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BSV Tyre Recycling - Alteration, Additions and Expansion

Air Quality Impact Assessment

Addressee(s):	BSV Tyre Recycling Australia Pty Ltd
Site Address:	30 Daisy Street, Revesby, NSW
Report Reference:	25.1006.FR1V4
Date:	19 September 2024
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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.

Declan Alder **19 September 2024**

NON-TECHNICAL SUMMARY

JEP Environment and Planning Pty Ltd on behalf of BSV Tyre Recycling Australia Pty Ltd has engaged Northstar Air Quality Pty Ltd to conduct an air quality impact assessment as part of a statement of environmental effects and development application for the proposed alteration, additions and expansion of the existing tyre recycling facility located at 30 Daisy Street, Revesby, NSW.

Currently, BSV operates the facility under Environment Protection Licence 20387 and DA-843/2013. The proposed expansion seeks to increase the facility's capacity from processing 14 600 tonnes to 29 900 tonnes per year of end-of-life tyres to produce tyre derived fuel, while continuing to manufacture crumbed rubber.

The air quality impact assessment evaluated the potential impacts of these changes by characterising existing air quality and meteorological conditions, and quantifying emissions using the CALPUFF dispersion model. The modelling predicted various criteria and hazardous air pollutant concentrations, comparing them with the applicable air quality standards to assess their impact on the surrounding environment.

The results indicate that predicted short-term and annual NO_2 and PM_{10} concentrations, as well as annual average $PM_{2.5}$ concentrations, meet the respective impact assessment criteria. Annual average dust deposition rates and individual air toxics are also predicted to be within acceptable limits. There are limited predicted exceedances of the 24-hour average $PM_{2.5}$ criterion at some receptor locations although these are attributed to exceptionally high background $PM_{2.5}$ levels experienced across NSW in 2021 due to hazard reduction burn-offs, and the predicted contributions from the operation of the premises are considered to be minor in comparison.

To manage emissions effectively, the air quality impact assessment recommends installing a local exhaust ventilation system to capture and properly disperse emissions from the additional two shredders. With these measures in place, the facility is anticipated to comply with all adopted air quality criteria.

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1. INTRODUCTION

JEP Environment and Planning Pty Ltd (JEP) on behalf of BSV Tyre Recycling Australia Pty Ltd (BSV) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA) for the proposed alteration and additions to the tyre recycling facility (the premises) located at 30 Daisy Street, Revesby, NSW. This AQIA is intended to accompany the Statement of Environmental Effects (SEE) prepared for a Development Application (DA) for the premises.

BSV operates under development consent DA-843/2013 and manages its premises in accordance with Environmental Protection Licence (EPL) 20387, processing up to 14 600 tonnes per year ($t{\cdot}yr^{-1}$) of passenger vehicle and truck tyres. Historically, the premises primarily focused on baling and exporting used tyres. However, in 2019, the Council of Australian Governments (COAG) agreed to ban the export of various waste types, including whole tyres (with the exception of truck, bus, and aviation tyres intended for re-treading). This ban came into effect on December 1, 2021. Since then, the premises has shifted its focus to producing crumb rubber for use in asphalt and sustainable playground surfaces, as well as manufacturing tyre chips for export as a coal replacement, known as Tyre Derived Fuel (TDF).

The proposed alteration and additions seek to increase the throughput from the currently approved rate of 14 600 $t{\cdot}yr^{-1}$ to 29 900 $t{\cdot}yr^{-1}$. This includes the installation of tyre shredding equipment to produce tyre derived fuel (TDF) while still retaining the capability to manufacture crumbed rubber approved under DA-843/2013.

The AQIA presents an assessment of the potential air quality impacts of activities associated with the proposed alteration and additions to operations at the premises. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for prevailing background air quality conditions.

1.1. Purpose of the Report

The purpose of this AQIA is to assess the potential impact of air emissions resulting from the operation of the premises with the proposed alteration and additions applied. The AQIA adopts established methods for dispersion modelling and emissions estimation, considering source characteristics, emission rates, local meteorology, terrain, land use, and sensitive receptor locations.

The AQIA has been performed with reference to the following relevant statutory legislative guidelines and assessment documents (in no order):

- *Protection of the Environment Operations Act* 1997 (POEO Act);
- Protection of the Environment Operations (Clean Air) Regulation 2022 (POEO CAR);
- Approved Methods for the Modelling and Assessment of Air Quality in NSW (NSW EPA, 2022a); and,
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (NSW EPA, 2022b).

2. THE PROPOSED ALTERATION AND ADDITIONS

The following provides a description of the context, location and scale of the proposed alteration and additions, and a description of the processes and development activities at the premises. It also identifies the potential for emissions to air associated with the proposed alteration and additions.

2.1. Environmental Setting

The premises is located at 30 Daisy Street in the suburb of Revesby, which forms a part of the City of Canterbury-Bankstown local government area (LGA), approximately 3.2 kilometres (km) south-west of Bankstown central business district (CBD) and approximately 19.9 km to the south-west of the Sydney CBD.

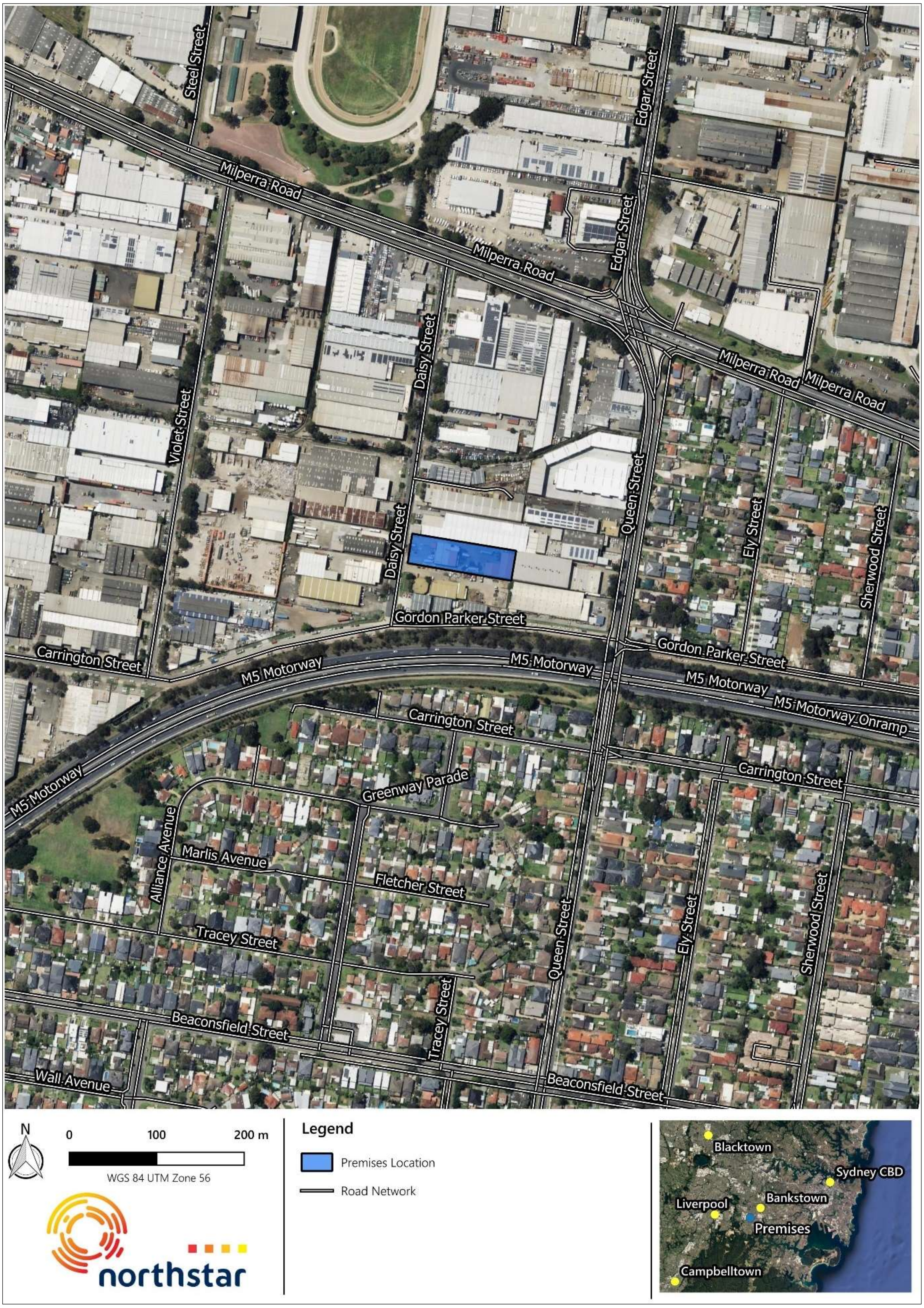
The premises is contained within Lot 198 of Deposited Plan (DP) 7866, which covers a total area of approximately 4 000 square metres (m^2).

In its existing state, the premises contains a single storey industrial building with associated mezzanine office level located towards the western boundary of the premises. The building is used for tyre shredding and crumbing with mechanical plant and equipment. A weighbridge is located on the southern boundary of the premises. A large outdoor covered area (awning) at the eastern boundary of the premises is used for tyre storage, baling and containerisation. The premises has a total of 11 no. existing car parking spaces within the front setback area.

The premises is bounded by neighbouring industrial lots located along Daisy Street and Gordon Parker Street. The nearest arterial road is the M5 South Western Motorway, positioned approximately 80 metres (m) to the south of the premises. Residential properties are situated within 500 m of the premises' boundary, including lots situated to the east along Queen Street.

A map showing the location of the premises is provided in Figure 1. A full description of the sensitivity and uses of the surrounding land, and the identification of discrete receptor locations used in the AQIA, is provided in Section 4.2.

Figure 1 Premises location



Source: Northstar

2.2. Overview of Alteration and Additions

The premises currently operates under development consent DA-843/2013 for the *"Use of premises for tyre recycling and transportation"* and DA-764/2016 for the *"Installation of Weigh Bridge"* by City of Canterbury Bankstown Council (Council). The premises also operates under EPL 20387 as issued by NSW Environment Protection Authority (NSW EPA) for the storage and recovery of end-of-life tyres (ELTs) and is accredited by Tyre Stewardship Australia (TSA), an industry body established to ensure the sustainable management of used tyres in Australia.

BSV is seeking development approval for the alteration and additions to its existing consent to increase the receival capacity of passenger and truck tyres at the premises from the permitted limit of 14 600 tonnes per year ($t{\cdot}yr^{-1}$) to 29 900 $t{\cdot}yr^{-1}$ including the installation of new processing equipment to develop the production of tyre derived fuel (TDF) whilst retaining the ability to manufacture crumbed rubber under DA-843/2013.

Specifically, the proposed alteration and additions comprises:

- Decommissioning of the tyre baling machines located under the rear awning of the premises;
- Alternative positioning of existing shipping containers for storage of rubber products;
- Installation of two additional diesel-fuelled tyre shredding units to increase the production of TDF to the rear of the premises with conveyors, with ducted local exhaust ventilation (LEV) to dedicated discharge stacks located 1 m above the awning over the shredders;
- Establishment of a dedicated area for tyre unloading and temporary storage prior to processing;
- Installation of a pre-cast concrete panel wall along the southern boundary of the premise to improve fire safety and noise attenuation; and
- Installation of a fire hydrant on the southern boundary of the premises, a hose reel on the eastern boundary, firewater containment bunding and fire extinguishers adjacent to all ELTs and product storage locations.

A summary of the activities performed at the premises under the proposed alteration and additions is presented below.

Medium rigid vehicles carrying tyres will enter the premises from Daisy Street via a weighbridge. The tyres will then be unloaded using a forklift or bobcat skid-steer loader and sorted according to tyre type (passenger or truck). Any contamination found will then be removed for appropriate disposal. Tyres will be stored at the premises in two locations towards the eastern boundary in accordance with NSW Fire Brigade guidance document Guideline for Bulk Storage of Rubber Tyres (Fire & Rescue NSW, 2014).

Under the proposed alteration and additions, the ELTs are processed either for crumb rubber or to create TDF.

The crumb rubber production process is briefly summarised as follows:

- ELTs are transferred from the storage area using a tyre trolley;
- ELTs are loaded into a de-beader to remove steel reinforcing;
- ELTs are pre-processed to remove metals, textiles and fibres and then loaded into the tyre shredder;
- Residual rubber enters a granule processing machine to produce the crumb rubber product;
- Steel is baled and prepared for despatch; and
- Final crumb rubber product and residual textiles are package and transferred for despatch off-premises.

The TDF final product consists of rubber chips which are derived from two external shredders. For this AQIA, the process is assumed to be broadly consistent with crumb rubber production and has been assessed as equivalent.

The hours of operation under the proposed alteration and additions are:

- Monday to Friday: 7:00 am to 6:00 pm for most process operations including the crumb rubber plant and shredders. Extended hours are proposed for bobcat (6:00 am to 6:00 pm) and forklift (6:00 am to 11:00 pm) movements. Extended hours are proposed for ELT import and final product export movements (6:00 am to 11:00 pm).
- Saturday: 8:00 am to 5:00 pm for process operations and associated haulage movements.
- Sunday: 9:00 am to 4:00 pm for process operations and associated haulage movements.

The premises will process up to 29 900 t of tyre waste per year under the proposed alteration and additions. For this AQIA, the anticipated output from the tyre recycling process is 92 % rubber, 6 % steel, and 2 % cotton, as observed in similar development projects (RWDI, 2024). The disaggregation of processing activity rates is outlined in Table 1 and the vehicle movements at the premises are summarised Table 2.

Table 1 Activity rates at the premises

Parameter	Tonnes per day ($t \cdot day^{-1}$)	Tonnes per year ($t \cdot yr^{-1}$)
Existing consent - DA-843/2013		
Baled tyres	38.6	13 547
Crumb rubber	3.0	1 053
Tyre derived fuel (TDF)	0.0	0.0
Total	**41.6**	**14 600**
Proposed alteration and additions		
Baled tyres	0.0	0.0
Crumb rubber	3.0	1 053
Tyre derived fuel (TDF)	82.2	28 847
Total	**85.2**	**29 900**

Note: Average daily rate is assumed for 351 working days per year.

