – Terrey Hills AWS (2021)

TAPM generated wind rose	Observations at Terrey Hills AWS (2021)

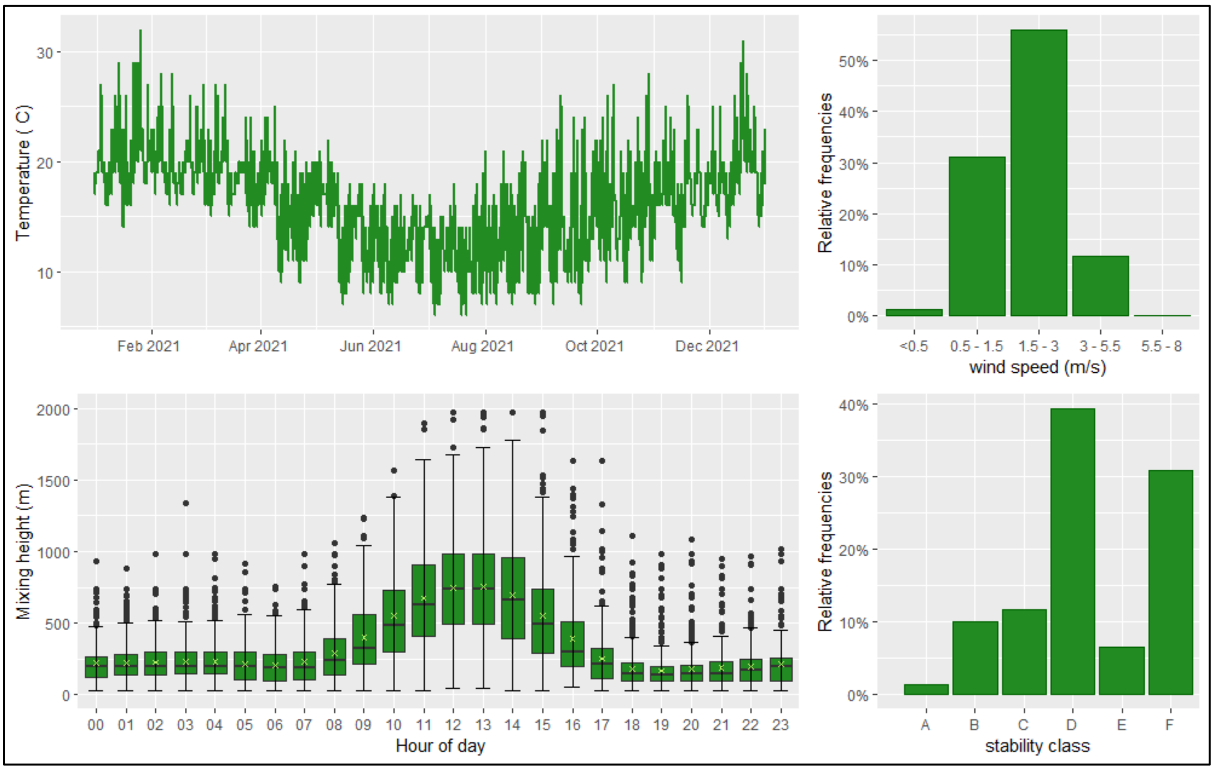


As generally required by the NSW EPA the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Proposal site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirculation potential of the Proposal site has not been provided. Details of the predictions of wind speed and direction, mixing height and temperature at the Proposal site are provided below.

Diurnal variations in maximum and average mixing heights predicted by TAPM at the Proposal site during 2021 are illustrated in Figure B5.

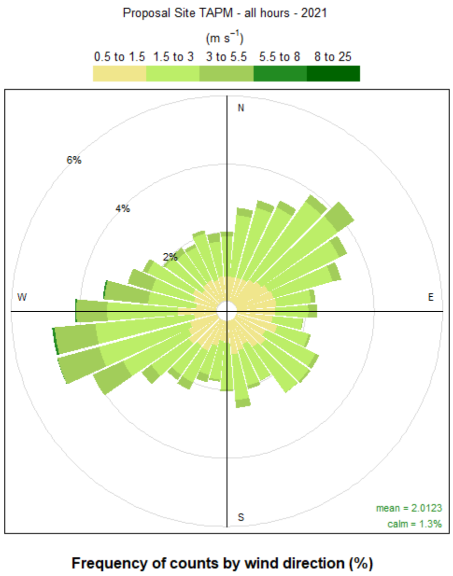
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

Figure B4 Predicted mixing height, wind speed and stability class frequency at the Proposal site (2021)



The modelled wind speed and direction at the Proposal site during 2021 are presented in Figure B5.