Table 2 Vehicle movements at the premises

Vehicles	Movements per day	Movements per year
Existing consent - DA-843/2013		
Incoming loads	5	1 755
Outgoing loads	3	1 053
Staff vehicles	15	5 265
Fuel truck	1 per week	52
Skip bin truck	1 per month	12
Total	**23**	**8 137**
Proposed alteration and additions		
Incoming loads	17	5 967
Outgoing loads	5	1 755
Staff vehicles	20	7 020
Fuel truck	1 per week	52
Skip bin truck	1 per month	12
Total	**44**	**14 806**

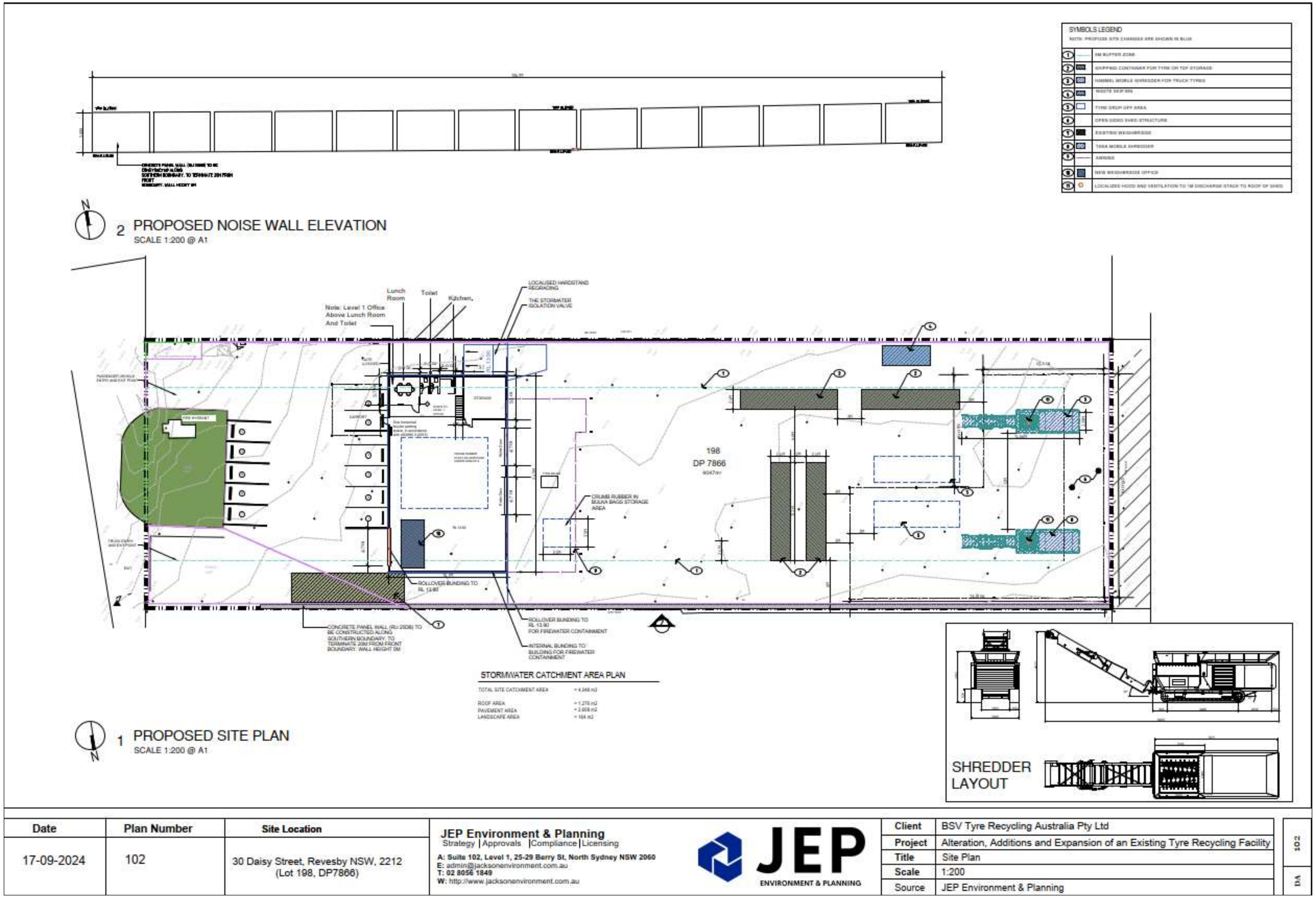
Note: Assumed processing is conducted 7 days per week for 351 working days per year

Vehicles entering the premises include tyre collection vehicles (8.8 m Medium Rigid Vehicles) and semi-trailers used to transport shipping containers. These vehicles will enter in the forward direction off Daisy Street, over the weighbridge, then will proceed to the open-sided shed towards the rear of the premises where tyres will be unloaded. Once the vehicle deposits tyres for recycling, it will turn around on the hardstand area and leave the premises in a forward direction, via the weighbridge then on to Daisy Street.

BSV is currently approved to store 150 t of waste tyres at any one time. All ELTs are brought to the premises from tyre retailers across the Sydney conurbation. No other forms of waste are brought on to the premises.

The premises site layout is presented is illustrated in Figure 2.

Figure 2 Premises layout



Source: JEP – BSV Tyre Recycling Australia Pty Ltd - Plan Number 102

2.3. Identification of Potential Emissions to Air

Given the nature of the proposed alteration and additions described above, the potential emissions to air would be likely to be generated from the following activities and processes:

- Transportation and unloading of ELTs to the premises;
- Transfer of ELTs to the de-beader by tyre trolley;
- Transfer of materials between processes by belt conveyors;
- Removal of metals, textiles and fibres prior to shredding;
- Grinding and shredding of rubber material;
- Transfer of TDF and crumb rubber product to storage area; and,
- Despatch from storage area off-premises.

The processes assessed are briefly discussed below.

2.3.1. Crumb Rubber and TDF Processing

Pollutants which may potentially be emitted from the tyre processing activities may include emissions of particulates, and 'Hazardous Air Pollutants' (HAP, or 'air toxics') which may be assessed in terms of their potential toxicity and odour impacts.

Emissions of particulate are generally resultant from the cutting of tyre fragments to produce crumb, and consequently these emissions have been assessed as PM_{10} (refer Appendix A for definition) which is consistent with the assumptions presented in the source of the emission factors adopted (refer Section 5.2).

Emissions from TDF production have been assessed similarly, as the process involves shredding tyre fragments.

Potential emissions from diesel fuel combustion during the shredding process for TDF production may occur on-premises while the shredders operate. The specified shredders, TANA SHARK 440DT and HAMMEL VB 950DK, both use diesel, resulting in the release of air pollutants such as oxides of nitrogen (NO_X) and particulate matter (PM) as combustion by-products. The capacity for the HAMMEL VB 950DK is specified as 20 $t{\cdot}hr^{-1}$ with the TANA SHARK 440DT noted as 12 $t{\cdot}hr^{-1}$.

2.3.2. Vehicles Emissions

Based upon information supplied by BSV, the number of vehicle movements associated with the delivery of ELTs and/or the export of TDF and crumb rubber product will number 22 movements per day (refer Table 2). Based upon the premises layout (refer Figure 2) it is assumed that a delivery vehicle movement covers up to approximately 190 m in length on paved surfaces.

The proposed operation at the premises also includes the operation of one forklift and one bobcat to transfer tyre materials between processes on-premises. The forklift and bobcat are anticipated to be light weight (approx. 4 tonnes). They have assumed to be operating at 50 % utilisation across all operating hours at 5 kilometres per hour ($km \cdot hr^{-1}$).

Staff vehicle movements have been considered in this AQIA, with an estimated 20 movements per day (refer Table 2). Staff vehicles are expected to enter through the passenger vehicle access point and park at the front of the premises in dedicated parking bays. Each staff vehicle movement is assumed to cover up to 70 m on paved surfaces.

2.3.3. Fugitive Wind Generation Emissions

Given the nature of the site, the freestanding areas of the site have been assumed to be a potential source of wind erosion.

2.3.4. Summary

The methodology adopted in this AQIA to estimate emissions and model the dispersion of potential air emissions is provided in Section 5. Assessment of the potential impacts upon local air quality resulting from those activities is presented in Section 6.

Table 3 lists the pollutants assessed for this AQIA.

Table 3 Identification potential for emissions to air

Process / Activity	Emissions considered			
	Particulates	Combustion gases	Air toxics (toxicity)	Air toxics (odour)
Crumb rubber processing	✓	-	✓	✓
TDF processing	✓	✓	✓	✓
Delivery/despatch vehicles	✓	-	-	-
Forklift and bobcat movements	✓	-	-	-
Fugitive wind-generated emissions	✓	-	-	-

A range of 'air toxics' have been assessed as part of this AQIA, which includes a range of micro-pollutants assessed in terms of their potential toxicity and odour impacts.

The reference used to identify and quantify the potential emission rate of pollutants is discussed in further detail in Section 5.2, and which includes a range of HAPS (US EPA, 2008) which has been used to identify the air toxics applicable for this AQIA. Where those identified pollutants have an assessment criterion for toxicity and/or odour, these are discussed in Section 3.

3. LEGISLATION, REGULATION AND GUIDANCE

The following outlines the legislation and air quality criteria which are applicable to the activities being performed at the premises.

3.1. Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act* 1997 (POEO Act) sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises and a range of air pollution offences and penalties.

Schedule 1, Part 34 of the POEO Act details 'Resource Recovery' as a scheduled activity. The relevant activity which applies to the premises is:

> *"recovery of waste tyres, meaning the receiving of waste tyres from off site and their processing, otherwise than for the recovery of energy".*

This activity is declared to be 'scheduled' if it meets the following criteria:

- Involves having at the premises at any time (other than in or on a vehicle used to transport the tyres to or from the premises) more than 5 t waste tyres or 500 waste tyres, or
- Involves processing more than 5 000 $t{\cdot}yr^{-1}$ of waste tyres.

BSV currently holds EPL 20387 issued by the NSW EPA under the POEO Act as more than 5 000 $t{\cdot}yr^{-1}$ of waste tyres are processed at the premises. Since the proposed alteration and additions seeks to process up to 29 900 $t{\cdot}yr^{-1}$ an EPL variation from NSW EPA will be required post development consent. All requirements of the EPL will be continued to be strictly adhered to.

Condition L2.2 of EPL 20387 restricts on-site waste storage (processed and unprocessed) to 150 t at any one time. It is understood that no increase in storage capacity is proposed at this stage.

Chapter 5, Part 5.4, Section 128 relates to the control of air emissions (emphasis added).

> *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…

Section 129 provides the requirements for the control of emissions of odour from licensed activities.

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…

For reference, '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.

Plant and machinery operating at the premises will be maintained regularly. Handling of materials at the premises will be performed with the inclusion of control measures as described in Section 5.3. As such, the requirements of the POEO Act would be met.

3.2. Protection of the Environment (Clean Air) Regulation 2022

The Protection of the Environment Operations (POEO) (Clean Air) Regulation 2022 (POEO CAR) sets requirements and standards of concentration for emissions to air for industrial activities within NSW.

Schedule 2, Division 3 of the POEO CAR sets emission limits for activities not covered by Division 1 or Division 2. Table 4 outlines the relevant concentration standards for the existing and proposed activities.

Table 4 General standards of concentration for scheduled premises – Group 6

Air impurity	Activity	Standard of concentration
Solid particles (total)	A crushing, grinding, separating or materials handling activity	20 mg·Nm^{-3}
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both as NO_2 equivalent	Stationary reciprocating internal combustion engines	450 mg·Nm^{-3} (A)
Type 1 & Type 2 substances (in aggregate)	An activity or plant	1 mg·Nm^{-3}
Volatile organic compounds (VOC) as *n*-propane	Any stationary reciprocating internal combustion engine using a liquid fuel	1 140 mg·Nm^{-3} VOCs *or* 5 880 mg·Nm^{-3} CO (A)
Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	20 % opacity (B)

Notes: Table 3 relates to Scheduled premises - Group 6 i.e., pursuant to application made on or after 1 September 2005
(A) Reported at 273 K, 101.3kPa, dry, 7 % O_2 as specified in Part 3 Division 1, Group 6.
(B) Gas stream temperature above dew point. Path length corrected to stack exit diameter as per CEM-1

The premises would be operated, and equipment maintained in an appropriate manner to ensure that general standards of concentrations, and requirements associated with emissions from motor vehicles are achieved.

3.3. Ambient Air Quality Standards

State air quality guidelines adopted by NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Quality in NSW'* (NSW EPA, 2022a) (the Approved Methods) which has been consulted during the preparation of this AQIA.

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 and Section 7.2 of the Approved Methods outlines the impact assessment criteria for those pollutants of interest and both individual and principal toxic air pollutants. Principal toxic air pollutants are defined in the Approved Methods (NSW EPA, 2022a) on the basis that they are carcinogenic, mutagenic, highly persistent, or highly toxic in the environment.

The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE, WHO and ANZECC).

Where relevant to this AQIA (coincident with the potential emissions identified in Section 2.3), the criteria have been adopted as set out in Section 7.1 of (NSW EPA, 2022a) which are presented in Table 5.

Table 5 NSW EPA impact assessment criteria

Pollutant	Averaging period	Criterion	Units (E)	Notes
Nitrogen dioxide (NO_2)	1 hour	164	$\mu g \cdot m^{-3}$ (A)	Numerically equivalent to the AAQ NEPM (B) standards and goals.
	Annual	31	$\mu g \cdot m^{-3}$	
Particulates (as PM_{10})	24 hours	50	$\mu g \cdot m^{-3}$	
	Annual	25	$\mu g \cdot m^{-3}$	
Particulates (as $PM_{2.5}$)	24 hours	25	$\mu g \cdot m^{-3}$	
	Annual	8	$\mu g \cdot m^{-3}$	
Particulates (as TSP)	Annual	90	$\mu g \cdot m^{-3}$	
Deposited dust	Annual	2	$g \cdot m^{-2} \cdot month^{-1}$ (C)	Assessed as insoluble solids as defined by AS 3580.10.1
	Annual	4	$g \cdot m^{-2} \cdot month^{-1}$ (D)	

Notes: (A): micrograms per cubic metre of air (B): National Environment Protection (Ambient Air Quality) Measure
(C): Maximum increase in deposited dust level (D): Maximum total deposited dust level
(E): Gas volumes are expressed at 25°C (298 K) and at an absolute pressure of 1 atmosphere (101.325 kPa)

Table 6 below provides a summary of impact assessment criteria for principal and individual toxic pollutants that are referenced within this AQIA, as outlined in Section 7.2 of (NSW EPA, 2022a).

Table 6 NSW EPA impact assessment criteria for principal and individual toxic pollutants

Pollutant	Averaging period	Criterion		Notes
		ppm (A)	$mg \cdot m^{-3}$ (B)	
1,3-Butadiene	1 hour	0.018	0.04	
Acrolein	1 hour	0.00018	0.00042	
Benzene	1 hour	0.009	0.029	
Biphenyl	1 hour	0.0037	0.024	
Carbon disulfide	1 hour	0.023	0.07	Odour
Chromium (Cr) compounds	1 hour	-	0.009	
Methylene chloride	1 hour	0.9	3.19	
Nickel (Ni) compounds	1 hour	0.00009	0.00018	
Xylenes	1 hour	0.04	0.19	
Phenol	1 hour	0.0052	0.02	Odour
Styrene	1 hour	0.027	0.12	Odour
Toluene	1 hour	0.09	0.36	Odour

Notes: (A): parts per million (10^6) (B): milligrams per cubic metre of air

It is noted that the air toxics presented in Table 6 are assessed as the 99.9th percentile of 1-hour average predictions, as per the requirements of the Approved Methods (NSW EPA, 2022a).

3.4. NSW Government Air Quality Planning

NSW EPA has formed a comprehensive strategy with the objective of driving improvements in air quality across the State. This comprises several drivers, including:

- **Legislation:** formed principally through the implementation of the *Protection of the Environment Operations Act* 1997, and the *Protection of the Environment Operations (Clean Air) Regulations* 2022. The overall objective of the legislative instruments is to achieve the requirements of the National Environment Protection (Ambient Air Quality) Measure;
- **Clean Air for NSW**: The 10-year plan for the improvement in air quality;
- **Inter-agency Taskforce on Air Quality in NSW:** a vehicle to co-ordinate cross-government incentives and action on air quality;
- **Managing Particles and Improving Air Quality in NSW**; and
- **Diesel and Marine Emission Management Strategy.**

In regard to the relevance of the NSW Government's drive to maintain and improve air quality across the State and this AQIA, it is imperative that this premises would lead to the development of the NSW economy (in terms of activity and employment) and concomitantly not cause a detriment in air quality in achieving its objectives.

4. EXISTING CONDITIONS

This section of the AQIA examines current conditions, covering background air quality and meteorological conditions, the topography of the surrounding area, the identification of sensitive receptor locations, and considers potential sources of cumulative impacts in the area surrounding the premises.

4.1. Surrounding Land Use

The premises and immediate surrounds are currently zoned as IN1 General Industrial under the Canterbury-Bankstown Local Environmental Plan (LEP) 2023.

Land use class in the wider environs includes SP2 Infrastructure use located to the north as A34 Milperra Road, and south of the premises encompassing M5 South Western Motorway, There is R2 Low Density Residential located to the east along Ely Street, Gordon Parker Street and Queen Street, and further south including Carrington Street and Alliance Avenue.

4.2. Sensitive Receptor Locations

Air quality assessments typically use a desk-top mapping study 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, 2022a) denotes 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 AQIA has been on discrete receptor locations, which are specified in consideration of the Approved Methods (NSW EPA, 2022a) and are broadly representative of those areas or sites that may experience the greatest or most likely levels of exposure on account of the proposed alteration and additions.

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 the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the premises 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·km^{-2}):

- No population — Zero (0)
- Very low — Up to 500
- Low — Between 500 and 2 000
- Medium — Between 2 000 and 5 000
- High — Between 5 000 and 8 000
- Very high — More than 8 000

Using ABS data in a GIS, the population density of the area surrounding the premises and locality is in an area of low population density (between 500 and 2 000 persons·km^{-2}). The population density of the area surrounding the premises are presented in Figure 3.

In accordance with the requirements of the Approved Methods (NSW EPA, 2022a) several receptors have been identified and the receptors adopted for use within this AQIA are presented in Table 7 and illustrated in Figure 3.

Table 7 Discrete sensitive receptor locations

Receptor ID	Address	Land use description	Co-ordinates (m, UTM 56)	
			mE	mS
R1	Daisy Street, Revesby	Industrial	315 965	6 242 925
R2	Queen Street, Revesby	Industrial	316 173	6 242 835
R3	Queen Street, Revesby	Residential	316 209	6 242 834
R4	Daisy Street, Revesby	Industrial	315 959	6 242 839
R5	Carrington Street, Revesby	Residential	315 955	6 242 718
R6	Daisy Street, Revesby	Industrial	315 918	6 242 885
R7	Queen Street, Revesby	Industrial	316 082	6 242 947
R8	Carrington Street, Revesby	Recreational	315 789	6 242 685
R9	Daisy Street, Revesby	Industrial	316 034	6 242 998
R10	Queen Street, Revesby	Residential	316 232	6 242 994
R11	Queen Street, Revesby	Residential	316 228	6 242 932
R12	Queen Street, Revesby	Residential	316 148	6 242 697

Note: The requirements of this AQIA 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 Population density and discrete sensitive receptor locations

Source: Northstar

4.3. Meteorology

In accordance with the requirements of the NSW EPA Approved Methods, the AQIA is required to describe and account for the influence of the prevailing meteorological conditions.

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 meteorology of the area surrounding the premises has been examined using data collected by the Australian Government Bureau of Meteorology (BoM) at the Bankstown Airport Automatic Weather Station (AWS), which is approximately 3 km northwest of the premises. This AWS is considered the most representative station for the area surrounding the premises.

Meteorological conditions measured at the Bankstown Airport AWS are presented in Appendix B and are considered representative of the premises due to proximity. Data from 2019 to 2023 were analysed for this AQIA. The associated wind roses in Appendix B indicate consistent wind patterns across the five-year period with no predominant wind direction.

The majority of wind speeds experienced at the Bankstown AWS between 2019 and 2023 are generally in the range 1.5 meters 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 predominantly from south-easterly directions. Winds of this speed occur during 1.6 % of the observed hours during the years. Calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 20.8 % of hours on average across the years.

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

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

4.4. Background Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant should also be assessed. This 'background' (sometimes called 'baseline') air quality will vary depending on the pollutants to be assessed and can often be characterised by using representative air quality monitoring data.

Air quality monitoring data from Lidcombe AQMS has been adopted to provide a representative dataset for the area surrounding the premises for the assessment year of 2021 (consistent with the selected meteorological modelling data [refer Appendix B]). As such, PM and NO_2 data as monitored at Lidcombe AQMS in 2021 have been used to approximate typical conditions around the premises.

Appendix C provides a detailed assessment of the background air quality monitoring data used in this AQIA.

It is noted that TSP is not measured at Lidcombe AQMS. Correspondingly, other sources of data have been adopted to allow representation of the TSP environment in the area surrounding the premises, and a full discussion is provided in Appendix C.

The air toxics outlined in Section 3.3 are not routinely monitored at AQMS within NSW. For the purposes of this AQIA, the background concentrations of those pollutants have been assumed to be negligible.

Additionally, the impact assessment criteria used for deposited dust (refer Table 5) are presented as (i) a cumulative deposition rate of 4 $g{\cdot}m^{-2}{\cdot}month^{-1}$ and (ii) a discrete deposition rate of 2 $g{\cdot}m^{-2}{\cdot}month^{-1}$. In lieu of a background deposition rate to derive a cumulative rate, the incremental impact assessment criterion of (2 $g{\cdot}m^{-2}{\cdot}month^{-1}$) will be used. This is a commonly adopted approach when background deposition rates are not available, and the assessment outcomes are the same.

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 8.

It is noted that although impacts of ozone (O_3) have not been considered in this AQIA, Ozone (O_3)data have been adopted to assist in calculating the conversion of NO_X to NO_2 for the dispersion modelling assessment (refer Section 5.5).

Table 8 Summary of background air quality used in the AQIA – Lidcombe AQMS 2021

Pollutant	Averaging period	Units	Measured value	Notes
Nitrogen dioxide (NO_2)	1 hour	$\mu g \cdot m^{-3}$	Hourly Varying	The 1 hour maximum NO_2 concentration in 2021 was 102.5 $\mu g.m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	19.0	
Particles (as TSP) (derived from PM_{10})	Annual	$\mu g \cdot m^{-3}$	32.2	Estimated on a TSP:PM_{10} ratio of 2.0551 : 1
Particles (as PM_{10})	24 hour	$\mu g \cdot m^{-3}$	Daily Varying	The 24 hour maximum PM_{10} concentration in 2021 was 39.2 $\mu g.m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	15.7	
Particles (as $PM_{2.5}$)	24 hour	$\mu g \cdot m^{-3}$	Daily Varying	The 24-hour maximum $PM_{2.5}$ concentration in 2021 was 31.5 $\mu g.m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	6.1	
Photochemical oxidants (as ozone)	1 hour	$\mu g \cdot m^{-3}$	184.0	Maximum 1 hour average in 2021
	Annual	$\mu g \cdot m^{-3}$	33.8	Annual average in 2021
Dust deposition	Annual	$g \cdot m^{-2} \cdot month^{-1}$	2.0	Difference in NSW EPA maximum allowable and incremental impact criterion

Note: Reference should be made to Appendix C

The AQIA has been performed to assess the contribution of the operations at the premises to the air quality of the surrounding area. A full discussion of how the proposed alteration and additions to the premises may impact upon air quality is presented in Section 6.

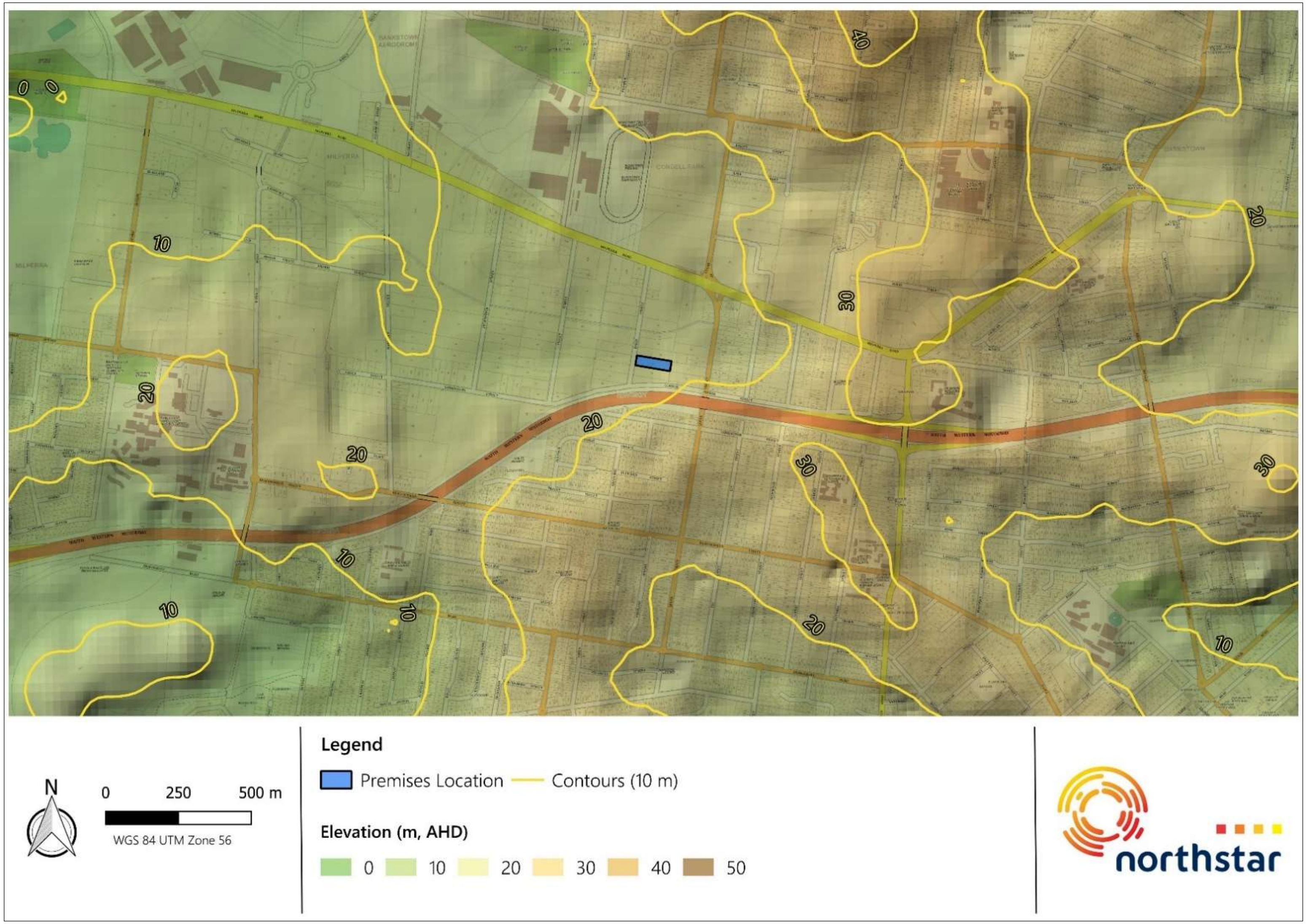
4.5. Topography

The topography between the premises and identified sensitive receptor locations is relatively consistent with elevation variances of less than 15 m within the immediate locality. The elevation of the premises is approximately 15 m Australian Height Datum (AHD). The topography between the premises and nearest sensitive receptor locations is uncomplicated from an air quality modelling perspective.

A graphical representation of the local topography, as obtained from the Elvis Elevation and Depth[1] system, hosted by the Intergovernmental Committee on Surveying and Mapping (ICSM) is presented in Figure 4.

[1] https://elevation.fsdf.org.au/

Figure 4 Local topography



Source: Northstar

5. APPROACH TO ASSESSMENT

The AQIA is a quantitative assessment designed to align with the approach outlined in (NSW EPA, 2022a) for evaluating potential air quality impacts during the operational phase of development.

5.1. Dispersion Modelling

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 (2-D) mode. Given the flat (uncomplex) terrain and the proximity of the receptors to the premises, a detailed assessment using a 3 D meteorological dataset is not warranted. The 2-D meteorological dataset has been developed using The Air Pollution Model (TAPM, v 4.0.5) (refer Appendix B for further information).

An assessment of the impacts of the operation of activities at the premises has been performed which characterises the likely day-to-day activities, approximating average operational characteristics which are appropriate to assess against longer term (annual average) criteria for emissions to air. The likely peak activities at the premises have also been characterised to allow comparison of potential impacts against shorter term (1-hour, 24-hour) criteria for emissions to air.

The modelling scenarios provide an indication of the air quality impacts of the operation of activities at the premises. Added to these impacts are background air quality concentrations (where available and discussed in Section 4.3 and Appendix C) which represent the air quality which may be expected within the area surrounding the premises, without the impacts of the premises itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the premises.

5.2. Emissions 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. The processes which may result in the emission of pollutants to air are outlined in Section 2.3 and the criteria relevant to those emissions are summarised in Section 3.

Further details of the emissions inventory adopted in this AQIA are presented in Appendix D.

5.2.1. Crumb Rubber and TDF Processing

Reference emission factors for the specific activities performed at the premises including the crumb rubber plant are not available. Instead, emissions factors as taken from the United States Environmental Protection Agency (US EPA) AP-42 documentation for the manufacture of rubber products (US EPA, 2008) has been used. These included specific factors for tyre grinding, particularly for the processes of tyre carcass, belt and sidewall grinding, and tyre retread buffing.

Section 3.4 of (US EPA, 2008) states that:

> *The grinding processes used in tire manufacturing are specific to each application. Four types were identified for this program: retread buffing, carcass grinding, whitewall (sidewall) grinding, and truing (force) or uniformity grinding. The grinding processes, in general, generate quantities of rubber dust and particles, and may generate HAP emissions, depending on the rubber formulation and the amount of heat generated during grinding.*

An environmental approval for a tyre shredding development in Indiana (US) by the State Department of Environmental Management adopted the AP-42 emission factor for 'tyre retread buffing' as being applicable to tyre shredding and stated:

> *The emission factors for tire retread buffing were used because this operation is more representative of tire shredding than belt rubber, carcass rubber, or sidewall/whitewall rubber grinding operations.*

The existing crumb rubber processing line approved under DA-843/2013 comprises of the following processes, each processing 3 t·day^{-1}:

- 2 no. grinder mills;
- 2 no. conveyor systems;
- 4 no. block cutter machines;
- 2 no. strip cutter machines;
- 3 no. tyre side wall cutter machines;
- 2 no. tyre debeader machines; and,
- 1 no. fluff extractor.

For the purposes of this AQIA, the emission factors for 'tyre retread buffing' and 'sidewall removal' from (US EPA, 2008) have been adopted to represent the applicable processes considered for the crumb rubber plant. The existing crumb rubber plant includes a tyre shredder and associated belt conveyor, permitted under DA-843/2013 to process up to 3 t·hr^{-1}. For the purposes of this AQIA, the emission factor for 'tyre retread buffing' (US EPA, 2008) has been adopted to represent the tyre shredding component of the crumb rubber plant.

The corresponding tyre retread buffing emissions factors for total particulate matter (PM) and total Hazardous Air Pollutants (HAPS) are:

- Total PM: 9.09E-07 kg.kg^{-1} processed.
- Total HAPs: 1.33E-05 kg·kg^{-1} processed.

Regarding individual HAPs, the AP-42 documentation for rubber product manufacturing (US EPA, 2008) specifies a range of air toxics that may be emitted during tyre grinding processes. It is also noted that the NPI EETM for rubber product manufacturing (NPI, 2002) identifies a series of emission factors that are broadly replicated from the (US EPA, 2008) documentation.

Based on Northstar's experience with similar projects, acrolein and benzene are pollutants of concern due to their toxicity. These pollutants can potentially be generated during the mechanical grinding and shredding process from the stress and heat produced as rubber passes through the grinder. Subsequently, acrolein and benzene emissions have been assessed in more detail using species specific emission factors presented in (US EPA, 2008). The emissions factors are provided below for clarity:

- Acrolein: 4.70E-07 kg·kg^{-1} processed.
- Benzene: 9.96E-06 kg·kg^{-1} processed.

For other identified HAPS (refer Table 6), a proportional assessment has been conducted based on the emission factor of each of individual species taken against the emission factors for total emission estimates. This approach has been applied by Northstar in similar AQIAs for tyre recycling facilities (Northstar, 2018).

Two additional tyre shredders will be positioned at the rear of the premises, underneath an external awning structure. For this AQIA, the premises is assumed to process up to 98.6 t·day^{-1} with a 20 % increase factored into the quantity of ELTs to be directed for TDF production (refer Table 1). This represents the daily maximum throughput, specified based on the premises' current approval to store 150 t of ELTs at any one time. Processing totals have been adjusted by 92 % to account for the removal of steel wires, rims, belts, and textile cord before grinding (RWDI, 2024) which contribute the remaining 8 % of the tyre material.

A 62.5 % to 37.5 % split has been applied to the assumed daily maximum throughput based on the operational capacities of the 2 no. shredders ('HAMMEL VB 950DK' and 'TANA SHARK 440DT' shredders) respectively, to allocate a representative throughput to each shredder and to consequently predict operational impacts. The AP-42 emission factors for 'tyre retread buffing' has been adopted as discussed above.