Figure B5 Predicted wind direction and speed – Proposal site (2021)



APPENDIX C

Air Quality Risk Assessment

Provided below is the summary for the risk assessment methodology used for the operational phase of this assessment. It is based upon the definitions provided under ISO 31000.

The risk assessment procedure adopted in this instance uses the determinations of:

- Sensitivity of receptors; and
- Impact magnitude; to derive
- Risk.

These terms are defined and discussed in the following subsections.

Sensitivity of Receptors

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 C1.

Table C1 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.

Impact Magnitude

Impact magnitude is a descriptor for the predicted scale of change to the air quality / odour environment that may be attributed to the operation of the Proposal and is evaluated on a scale from 'major' to 'negligible' as defined in Table C2.

Table C2 Methodology - impact magnitude

Magnitude		Descriptions
4	Major	• Potential impact magnitude may cause statutory objectives / standards to be exceeded. • Potential major magnitude of impacts may generate nuisance complaints, resulting in regulatory action.
3	Moderate	• Potential impact may give rise to a perceivable health and/or amenity impact. • Potential moderate magnitude of impacts may generate nuisance complaints, likely to require management but not result in regulatory action.
2	Slight	• Potential impact may be tolerated. • Potential slight magnitude of impacts is not likely to generate nuisance complaints.
1	Negligible	• Potential impact magnitude is unlikely to cause significant consequences. • Potential negligible magnitude of impacts is unlikely to generate nuisance complaints and is likely to only be perceptible within the site boundary.

Risk

The risk matrix provided in Table C3 illustrates how the definition of the impact magnitude and sensitivity of receptors interact to produce impact risk (composite risk index). For example, an air quality / odour impact of slight magnitude at a medium sensitive receptor location would be determined to be of *medium* risk (significance).

Table C3 Methodology –risk matrix

Magnitude (Table C2) / Sensitivity (Table C1)	**Negligible (1)**	**Slight (2)**	**Moderate (3)**	**Major (4)**
Very High (4)	Medium (4)	Medium (8)	High (12)	High (16)
High (3)	Medium (3)	Medium (6)	Medium (9)	High (12)
Medium (2)	Low (2)	Medium (4)	Medium (6)	Medium (8)
Low (1)	Low (1)	Low (2)	Medium (3)	Medium (4)

The '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 and/or sensitivity
Medium	An intermediate risk, and recommendations are to reduce risk as low as practicable through changes to impact magnitude and/or sensitivity
Low	No further management required, although risks should be managed

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

The determined risk (significance) may be used to highlight the relative environmental risk and to highlight the general requirement for further assessment. For the purposes of this study, proposed activities that are associated with a *high* risk of potential adverse air quality (including odour) impacts will be further examined as part of a dispersion modelling assessment to better understand those potential impacts and identify the requirement for additional emissions control.

Risk Assessment

The following represents the risk assessment that is used to identify the risks associated with operation without any supplementary mitigation and identify the type and nature of controls that are required to be applied to avoid unreasonable emissions to air.

Sensitivity of Receptors

The Proposal site is located in an area comprising proximate industrial and residential land uses. Given the nature of the location, the sensitivity of receptors is determined to be high (commercial receptors) in accordance with Table C1.

Impact Magnitude

In the context of the risk assessment methodology, the impact magnitude relates to the definitions presented in Table C2 and is described on a scale from major to negligible. The key considerations in the assessment of potential impact magnitude are:

- Assessing the potential emissions from the processes to give rise to off-site impacts;
- Assessing the scale, frequency and duration of those emissions.

As discussed in Section 2.3, the coffee roasting process typically involves a number of stages or processes, including the following.

- Cleaning,
- Roasting,
- Cooling,
- Grinding, and
- Packaging.

Typically, the most significant potential source of odour from coffee roasting operations is the emission of various volatile organic compounds (VOCs) derived from the roasting process (experienced as odour impacts). As reported in *On-line analysis of coffee roasting with ion mobility spectrometry-mass spectrometry (IMS-*

MS) (Gloess A.N., 2018) the number of identified speciated VOCs is almost 1 000 and vary over time of the coffee bean roasting process.

Based on Northstar's experience in assessing and managing air quality (including odour) from similar industries, the pre-mitigated magnitudes presented in Table C4 represents the potential for impacts to be experienced at sensitive receptors as a result of the processes performed at the Proposal site.