Emissions from the shredders will be captured by a local exhaust ventilation (LEV) system and drawn by an internal draft (ID) fan to dedicated discharge stacks located 1 m above the awning over the shredders. Consequently, each of the shredders have been modelled as separate point sources. The existing crumb rubber plant's shredder has been specified to discharge at 1 m above roof level, set at 5.8 m AGL, while the additional shredders to the rear are to discharge at 7.9 m AGL. The corresponding emissions have been modelled with a discharge velocity of 15 m·s^{-1} and a temperature of 25 °C consistent with (Northstar, 2018). A stack diameter of 200 mm ID was assumed for each shredder.

The two shredders are to be diesel-fuelled which will give rise to combustion emissions. Subsequent emissions from the operation of the shredders have been assessed as NO_X which is commonly regarded as the principal air pollutant from such an activity and PM have been assessed as 100 % $PM_{2.5}$ which best represents the particle size distribution for diesel combustion.

The TANA SHARK 440DT and HAMMEL VB 950DK shredders have been sourced for use at the premises. The associated technical specifications denote that the following engine manufacturer and output capacities have been noted:

- Cummins X15[2] diesel engine with a power rating of 399 kW; and,
- CAT C18[3] industrial diesel engine with a power rating of 597 kW.

Non-road diesel engines used in Australia commonly adhere to either United States (US) emissions standards (Tier 1 to Tier 4) or European Union (EU) emissions standards (Stage I to Stage V) due to the prevalent manufacturing of diesel engines in these regions.

Non-road engine emissions are regulated in Europe under EU Directive 2016/1628, known as the NRMM Regulation. This EU Directive sets emission limits for different power ranges and applications, specifying procedures for engine manufacturers to achieve type-approval. Derived from this directive, European Stage V standards impose strict PM emission limits. Non-road engines between 19 kW and 560 kW must be equipped with diesel particulate filters (DPFs). Additionally, Stage V standards apply to engines exceeding 560 kW, establishing their own emission limits.

The emissions standards for each diesel engine have been determined based on their technical specifications. The Cummins X15 meets EU Stage IIIA standards, whereas the CAT C18 meets EU Stage V standards.

Table 9 provides the EU Stage IIIA and Stage V emissions limits acquired for non-road diesel engines rated between 19 kW and 560 kW and the corresponding emission rates adopted for use in this AQIA for each specified external shredder.

Table 9 EU Stage IIIA/V emission standards and emission rates adopted in AQIA

Category	Net Power (P)	Emission standard (g·kWh)		Power Rating (kW)	Emission rate (g·s^{-1})	
		NO_X	PM		NO_X	PM
TANA SHARK 440DT / Cummins X15						
H	130 ≤ P ≤ 560	4.0	0.2	399	4.43E-02	2.77E-03
HAMMEL VB 950DK / CAT C18						
NRE-v/c-7	P > 560	3.5	0.045	597	5.80E-01	7.46E-03

Combustion exhaust emissions associated with the two external shredders have been modelled at 3.2 m and 3.4 m above ground level, respectively, based on observed technical data. In the absence of further details, an exhaust diameter of 200 mm ID was assumed for each shredder, with vertical discharge velocities set at 15 m·s^{-1} at 100 °C.

[2] https://tana.fi/products/tana-shredder-440dt/

[3] https://www.pon-cat.com/en-nl/products/cat-power-generation/industrial-engines/cat-c18

Tyre processing emissions, including the crumb rubber production line and the shredders have been assessed as constant emission rates over a period from 7:00 am to 6:00 pm daily (11 hrs·day^{-1}).

5.2.2. Vehicle Emissions

The daily rate of vehicle movements at the premises is relatively low and assumed to be 13 no. heavy rigid vehicles and 4 no. semi-trailers per day incoming and 1 no. heavy rigid vehicle and 4 no semi-trailers outgoing per day, equating to 22 no. vehicles per operational day over a period from 6:00 am to 11:00 pm.

The internal road at the premises comprises of paved hardstand surfaces and correspondingly, the traffic generated particulate emissions have been estimated using the published AP-42 emission factor for paved roads (US EPA, 2011).

The silt content on the paved road has been assumed to be relatively high at 7.4 g·m^{-2}, which is generally representative of paved roads on municipal solid waste landfills (US EPA, 2011).

Emissions from forklift and bobcat movements were estimated similarly. Both non-road mobile machinery units were assumed to travel at 5 km·hr^{-1} with 50 % utilisation across the premises. Bobcats were assessed over a 12-hour operational period (6:00 am to 6:00 pm), while forklifts operated daily from 6:00 am to 11:00 pm (17 hr·day^{-1}).

Delivery and staff vehicles have been assessed as constant emission rates over a period from 6:00 am to 11:00 pm daily (17 hrs·day^{-1}).

5.2.3. Fugitive Wind Generated Emissions

Emissions of particulate matter resulting from the wind erosion of exposed areas have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The entire site, excluding land occupied by the two structures has been assumed to be an available source for fugitive wind erosion for all hours of the day.

5.3. Emissions Controls

BSV have outlined a number of controls in their Operational Environmental Management Plan (OEMP) (BSV, 2018) and Pollution Incident Response Management Plan (PIRMP) (BSV, 2022) to reduce air emissions from the premises. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the premises' operation.

A summary of the emissions reductions measures that would be adopted during the premises' operation is presented in Table 10. The emission control efficiencies associated with these measures are outlined in the

NPI Emissions Estimation Technique Manual (EETM) for Rubber Product Manufacture (NPI, 2002) and relevant AP-42 documentation (US EPA, 1995), Katestone Environmental (Katestone Environmental, 2011) and Countess Environmental (Countess Environmental, 2006).

Table 10 Summary of emission reduction methods adopted as part of premises' operation

Emission control method	Control efficiency (%)
All truck loads are covered during transportation to prevent wind-borne losses and spillages	Unquantified
Sweeping of paved road surfaces and outdoor hardstand areas	Unquantified
Vehicle speed limited at the premises to less than 10 $km \cdot hr^{-1}$	85
Minimised drop heights during tyre unloading activities	30
Performance of tyre processing operations within an enclosed building enclosure	70
Tyre and tyre products to be stored indoors	99

5.4. Exposure Averaging Periods

The discrete receptors identified in Section 4.2 contain a mix of industrial and residential receptor locations. The predicted impacts of the AQIA need to be evaluated at those receptor locations in cognisance of the respective averaging period of the relevant criteria identified in Section 3.

In regard to impact assessment criteria for particulates, the relevant averaging periods are 24-hours (for PM_{10} and $PM_{2.5}$) and annual average (for TSP, PM_{10} and $PM_{2.5}$). In regard to the impact assessment criteria for NO_2, the averaging periods are 1-hour and annual average, and in regard to air toxics, the averaging period for all assessed species is 1-hour.

As the function of the impact assessment criteria is to protect health, as acute (short-term) and chronic (long-term) potential impacts, the land use at the receptor locations is of relevance to this AQIA. For residential receptor locations, it is feasible that exposure may occur over any assessment period from 1-hour to 1-year. For industrial receptors, where persons may be present for the duration of the working day, it is not reasonable to assume that exposure at that location would occur over a 24-hour period.

Correspondingly, particulate impacts over averaging periods of 24-hours and annual average are not to be assessed at industrial receptor locations but predicted impacts of 1-hour NO_2 and 1-hour average air toxics are, as it is reasonable to assume an exposure over that averaging period. Amenity impacts, as annual average dust deposition rates and annual average TSP concentrations are assessed at all receptors.

5.5. NO_X to NO_2 Conversion

Emissions of NO_X have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_X is a mixture of NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed.

Approximately 90 % - 95 % of NO_X from a combustion process will be emitted as NO, with the remaining 5 % - 10 % emitted directly as NO_2. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions to form NO_2, and this reaction often occurs at a considerable distance downwind from the point of emission, and by which time the plume will have dispersed and diluted significantly from the concentration at point of discharge.

AQIAs are required to account for the conversion of NO_X emissions to NO_2 to enable a comparison against the air quality criterion for NO_2. To perform this, various techniques are common, which are briefly outlined below:

- **100% conversion**: the most conservative assumption is to assume that 100 % of the total NO_X emitted is discharged as NO_2, and that further reactions do not occur.
- **Ozone limiting method (OLM)**: this method uses contemporaneous ozone data to estimate that rate at which NO is oxidised to NO_2 hour-on-hour using an established relationship.
- **Janssen method**: where the location is represented by good monitoring data for NO and NO_X, the empirical relationship between NO and NO_2 may be used to derive 'steady state' relationships.

This AQIA has applied the Janssen method (Method 3) to approximate the conversion of NO_X to NO_2, in accordance with the methodology described in (NSW EPA, 2022a).

$$NO_2 \ / NO_x = A(1 - \exp(-\alpha x))$$

Where:

x = distance from the source (km)

A and α are classified according to O_3 concentration, wind speed and season, with (Janssen, Van Wakeren, Van Duuren, & Elshout, 1988) providing values for A and α.

At each receptor, the hourly varying $NO_2 \ / NO_x$ relationship has been calculated, based on the season, hourly varying O_3 concentration, and wind speed.

For the AQIA, the incremental and cumulative NO_2 concentrations have been derived using the Method 3, Level 2 assessment, as per (NSW EPA, 2022a).

6. AIR QUALITY IMPACT ASSESSMENT

This section presents the results of the dispersion modelling assessment and uses the following terminology:

- **Incremental impact** – relates to the concentrations predicted due to the premises in operation with the proposed alteration and additions, in isolation;
- **Cumulative impact** – relates to the incremental concentrations predicted due to the premises in operation with the proposed alteration and additions PLUS background air quality concentrations discussed in Section 4.4.

The results are presented in this manner to allow examination of the likely impact of the premises in isolation and the contribution to air quality impacts in a broader sense.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	Pollutant concentration / deposition rate equal to, or greater than the relevant criterion

6.1. Particulate Matter

6.1.1. Annual Average TSP, PM_{10} and $PM_{2.5}$ Concentrations

As discussed in Section 5.4, the nature of the receptor location and anticipated duration of exposure is of relevance when interpreting predictive modelling results.

Annual average PM_{10} and $PM_{2.5}$ concentrations should be assessed at locations where long-term exposure which might impact health would be reasonable to be assumed, which would apply to receptors R3, R5, R10, R11 and R12 in this AQIA. The predicted results at non-relevant receptors have been provided as greyed and italicised text to denote that differentiation.

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) are presented in Table 11.

Table 11 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

Receptor ID	Land use description	Annual average concentration ($\mu g \cdot m^{-3}$)								
		TSP			PM_{10}			$PM_{2.5}$		
		Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion		90			25			8		
Max. % of criterion		6.5	35.8	42.3	12.0	62.8	74.8	9.1	76.3	85.3
R1	Industrial	3.0	32.2	35.2	*1.5*	*15.7*	*17.2*	*0.5*	*6.1*	*6.6*
R2	Industrial	0.8	32.2	33.0	*0.5*	*15.7*	*16.2*	*0.3*	*6.1*	*6.4*
R3	Residential	0.5	32.2	32.7	0.4	15.7	16.1	0.2	6.1	6.3
R4	Industrial	5.8	32.2	38.0	*3.0*	*15.7*	*18.7*	*0.7*	*6.1*	*6.8*
R5	Residential	0.5	32.2	32.7	0.3	15.7	16.0	0.1	6.1	6.2
R6	Industrial	2.3	32.2	34.5	*1.1*	*15.7*	*16.8*	*0.3*	*6.1*	*6.4*
R7	Industrial	1.3	32.2	33.5	*0.8*	*15.7*	*16.5*	*0.4*	*6.1*	*6.5*
R8	Recreational	0.2	32.2	32.4	*0.1*	*15.7*	*15.8*	*< 0.1*	*6.1*	*6.2*
R9	Industrial	0.9	32.2	33.1	*0.5*	*15.7*	*16.2*	*0.3*	*6.1*	*6.4*
R10	Residential	0.3	32.2	32.5	0.2	15.7	15.9	< 0.1	6.1	6.2
R11	Residential	0.4	32.2	32.6	0.3	15.7	16.0	0.1	6.1	6.2
R12	Residential	0.3	32.2	32.5	0.2	15.7	15.9	0.1	6.1	6.2

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at applicable receptor locations are low, being 6.5 % of the annual average TSP criterion, 12.0 % of the annual average PM_{10} criterion and 9.1 % of the $PM_{2.5}$ criterion.

6.1.2. Annual Average Dust Deposition Rates

Table 12 present the annual average dust deposition rates predicted as a result of the operations at the premises with consideration of the proposed alteration and additions.

Table 12 Predicted annual average dust deposition rates

Receptor ID	Land use description	Annual average dust deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
		Incr.	Bkg.	Cumul.
Criterion		2.0	-	4.0
Max. % of criterion		22.6	-	61.3
R1	Industrial	0.2	2.0	2.2
R2	Industrial	< 0.1	2.0	2.1
R3	Residential	< 0.1	2.0	2.1
R4	Industrial	0.5	2.0	2.5
R5	Residential	< 0.1	2.0	2.1
R6	Industrial	0.2	2.0	2.2
R7	Industrial	< 0.1	2.0	2.1
R8	Recreational	< 0.1	2.0	2.1
R9	Industrial	< 0.1	2.0	2.1

Receptor ID	Land use description	Annual average dust deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
		Incr.	Bkg.	Cumul.
R10	Residential	< 0.1	2.0	2.1
R11	Residential	< 0.1	2.0	2.1
R12	Residential	< 0.1	2.0	2.1

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in Table 12, although comparison of the incremental concentration with the incremental criterion of 2 $g \cdot m^{-2} \cdot month^{-1}$ is also valid. In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the premises, where the predicted impacts are 22.6 % of the incremental criterion, and 61.3 % of the cumulative criterion.

6.1.3. Maximum 24-hour Average PM_{10} and $PM_{2.5}$ Concentrations

As discussed in Section 5.4, the nature of the receptor location and anticipated duration of exposure is of relevance when interpreting predictive modelling results. 24-hour average PM concentrations should be assessed at locations where day-long exposure periods would be reasonable to be assumed, which would apply to receptors R3, R5, R10, R11 and R12 in this AQIA. The predicted results at non-relevant receptors have been provided as greyed and italicised text to denote that differentiation.

Presented in Table 13 are the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest sensitive receptors as a result of the operations at the premises. No background concentrations are included within this table.

Table 13 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor ID	Land use description	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
		PM_{10}	$PM_{2.5}$
Criterion		50	25
Max. % of criterion		23.6	20.6
R1	Industrial	*8.8*	*4.2*
R2	Industrial	*3.4*	*2.2*
R3	Residential	2.4	1.5
R4	Industrial	*11.8*	*5.2*
R5	Residential	1.9	1.2
R6	Industrial	*7.1*	*2.8*
R7	Industrial	*4.6*	*3.2*
R8	Recreational	*1.3*	*0.9*
R9	Industrial	*4.3*	*2.5*
R10	Residential	1.3	0.7
R11	Residential	1.6	0.9
R12	Residential	2.0	1.2

The predicted incremental concentrations of PM_{10} and $PM_{2.5}$ at relevant receptor locations are shown to be minor. The maximum predicted 24-hour PM_{10} concentration at receptor R3 represents 4.7 % of the respective criterion, while the maximum predicted 24-hour $PM_{2.5}$ concentration at receptor R3 represents 5.9 % of the respective criterion.

A contemporaneous analysis of the 24-hour PM_{10} and $PM_{2.5}$ data has been performed where each predicted incremental concentration is added to the corresponding measured background concentration, in accordance with Section 11.2.3(b) of the Approved Methods (NSW EPA, 2022a).

Table 14 and Table 15 present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the premises at relevant receptor locations, with background included for each day. Results are presented for the receptor at which the highest incremental PM_{10} and $PM_{2.5}$ impacts, and the highest cumulative impacts (increment plus background) have been predicted.

The left side of the tables show the predicted concentration on days with the highest cumulative impact (principally driven by the highest background concentrations), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations with the contemporaneous background values to derive the respective cumulative predictions.

Table 14 Summary of contemporaneous impact and background – PM_{10} concentrations

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor R1			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor R4		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
4/05/2021	4.6	39.2	43.8	24/05/2021	11.8	10.3	22.1
27/04/2021	4.0	37.8	41.8	3/06/2021	11.4	31.7	43.1
30/04/2021	2.3	34.5	36.8	1/05/2021	10.2	13.3	23.5
23/01/2021	0.2	36.4	36.6	22/10/2021	9.3	12.3	21.6
3/05/2021	< 0.1	36.2	36.3	28/04/2021	8.9	24.7	33.6
3/06/2021	4.4	31.7	36.1	12/05/2021	8.5	13.2	21.7
15/01/2021	1.7	33.1	34.8	8/12/2021	8.5	15.7	24.2
21/08/2021	< 0.1	33.1	33.2	29/08/2021	8.3	18.4	26.7
29/10/2021	0.1	31.9	32.0	7/03/2021	8.2	18.4	26.6
9/10/2021	0.1	31.8	31.9	30/06/2021	8.1	14.9	23.0
These data represent the highest cumulative impact 24-hour PM_{10} predictions (outlined in red) due to premises operations.				These data represent the highest incremental impact 24-hour PM_{10} predictions (outlined in blue) due to premises operations.			

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

Table 15 Summary of contemporaneous impact and background – $PM_{2.5}$ concentrations

Date	24-hour average $PM_{2.5}$ concentration ($\mu g{\cdot}m^{-3}$) - Receptor R2			Date	24-hour average $PM_{2.5}$ concentration ($\mu g{\cdot}m^{-3}$) - Receptor R4		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
4/05/2021	1.2	31.5	32.7	3/06/2021	5.2	19.4	24.6
21/08/2021	1.8	24.8	26.6	30/06/2021	4.2	6.4	10.6
3/05/2021	0.3	26.2	26.5	24/05/2021	4.2	4.6	8.8
27/04/2021	0.5	25.6	26.1	30/04/2021	3.2	23.9	27.1
30/04/2021	0.4	23.9	24.3	8/04/2021	3.2	2.2	5.4
22/08/2021	0.8	21.8	22.6	5/11/2021	3.1	3.1	6.2
3/06/2021	0.2	19.4	19.6	28/04/2021	3.0	15.1	18.1
14/08/2021	0.8	17.5	18.3	29/08/2021	2.9	13.4	16.3
8/07/2021	1.2	16.3	17.5	20/02/2021	2.8	3.4	6.2
9/07/2021	< 0.1	16.8	16.9	1/05/2021	2.8	7.5	10.3
These data represent the highest cumulative impact 24-hour $PM_{2.5}$ predictions (outlined in red) due to premises operations.				These data represent the highest incremental impact 24-hour $PM_{2.5}$ predictions (outlined in blue) due to premises operations.			

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

The results summarised in Table 14 indicates no exceedances of the cumulative 24-hour PM_{10} criterion. With the operation of the premises, no predicted additional exceedances would occur at any considered receptor location.

Table 16 presents the contemporaneous analysis for 24-hour average $PM_{2.5}$ concentrations based on considered receptors. Four exceedances of the cumulative 24-hour $PM_{2.5}$ criterion has been predicted, all occurring on days impacted by statewide hazard reduction activities, with three of the exceedances already reflected in the corresponding background $PM_{2.5}$ levels.

An exceedance of the 24-hour $PM_{2.5}$ impact assessment criterion is predicted at receptor R4. This is based on an elevated background $PM_{2.5}$ concentration of 23.9 $\mu g{\cdot}m^{-3}$ measured during an exceptional hazard reduction burning day, combined with an incremental impact of 3.2 $\mu g{\cdot}m^{-3}$, resulting in a cumulative concentration of 27.1 $\mu g{\cdot}m^{-3}$.

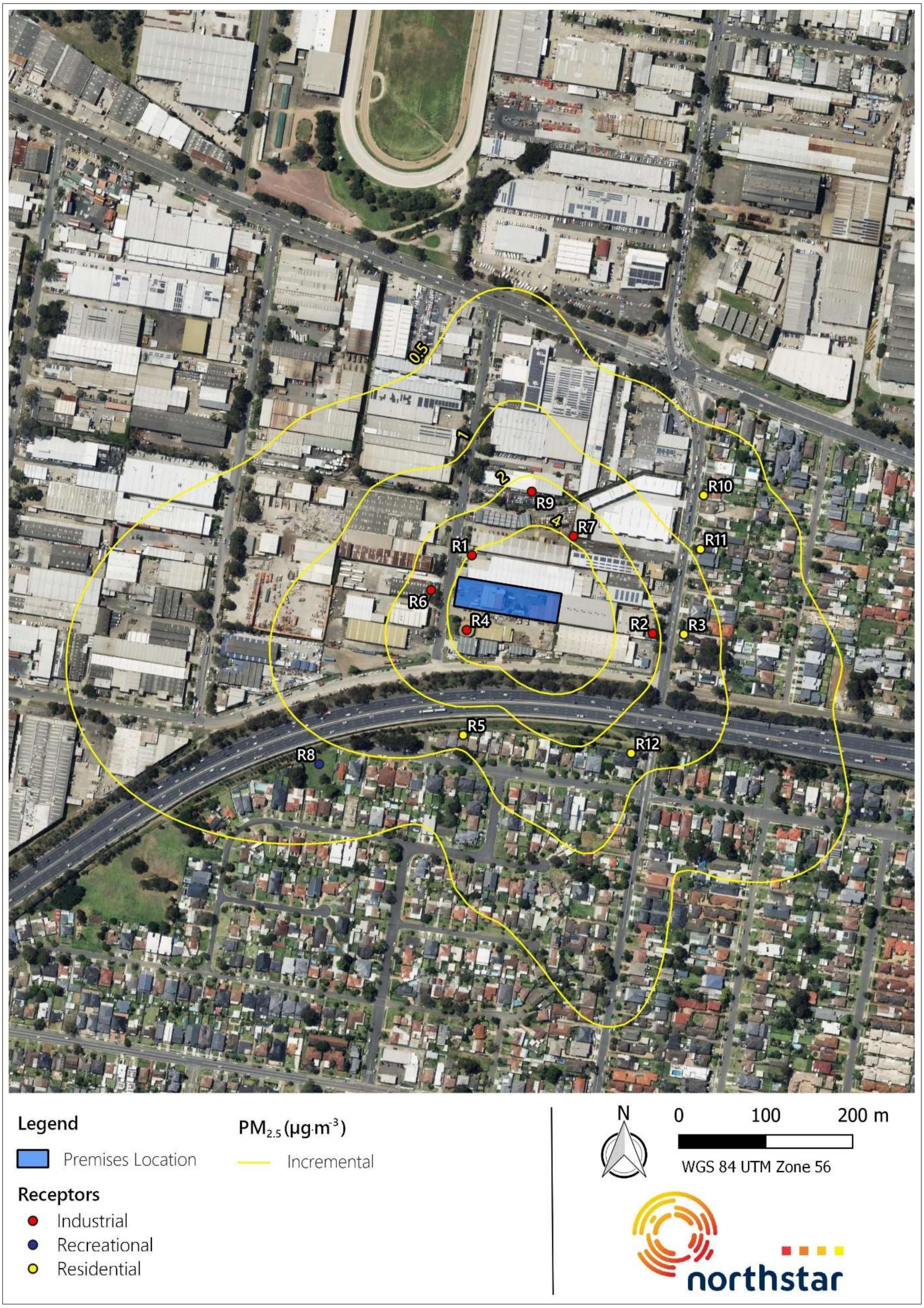
Additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion were also predicted at other considered receptors. **Further discussion of these predicted exceedances is provided in Section 6.4.**

Contour plots of the incremental contribution of the proposed operations at the premises to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in Figure 5 and Figure 6 respectively.

Figure 5 Predicted incremental 24-hour PM_{10} impacts

Source: Northstar

Figure 6 Predicted incremental 24-hour $PM_{2.5}$ impacts



Source: Northstar

6.2. Nitrogen Dioxide

As discussed in Section 5.4, the nature of the receptor location and anticipated duration of exposure is of relevance when interpreting predictive modelling results. 1-hour average NO_2 concentrations should be assessed at all locations where short-term exposure would be reasonable to be assumed, which would apply to all receptors in this AQIA.

Conversely, the predicted annual average NO_2 concentrations should be evaluated at receptor R3, R5, R10, R11 and R12 only. The predicted annual average NO_2 results at non-relevant receptors have been provided as greyed and italicised text to denote that differentiation.

Presented in Table 16 are the maximum predicted 1-hour and annual average cumulative NO_2 concentrations at the surrounding receptor locations.

The results presented in Table 16 predict no exceedances of both the 1-hour NO_2 criteria at all considered receptor locations and the annual average NO_2 criteria are at those relevant receptors.

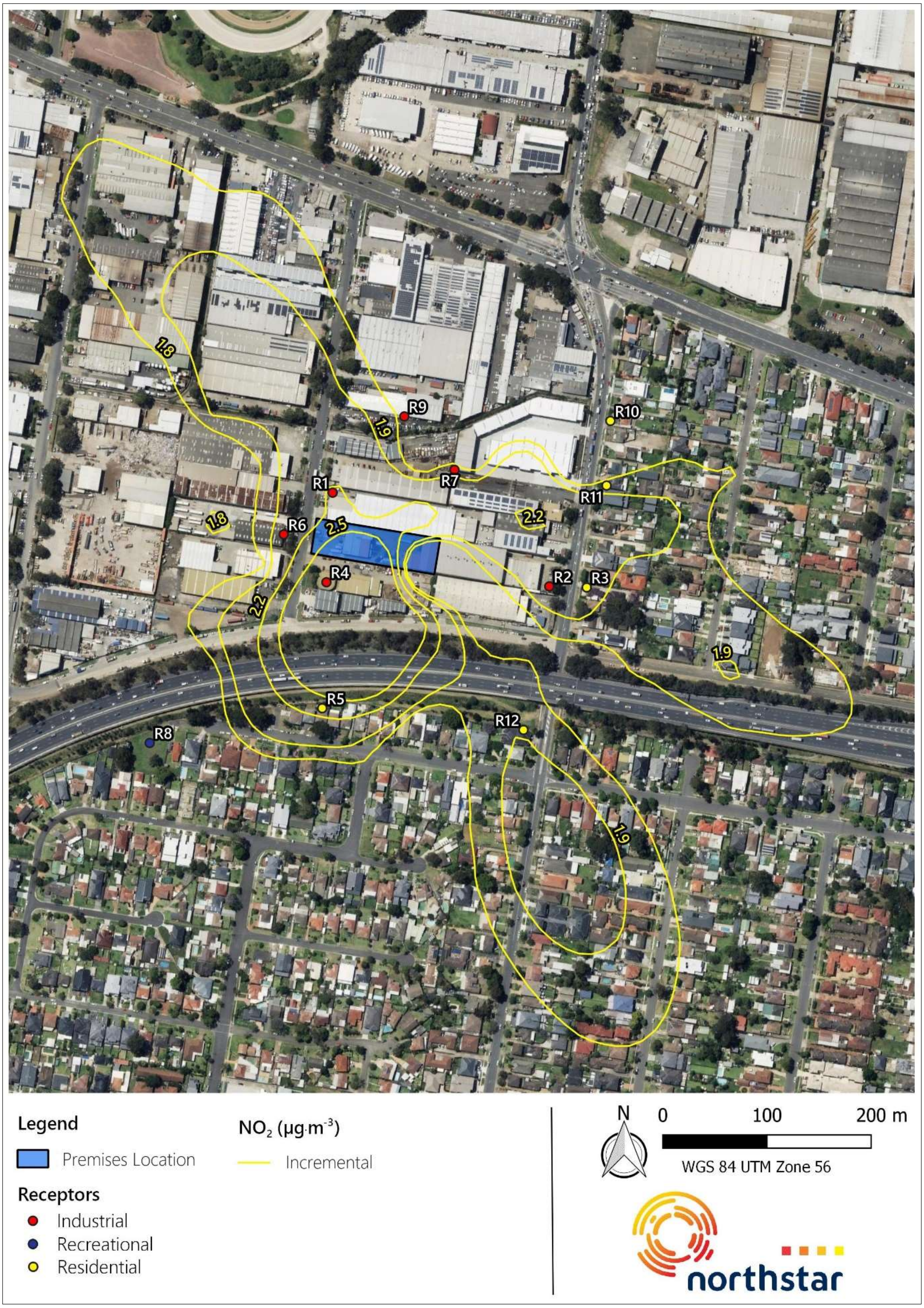
Table 16 Predicted maximum cumulative 1-hour and annual average NO_2 concentrations

Receptor ID	Land use description	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)					
		1-hour average			Annual average		
		Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion		164			31		
Max. % of criterion		1.9	18.8	19.8	0.0	61.3	61.5
R1	Industrial	2.2	28.7	30.9	*0.1*	*19.0*	*19.0*
R2	Industrial	2.1	2.1	4.1	*< 0.1*	*19.0*	*19.0*
R3	Residential	1.9	2.1	4.0	< 0.1	19.0	19.0
R4	Industrial	3.1	12.3	15.4	*< 0.1*	*19.0*	*19.0*
R5	Residential	2.3	12.3	14.6	< 0.1	19.0	19.0
R6	Industrial	2.0	10.3	12.3	*< 0.1*	*19.0*	*19.0*
R7	Industrial	1.9	6.2	8.0	*< 0.1*	*19.0*	*19.1*
R8	Recreational	1.4	12.3	13.7	*< 0.1*	*19.0*	*19.0*
R9	Industrial	1.8	26.7	28.4	*< 0.1*	*19.0*	*19.0*
R10	Residential	1.7	30.8	32.5	< 0.1	19.0	19.0
R11	Residential	1.8	10.3	12.1	< 0.1	19.0	19.0
R12	Residential	1.9	24.6	26.5	< 0.1	19.0	19.0

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

A contour plot of the predicted 1-hour incremental NO_2 impact generated from the proposed alteration and additions is presented in Figure 7.

Figure 7 Predicted incremental 1-hour NO_2 impacts



Source: Northstar

6.3. Air Toxics

As discussed in Section 5.4, the nature of the receptor location and anticipated duration of exposure is of relevance when interpreting predictive modelling results. In this case, 1-hour average air toxic concentrations should be assessed at all locations where short-term exposure would be reasonable to be assumed, which would apply to all considered receptors referenced in this AQIA.

Presented in Table 17 and Table 18 are the predicted 1-hour incremental air toxic concentrations at the surrounding receptor locations.

The results presented in Table 17 and Table 18 do not show any predicted exceedance for any of the air toxic pollutants considered as part of this AQIA.

Figure 8 shows a contour plot of the predicted 1-hour incremental impact of acrolein with the proposed alteration and additions in operation.