Table C4 Impact magnitude

Process	Pollutant of concern	Comments and application	Pre-mitigated magnitude
Cleaning	Odour	Pre-mitigated	Negligible
Roasting	Odour	Pre-mitigated	Major
Cooling	Odour	Pre-mitigated	Slight
Grinding	Odour	Pre-mitigated	Slight
Packaging	Odour	Pre-mitigated	Negligible

Risk

Based upon the above, the risk may be determined as presented in Table C5.

Table C5 Risk

Sensitivity of receptors		Impact magnitude		Risk Assessment
Location	Assessment	Process	Assessment	
Various locations at and beyond site boundary	High sensitivity	Cleaning	Negligible	Medium
		Roasting	Major	High
		Cooling	Slight	Medium
		Grinding	Slight	Medium
		Packaging	Negligible	Medium

The findings of the risk assessment indicate that emissions associated with roasting activities have *high* risks of odour impacts with no emissions control measures considered, while all other assessed activities are associated with *medium* risks, primarily due to the very high sensitivity of receptors.

Given the above, a dispersion modelling assessment has been performed to further assess emissions associated with coffee roasting at the Proposal site as presented in Section 7.

APPENDIX D

Example Odour Complaint Record

Complainant Contact Details			
Date and time complaint received			
Contact details for complainant			
Complaint Details			
Date and time start	/ / : am|pm		
Date and time stop	/ / : am|pm		
Location(s) of the impact			
Description of the impact			
Persistence *see note 1*	☐ Constant ☐ Intermittent		
Intensity (odour) *see note 2*	☐ 6 extremely strong	☐ 4 strong	☐ 2 weak
☐ generally ☐ at its worst	☐ 5 very strong	☐ 3 distinct	☐ 1 very weak
Prevailing Weather Conditions at the Time of the Complaint			
General description (dry, rain, windy, still etc)			
Temperature			
General wind direction *see note 3*			
General wind strength *see note 4*			
Operational Details, Actions, Resolution			
Operations during complaint			
Identified causes			
Actions taken			
Cause resolved	☐ Yes ☐ No		
Follow up required	☐ Yes ☐ No		
Complainant informed of outcome	☐ Yes ☐ No		
Signed			
Date	/ /		

Notes

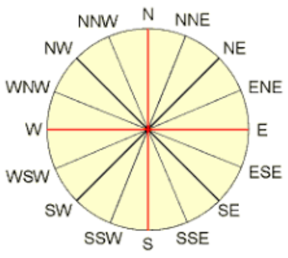
1. Persistence. Please record the descriptor that best describes the extent of the observation:

- Constantly: air quality impact was observed virtually constantly between the stated start and stop times
- Intermittently: air quality impact was observed intermittently between the stated start and stop times

2. Odour Intensity

ID	Descriptor	Notes
1	Very weak	A very faint odour. The VDI definition of a very weak odour requires the odour to be clearly defined without uncertainty or guessing involved.
2	Weak	This is a clearly defined odour (i.e. without uncertainty/guessing), immediately recognisable but not yet strong enough to be considered distinct and readily tolerable.
3	Distinct	Mid way between a weak and strong odour, this is a clearly defined odour, immediately recognisable and tolerable.
4	Strong	A clearly defined odour that is immediately recognisable and is tolerable but mildly uncomfortable.
5	Very strong	A strong odour that may initiate an involuntary action that you subsequently control. Odour is barely tolerable and exposure is uncomfortable
6	Extremely strong	Overpowering odour triggering a physical reaction (i.e. gaging, eyes watering etc.) or an involuntary action (i.e. turning away from odour, covering nose etc.).

3. Wind Direction.



Compass Points

4. Wind Strength

ID	Descriptor	Notes
0	Calm	Calm. Smoke rises vertically
1	Light air	Wind motion visible on smoke
2	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	Leaves and smaller twigs in constant motion
4	Moderate breeze	Dust and loose paper raised. Small branches move
5	Fresh breeze	Moderate branches move. Small trees begin to sway.
6	Strong breeze	Large branches in motion. Overhead wires whistle. Umbrella use is difficult. Empty rubbish bins tip.
7+	Near gale	Wind effects greater than above

air quality | environment | sustainability

air quality	Northstar specialises in all aspects of air quality, dust, and odour management, covering monitoring, modelling and assessment, due diligence and process specification, licencing and regulatory advice, peer review and expert witness.
environment	Our team has extensive experience in environmental management, covering environmental policy and management plans, licencing, compliance reporting, auditing, data, and spatial analysis.
sustainability	We look beyond compliance to add value and identify opportunities. Our services range from sustainability strategies, ecologically sustainable development reporting and assessment, to bespoke greenhouse gas and energy estimation and reporting.

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