Table 17 Predicted incremental 1-hour air toxics concentrations (1 of 2)

Receptor ID	Land use description	Air toxics 1-hour concentration ($mg \cdot m^{-3}$)					
		1,3-Butadiene	Acrolein	Benzene	Biphenyl	Carbon disulfide	Chromium (Cr) compounds
Criterion		0.04	0.00042	0.029	0.024	0.07	0.009
Max. % of criterion		0.4	88.5	27.3	0.1	3.8	1.5
R1	Industrial	1.43E-04	3.18E-04	6.90E-03	2.15E-05	2.20E-03	1.23E-04
R2	Industrial	4.03E-05	3.01E-04	6.42E-03	6.08E-06	6.21E-04	3.48E-05
R3	Residential	3.27E-05	2.12E-04	4.53E-03	4.94E-06	5.04E-04	2.82E-05
R4	Industrial	1.72E-04	3.50E-04	7.72E-03	2.59E-05	2.64E-03	1.48E-04
R5	Residential	3.17E-05	1.80E-04	3.88E-03	4.79E-06	4.89E-04	2.74E-05
R6	Industrial	1.16E-04	2.89E-04	6.41E-03	1.75E-05	1.79E-03	1.00E-04
R7	Industrial	5.08E-05	3.72E-04	7.91E-03	7.66E-06	7.82E-04	4.38E-05
R8	Recreational	1.84E-05	9.58E-05	2.08E-03	2.78E-06	2.83E-04	1.59E-05
R9	Industrial	4.28E-05	2.30E-04	4.96E-03	6.46E-06	6.59E-04	3.69E-05
R10	Residential	2.35E-05	1.47E-04	3.14E-03	3.54E-06	3.62E-04	2.03E-05
R11	Residential	2.81E-05	1.73E-04	3.69E-03	4.24E-06	4.32E-04	2.42E-05
R12	Residential	2.71E-05	1.69E-04	3.62E-03	4.08E-06	4.17E-04	2.34E-05

Table 18 Predicted incremental 1-hour air toxics concentrations (2 of 2)

Receptor ID	Land use description	Air toxics 1-hour concentration ($mg \cdot m^{-3}$)						
		m-Xylene + p-Xylene	Methylene chloride	Nickel (Ni) compounds	o-Xylene	Phenol	Styrene	Toluene
Criterion		0.19	3.19	0.00018	0.19	0.02	0.12	0.36
Max. % of criterion		0.1	<0.1	38.6	0.1	5.9	0.3	0.4
R1	Industrial	1.74E-04	5.44E-04	5.77E-05	1.35E-04	9.89E-04	3.20E-04	1.24E-03
R2	Industrial	4.92E-05	1.54E-04	1.63E-05	3.82E-05	2.79E-04	9.04E-05	3.50E-04
R3	Residential	3.99E-05	1.25E-04	1.32E-05	3.11E-05	2.27E-04	7.35E-05	2.84E-04
R4	Industrial	2.09E-04	6.55E-04	6.95E-05	1.63E-04	1.19E-03	3.85E-04	1.49E-03
R5	Residential	3.87E-05	1.21E-04	1.28E-05	3.01E-05	2.20E-04	7.13E-05	2.76E-04
R6	Industrial	1.42E-04	4.43E-04	4.70E-05	1.10E-04	8.05E-04	2.61E-04	1.01E-03
R7	Industrial	6.20E-05	1.94E-04	2.05E-05	4.82E-05	3.52E-04	1.14E-04	4.41E-04
R8	Recreational	2.24E-05	7.01E-05	7.44E-06	1.74E-05	1.27E-04	4.13E-05	1.60E-04
R9	Industrial	5.22E-05	1.63E-04	1.73E-05	4.06E-05	2.97E-04	9.61E-05	3.72E-04
R10	Residential	2.87E-05	8.96E-05	9.51E-06	2.23E-05	1.63E-04	5.27E-05	2.04E-04
R11	Residential	3.43E-05	1.07E-04	1.14E-05	2.66E-05	1.95E-04	6.30E-05	2.44E-04
R12	Residential	3.30E-05	1.03E-04	1.10E-05	2.57E-05	1.88E-04	6.08E-05	2.35E-04

Figure 8 Predicted incremental 1-hour acrolein impacts

Source: Northstar

6.4. Summary of Results

The results of the dispersion modelling assessment indicate that:

- Annual average TSP, PM_{10} and $PM_{2.5}$ concentrations are all predicted to be achieved at relevant receptor locations, even with the addition of existing background concentrations;
- Annual average monthly dust deposition rates are predicted to be below the relevant criteria, both as an incremental and cumulative impact;
- Several predicted exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion:
  - Receptors R4, R6 and R7 on 30 April 2021.
  - Receptors R2, R3, R4, and R12 on 21 August 2021.

  These exceedances are attributed to high background concentrations from hazard reduction burning events, with limited contributions attributable from the premises.
- No predicted exceedances of both the 1-hour NO_2 criterion at all considered receptor locations and the annual average NO_2 criterion at relevant receptors.
- No predicted exceedances of individual toxic or individual odourous pollutants considered for this AQIA.

Table 19 provides details on additional predicted 24-hour $PM_{2.5}$ exceedances at receptor locations with the proposed alteration and additions. Receptors R4, R6 and R7 were predicted to exceed the 24-hour $PM_{2.5}$ criterion on 30 April 2021 while receptors R2, R3, R4, and R12 were predicted to exceed the same criterion on 21 August 2021. Receptors R3 and R12 are identified as residential receptors while receptors R2, R4, R6 and R7 are classified as industrial receptors.

Table 19 Additional predicted 24-hour $PM_{2.5}$ exceedances

Receptor ID	Land use description	Date	24-hour average $PM_{2.5}$ concentration (µg·m^{-3})			
			Incr.	Bkg.	Cumul.	% criterion
R4	Industrial	30/04/2021	3.2	23.9	27.1	108.6
R6	Industrial	30/04/2021	1.8	23.9	25.7	102.7
R7	Industrial	30/04/2021	1.4	23.9	25.3	101.3
R2	Industrial	21/08/2021	1.8	24.8	26.6	106.4
R3	Residential	21/08/2021	1.1	24.8	25.9	103.5
R4	Industrial	21/08/2021	0.2	24.8	25.0	100.1
R12	Residential	21/08/2021	1.1	24.8	25.9	103.5

Note: Incr. = Incremental, Bkg.= Background, Cumul. = Cumulative

It is identified from Table 16 that four of the seven additional predicted 24-hour $PM_{2.5}$ exceedances occurred on 21 August 2021 which exhibited a background concentration of 24.8 µg·m^{-3} (99.2 % of the criterion). The remaining predicted exceedances occurred on 30 April 2021 whereby a 24-hour background $PM_{2.5}$ concentration of 23.9 µg·m^{-3} (95.6 % of the criterion) was recorded.

The NSW Annual Compliance Report 2021 (NSW DPE, 2023) states that,

> *"There were 23 days with daily $PM_{2.5}$ average levels above the national standard in 2021. Of the 23 exceedance days, events on 17 days were due to exceptional causes only (hazard reduction burns), while 5 were attributed to non-exceptional causes only (woodsmoke, agricultural burning). One day (21 August 2021) was identified where both exceptional and non-exceptional causes impacted different stations on the same day.*
>
> *…Hazard reduction burning was the major cause for exceptional $PM_{2.5}$ events and observed primarily at Sydney region stations."*

Further, it is noted from (NSW DPE, 2023) that on 30 April 2021 an exceptional event associated with hazard reduction burns occurred which would contribute to elevated background $PM_{2.5}$ concentrations across the Sydney region during that particular day. Based on the above, it is reasonable to consider that the key driver of the additional exceedances and associated cumulative impacts are predominantly influenced by elevated background $PM_{2.5}$ concentrations due to exceptional events, with the associated incremental impacts considered to be minor in comparison.

The dispersion modelling assessment has sought to represent emissions from the premises with the proposed alteration and additions at their potential maximum rate, including shredding conducted at maximum daily production rates and operation during justified worst case meteorological conditions.

7. MITIGATION AND MONITORING

7.1. Mitigation

The findings of the AQIA (refer Section 6) show that the proposed alteration and additions to the premises will comply with all relevant ambient air quality criteria (refer Table 5 and Table 6) and effectively minimise emissions and subsequent impacts. No additional mitigation measures are explicitly required beyond those already implemented (refer Table 10).

Dispersion modelling predicts that annual average concentrations of TSP, PM_{10}, and $PM_{2.5}$ along with dust deposition rates will remain below the relevant criteria, even when including background concentrations. Although there are predicted exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion, these are due to high background levels gained from exceptional hazard reduction burning events, with a limited contribution from the premises (refer Table 19). No further exceedances were predicted for those days outside of these exceptional events.

Emission control measures are considered to be implemented as part of the current premises' operation to effectively reduce impacts on sensitive receptors and ensure compliance with particulate matter criteria, with their efficiencies incorporated into the AQIA where quantifiable (refer Section 5.3).

The premises currently features an enclosed industrial shed housing the crumb rubber plant and an internal shredder, plus an open awning at the rear where the additional shredders will be installed as part of the proposed alteration and additions. Section 3.4 of (US EPA, 2008) states that emissions from tyre grinding processes are typically controlled using cyclones, baghouses, and electrostatic precipitators (ESPs), either alone or in combination. According to (US EPA, 2008) and (NPI, 2002), an emissions control efficacy of 97.9 % can be achieved with the implementation of a cyclone and baghouse for retreading processes. Other specified particulate matter control efficacies between 91.9 % and 99.97 %, dependant on the type of control measure utilised for each corresponding tyre grinding activity e.g. carcass and sidewall.

Implementing an air pollution control (APC) system such as a baghouse dust control system could further reduce particulate matter emissions from the crumb rubber process.

The two external shredders will operate under an open-sided awning with a local exhaust ventilation (LEV) system to be installed at each shredder. Section 3.4 of (US EPA, 2008) notes that '*Grinding operations are typically conducted in a collector hood with an exhaust duct leading to the control device(s).*' The AQIA assumes that the LEV system will capture emissions effectively and discharge them through a dedicated stack extending 1 m above the roof level and achieving a sufficient velocity to ensure proper dilution and dispersion from the source. Therefore, it is recommended that shredder emissions be captured by LEV and discharged appropriately.

The premises will be designed to meet best practice requirements for tyre recycling facilities, in accordance with Fire & Rescue NSW's Fire Safety Guideline – Guideline for Bulk Storage of Rubber Tyres (Fire & Rescue NSW, 2014) which presents minimum requirements for both internal and external bulk storage of rubber tyres.

7.2. Management

The following management strategies are recommended to control particulate emissions across the premises in accordance with best practice:

- External area of the site (hard stand and roadways) is sealed.
- Silt content on road surfaces is managed through regular sweeping and a water cart.
- All tyres and tyre products to be stored and processed indoors at all times
- Remove loose material from site entrance and exit
- Warehouse floors swept regularly to avoid dust tracking via vehicle movements.
- Outdoor hardstand areas regularly swept to minimise dust.
- Vehicle speeds at the premises are actively managed through the use of speed bumps, and appropriate signage.
- Speed limits for all vehicles in plant is 5 $km \cdot hr^{-1}$
- The storage areas for all materials are clearly demarked by road curbing or posts to delineate storage areas from vehicle access routes.
- Implementation of an Operational Environmental Management Plan (OEMP), with daily observations on visible dust emissions and a complaints procedure.
- Doors to be kept closed at all times during operations where practical and closed if visible dust is observed.
- Conveyors fitted with sidewalls and covers to minimise particulate emissions, where feasible.
- Appropriate use of equipment and proper management, supervision and training for all tyre processing operations conducted at the premises.
- Preventive maintenance of all equipment and plant pertaining to emissions control at the premises.

Several management measures outlined in (BSV, 2018; BSV, 2022), are detailed above for clarity. It is recommended that both the OEMP (BSV, 2018) and PIRMP (BSV, 2022) be updated upon receiving development consent to incorporate the new operating procedure and mitigation measures associated with the proposed alteration and additions.

Additionally, as the premises currently operates under EPL 20387, a licence variation will be necessary to account for the proposed changes. The premises will be required to adhere strictly to the requirements specified in EPL 20387.

7.3. Monitoring

The predictions presented in this AQIA indicate that there would be no predicted exceedances of the adopted air quality criteria, when due consideration is given to:

- The influence of background PM_{10} and $PM_{2.5}$ concentrations adopted in the AQIA (refer Section 4.4); and,
- The LEV system being implemented and operated as a mitigation measure for each shredder (refer Section 7.1).

The following monitoring is recommended:

- The emission discharge conditions from the crumb rubber processing equipment and shredders are quantified and evaluated against the assumptions presented in this AQIA.

Since the premises is classified under scheduled activities according to the NSW environmental regulatory framework, the NSW EPA may require specific testing related to emissions from the shredder equipment.

Notwithstanding the above, it is considered prudent to conduct monitoring of the emissions resulting from the operation of the shredders to ensure they meet efficient emission specifications in terms of rates and concentrations. This review should align with manufacturer performance guarantees and to meet any emissions limit that may be outlined by NSW EPA (refer Table 4). The emissions testing frequency and pollutants speciation would be subject to review by NSW EPA.

It is recommended that regular audits are performed to ensure that the premises is implementing the air quality control measures appropriately, as outlined within this AQIA. Additionally, it is recommended to keep records of any dust and odour complaints from neighbouring receptors and document the responses to these complaints. Responses to dust and odour events should be prompt, with a record of all corrective measures taken.

8. CONCLUSION

JEP on behalf of BSV has engaged Northstar to conduct an AQIA to accompany a SEE and DA for the proposed alteration, additions and expansion of the existing tyre recycling facility at 30 Daisy Street, Revesby, NSW. BSV currently operates scheduled activities at the premises under EPL 20387 and runs an existing crumb rubber processing plant under DA-843/2013.

BSV is seeking development approval to expand its current operations, aiming to increase its annual processing capacity of passenger and truck tires from 14 600 $t \cdot yr^{-1}$ to 29 900 $t \cdot yr^{-1}$ to produce TDF. The expansion includes installing new processing equipment for TDF production while continuing to manufacture crumbed rubber as required under DA-843/2013.

The AQIA has assessed the potential impacts of the proposed alteration and additions through characterisation of existing air quality and meteorological conditions and a quantification of emissions relating to the development through an atmospheric dispersion modelling exercise to predict air pollutant concentrations and the subsequent impacts on air quality in the surrounding environment.

The AQIA has been performed in accordance with the requirements of the NSW Approved Methods (NSW EPA, 2022a). Atmospheric dispersion modelling predictions for dust deposition, particulate matter (as TSP, PM_{10} and $PM_{2.5}$), NO_X (as NO_2) and various hazardous air toxic pollutants were made using the CALPUFF dispersion model in consideration of the operational profile of the premises and compared with the respective annual and short-term air quality criteria for toxicity and odour at identified sensitive receptor locations in the surrounding area.

The AQIA results show that the predicted short-term and annual NO_2 and PM_{10} concentrations, as well as annual average $PM_{2.5}$ concentrations meet the respective impact assessment criteria. Additionally, annual average dust deposition rates and individual air toxics are predicted to be within acceptable limits at all considered receptors. A number of additional exceedances of the 24-hour average $PM_{2.5}$ at the considered receptor locations, however these exceedances were driven by unusually high background $PM_{2.5}$ concentrations experienced across NSW in 2021 due to hazard reduction burn-offs which are classified as exceptional events, with predicted increments considered to be limited in comparison.

Section 7 outlines additional control measures to manage emissions at the premises according to best practices. This includes practical management recommendations to enhance overall emission performance, such as installing a local exhaust ventilation (LEV) system to capture emissions at the source and discharging them through a stack above the roof structure. The AQIA draws from several assumptions concerning emissions from the crumb rubber processing line and shredders, with Section 7.4 recommending a staged monitoring program to address these uncertainties.

It is demonstrated that, with the implementation of LEV control measures for the shredders, the premises can operate in compliance with all adopted air quality criteria.

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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

Symbol	Name	Quantity
$g{\cdot}m^{-2}{\cdot}s^{-1}$	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

Abbreviation	Term
CEMP	construction environment management plan
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
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 DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
NSW DPHI	NSW Department of Planning, Housing, and Infrastructure
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

Abbreviation	Term
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
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

As discussed in Section 4.3 a meteorological modelling exercise has been performed to characterise the meteorology at the premises in the absence of site-specific measurements. The meteorological monitoring has been based on measurements acquired from an automatic weather station (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

Four meteorological stations operated by BoM were identified within a 15 km radius of the premises. A summary of the relevant AWS is provided in Table B1

Table B1 Meteorological monitoring stations within 15 km radius of the premises

Site name	Station #	Approximate location		Approximate distance (km)
		mE	mS	
Bankstown Airport AWS	066137	313 856	6 245 099	3.1
Holsworth Aerodrome AWS	066161	310 553	6 236 779	8.2
Canterbury Racecourse AWS	066194	325 572	6 246 697	10.3
Sydney Olympic Park AWS	066195	320 948	6 252 558	13.0

Note: Climate statistics available at http://www.bom.gov.au/climate/data/index.shtml

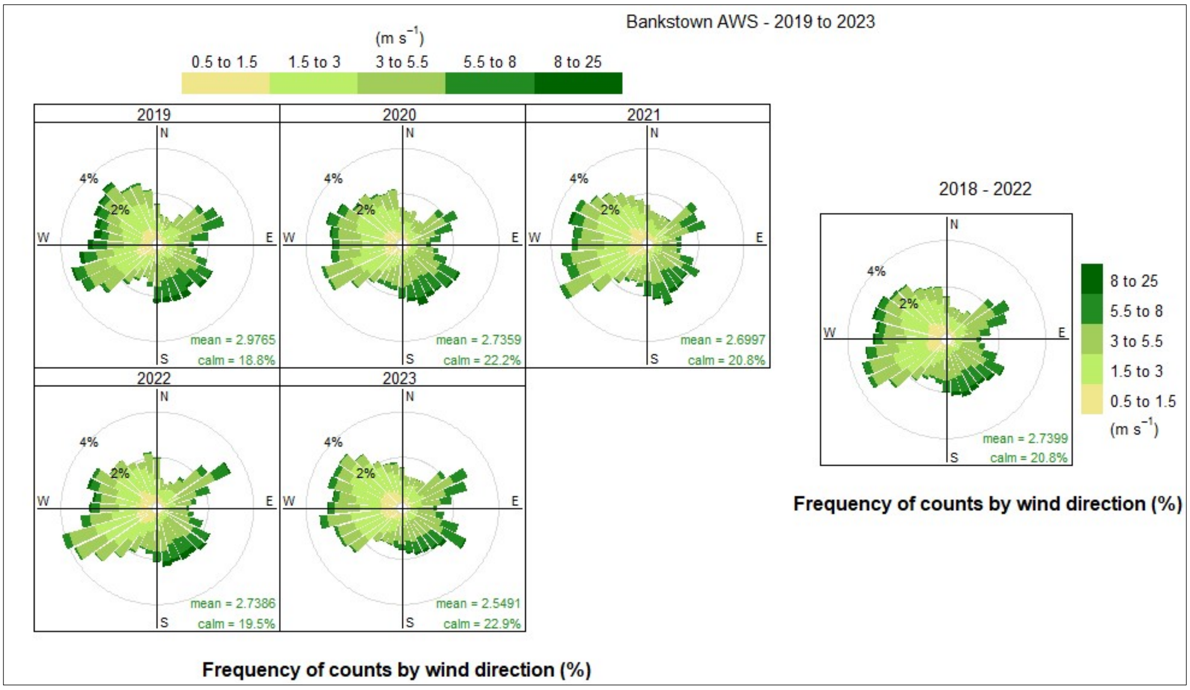
Meteorological conditions at Bankstown Airport AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for 2019 to 2023 are presented in Figure B1. The annual wind speed frequency distribution for the five-year period is presented in Figure B2.

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

The wind roses indicate that from 2019 to 2023, winds at Bankstown Airport AWS show generally similar wind distribution patterns across the years assessed, with no predominant wind direction.

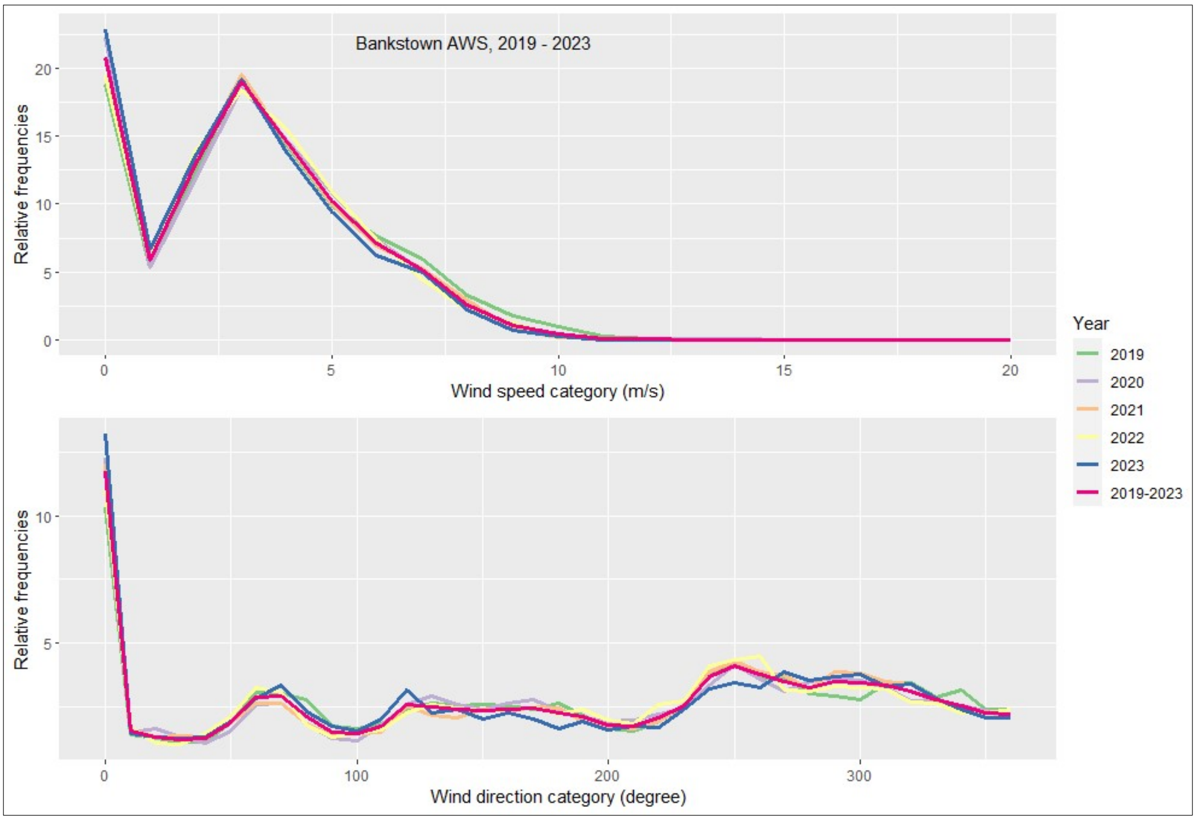
The majority of wind speeds experienced at the Bankstown Airport AWS between 2019 and 2023 are generally in the range 1.5 $m \cdot s^{-1}$ to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring predominantly from south easterly directions. Winds of this speed occur during 1.6 % of the observed hours during the years. Calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 20.8 % of hours on average across the years.

Figure B1 Annual wind roses – Bankstown Airport AWS (2019 to 2023)



Source: Northstar

Figure B2 Annual wind direction and speed distributions – Bankstown Airport AWS (2019 to 2023)



Source: Northstar

Table B2 Correlation coefficient analysis – Bankstown Airport AWS (2019 to 2023)

Parameter	Wind speed		Wind direction		Aggregated rank
	Corr.	Rank	Corr.	Rank	
2019	0.997	3	0.984	5	3
2020	0.998	2	0.992	2	2
2021	1.000	1	0.995	1	1
2022	0.997	4	0.986	4	3
2023	0.997	5	0.986	3	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 2021 is the highest ranked for correlation against the wind speed over the five-year period.

Wind direction observations for each year are well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than of 0.98. The year 2021 is the highest ranked for correlation against the wind direction over the five-year period.

It is noted that the combined rank for 2019, 2022 and 2023 is 8, thus they are equally ranked 3.

The aggregated ranking indicates that wind speed and direction observed in 2021 are most representative of the five-year period assessed. As such, it is concluded that meteorological conditions in 2021 may be considered to provide a suitably representative dataset for use in dispersion modelling and is therefore adopted for the purpose of the dispersion modelling assessment.

Meteorological Processing

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

In absence of any measured onsite meteorological data, site representative meteorological data for the premises was generated using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.1).

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.

It is noted that an initial TAPM modelling run provided wind roses which did not validate well against observations at Bankstown Airport AWS. Given the poor validation, that initial TAPM modelling run has not been used in this AQIA. Subsequently, a second TAPM run was performed which used observations at Sydney Olympic Park AWS to 'nudge' model predictions towards those observations, and this has been used in this AQIA.

A comparison of the TAPM generated meteorological data, and that observed at the Bankstown Airport AWS are 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 B3 TAPM meteorological parameters

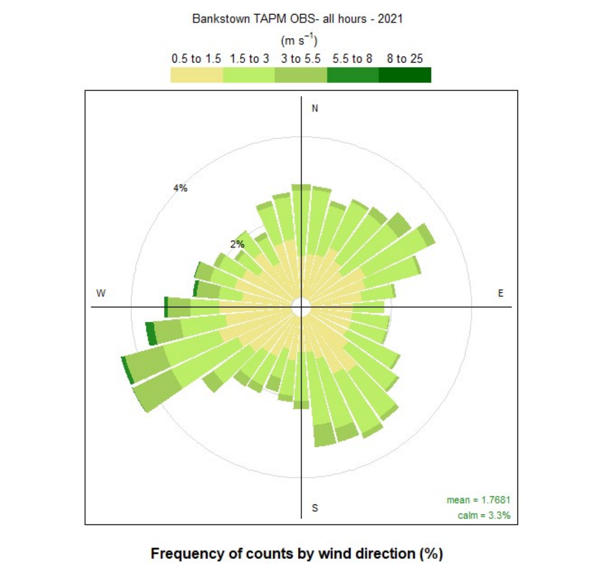
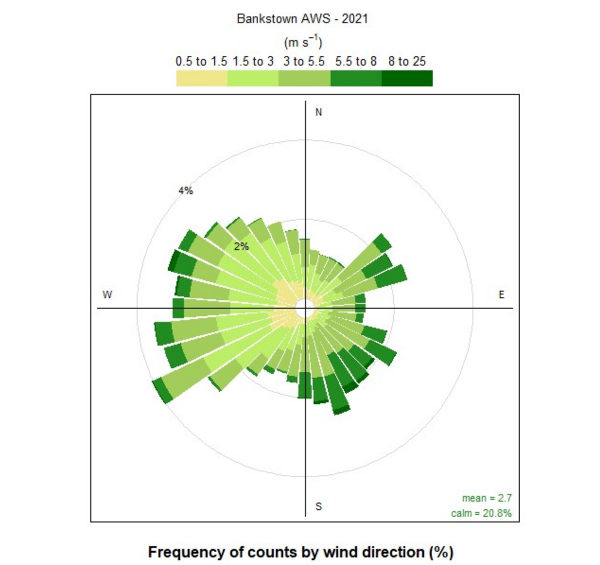
TAPM v 4.0.5	
Modelling period	1 January 2021 to 31 December 2021
Centre of analysis	326 566 mE 6 251 046 mS (UTM coordinates)
Number of grid points	40 x 40 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Sydney Olympic Park AWS (Archery Centre)

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

Diurnal variations in maximum and average mixing heights predicted by TAPM at the premises during 2021 are illustrated in Figure B4.

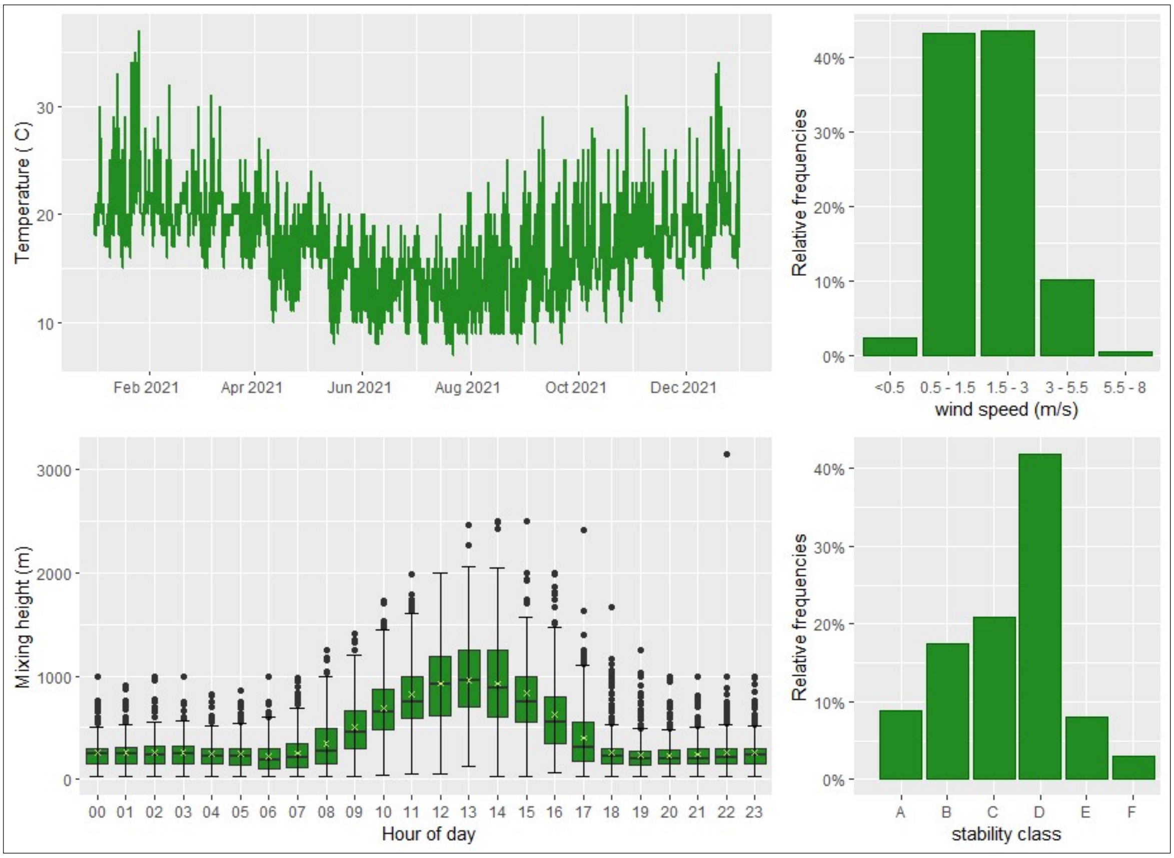
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

Figure B3 Modelled and observed meteorological data – Bankstown Airport AWS, 2021

Bankstown Airport TAPM generated windrose	Observations at Bankstown Airport AWS
	

Source: Northstar

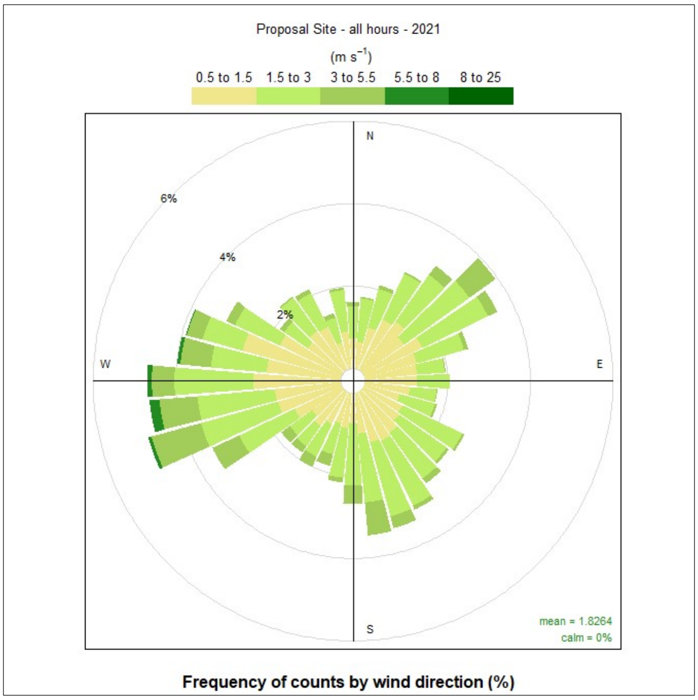
Figure B4 Predicted mixing height, wind speed and stability class frequency at the premises (2021)



Source: Northstar

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

Figure B5 Predicted wind direction and speed at the Premises (2021)



Source: Northstar

APPENDIX C

Background Air Quality Data

Air Quality Monitoring Stations

Air quality is not monitored at the premises and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this AQIA. Determination of data to be used as a location representative of the premises and during a representative year can be complicated by factors which include:

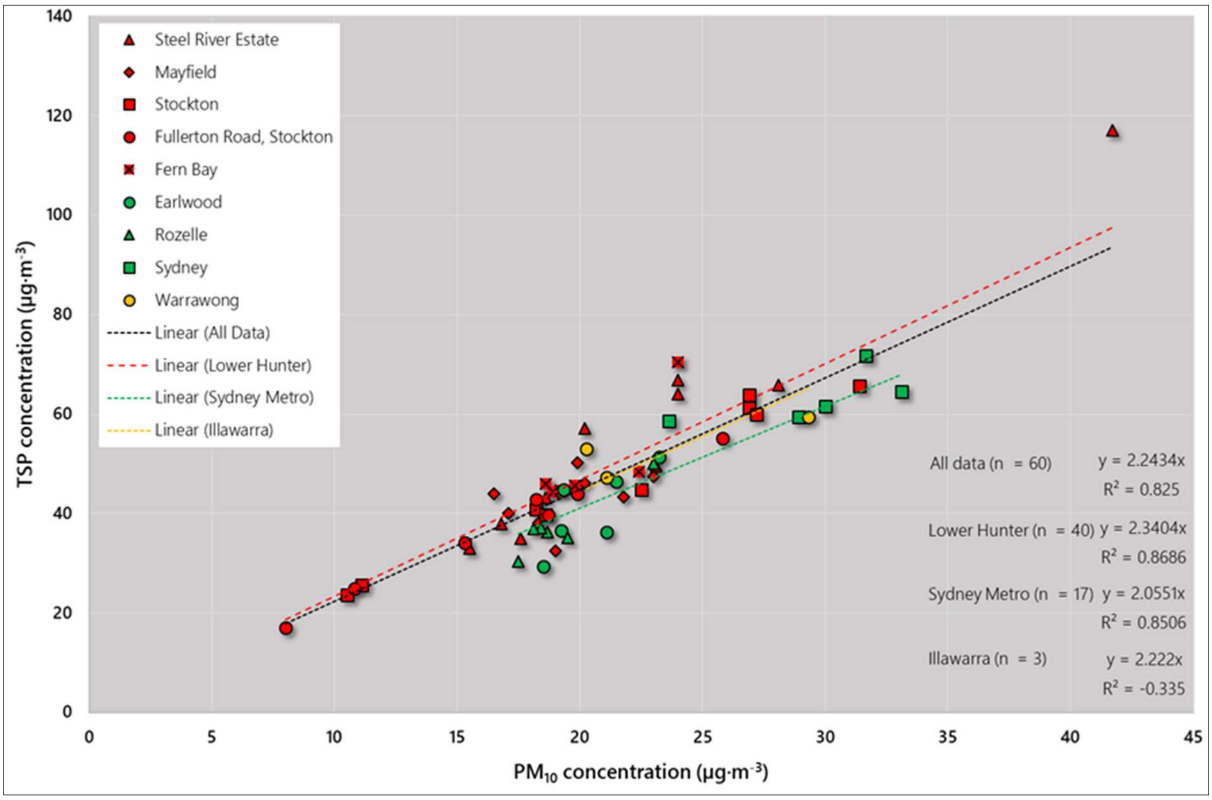
- The sources of air pollutant emissions around the premises and representative AQMS; and
- The variability of particulate matter concentrations (often impacted by natural climate variability).

As discussed in Section 4.4, air quality monitoring data from Lidcombe AQMS has been adopted to provide a representative dataset for the area surrounding the premises for the assessment year of 2021 (consistent with the selected meteorological modelling data [refer Appendix B]). As such, PM and NO_2 data as monitored at Lidcombe AQMS in 2021 have been used to approximate typical conditions around the premises.

It is noted that Lidcombe AQMS does not monitor total suspended particulate (TSP) which is of relevance to the expected emissions from the premises. Correspondingly, 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 C1.

The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.0551 : 1 (i.e. PM_{10} represents ~48.7 % of TSP) from the Sydney Metropolitan region is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 32.2 $\mu g \cdot m^{-3}$ being adopted.

Figure C1 Co-located TSP and PM_{10} measurements – Lower Hunter, Sydney Metro and Illawarra



Source: Northstar

Summary statistics for the selected data monitored at Lidcombe AQMS are presented in Table C1.

Figure C2 and Figure C3 present graphs showing the daily PM_{10} and $PM_{2.5}$ data monitored at Lidcombe AQMS in 2021 while Figure C4 presents the 1-hour average NO_2 data.

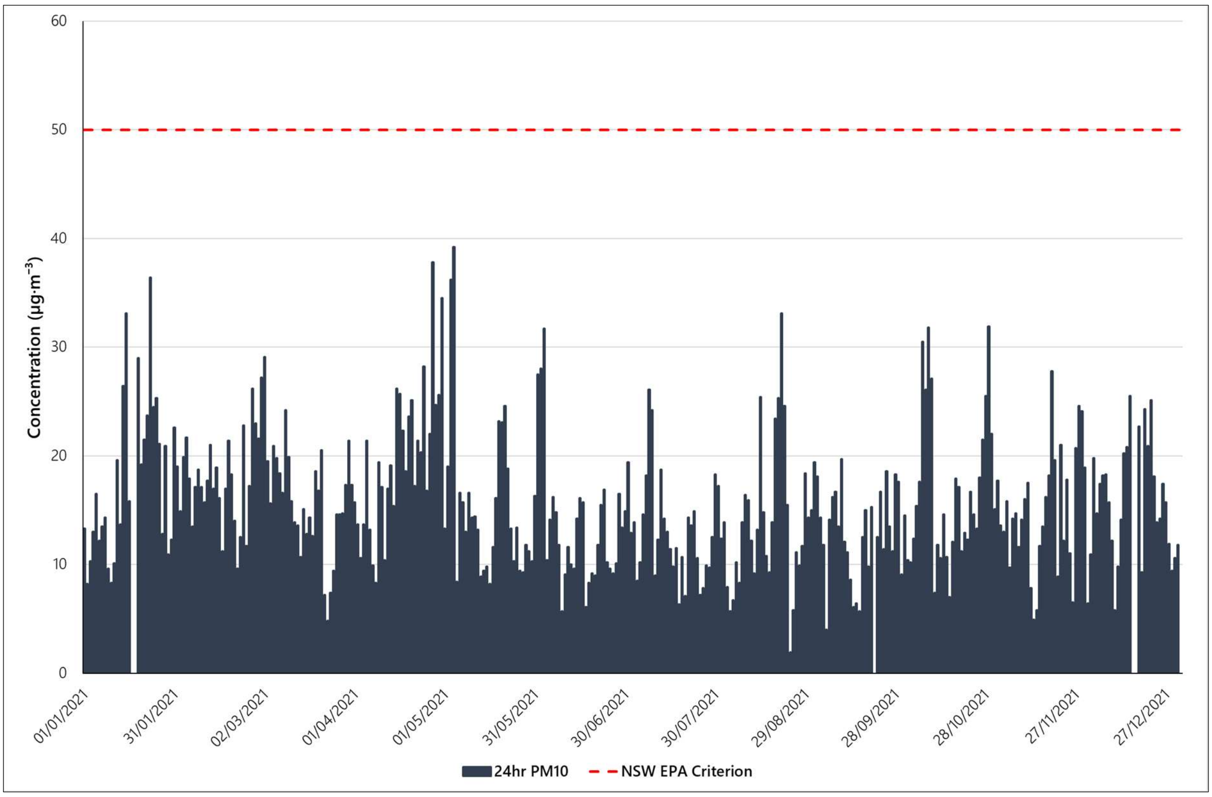
Table C1 Background air quality statistics – Lidcombe AQMS (2021)

Pollutant	TSP	PM_{10}	$PM_{2.5}$	NO_2	O_3
Averaging period	Annual	24-hour	24-hour	1-hour	1-hour
Units	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$
Statistics					
Data points (number)	360	360	356	8295	8243
Mean	32.2	15.7	6.1	19.0	33.8
Standard deviation	-	6.3	4.0	15.2	25.0
Skew[1]	-	*0.9*	*2.7*	*1.1*	*0.6*
Kurtosis[2]	-	*1.0*	*10.6*	*0.9*	*0.7*
Minimum	-	1.9	0.8	- 6.2	- 4.3
Percentiles					
25th	-	11.2	3.8	6.2	10.7
50th	-	14.6	5.1	14.4	34.2
75th	-	18.8	7.0	28.7	51.4
90th	-	24.6	10.2	41.0	64.2
95t	-	27.1	13.3	49.2	74.9
97th	-	29.4	15.2	53.3	83.5
98th	-	31.9	17.4	55.4	89.9
99th	-	35.2	24.3	63.6	102.7
Maximum	**-**	**39.2**	**31.5**	**102.5**	**184.0**
Data Capture (%)	**98.4**	**98.4**	**97.3**	**94.4**	**93.8**

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.

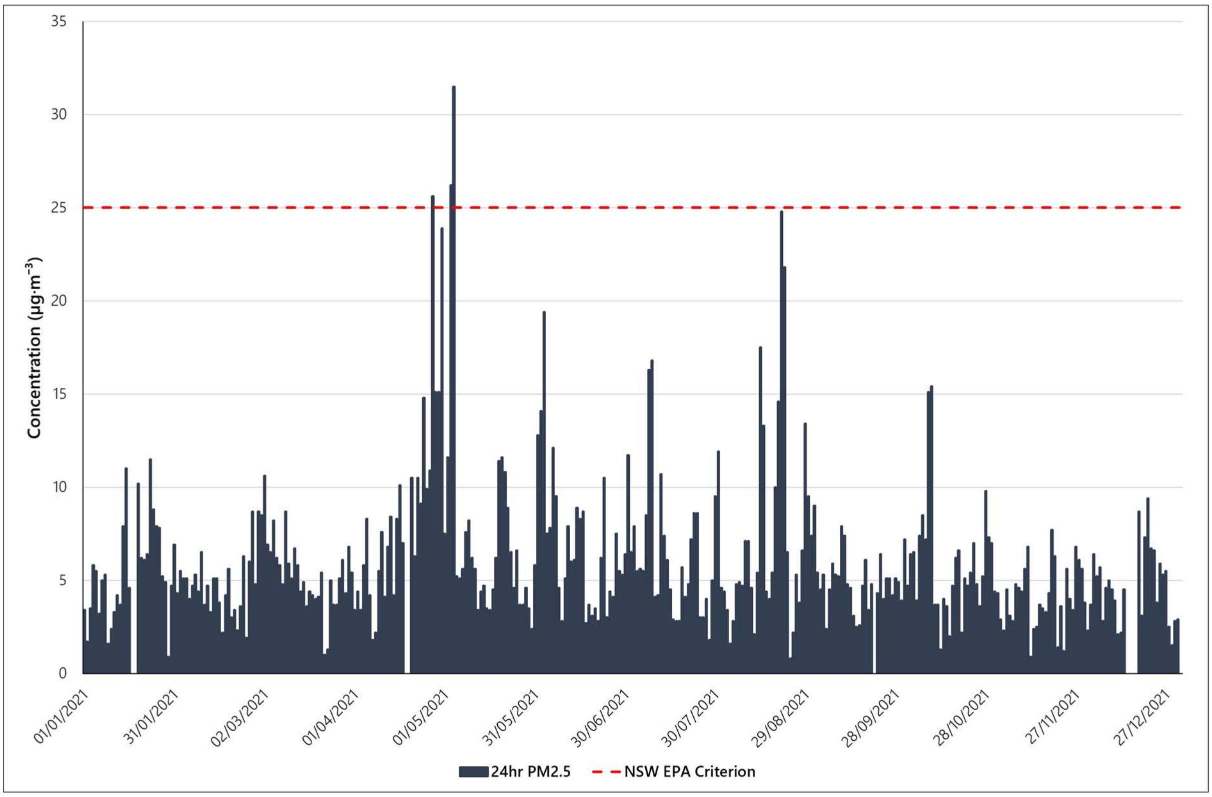
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure C2 Daily varying PM_{10} concentrations – Lidcombe AQMS (2021)



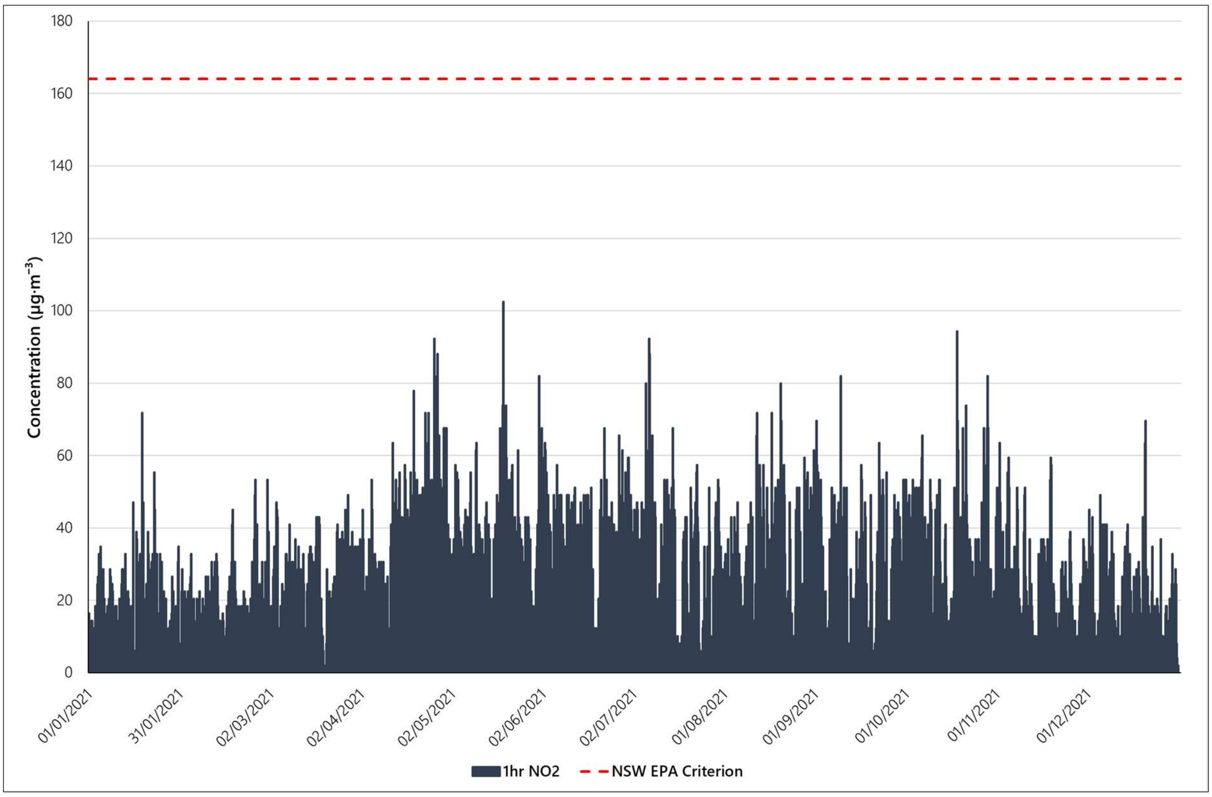
Source: Northstar

Figure C3 Daily varying $PM_{2.5}$ concentrations – Lidcombe AQMS (2021)



Source: Northstar

Figure C4 Hourly varying NO_2 concentrations – Lidcombe AQMS (2021)



Source: Northstar

APPENDIX D

Emissions Inventory

Tyre Processing

Tyre processing emissions have been estimated from the emission factors published in Section 4.12 of AP-42 (US EPA, 2008). The emission factors have been applied in accordance with the following:

$$E = A \times EF \times \left(\frac{1 - ER}{100}\right)$$

where:

E = Emissions

A = Activity rate

EF = Emission factor

ER = Overall emission reduction efficiency (%)

The emission factors are published on the accompanying spreadsheet for tyre retreading, and are replicated in Table D1 below:

Table D1 Emissions factors – Tyre retreading

Analyte Name	CAS #	Retread 30800153 Lb/lb rubber processed
Total VOC	-	2.43E-04
Total Speciated Organics	-	6.36E-04
Total Organic HAPs	-	1.33E-05
Total Metal HAPs	-	6.44E-08
Total HAPs	-	1.33E-05
Total Particulate Matter	-	9.09E-07
1,1,1-Trichloroethane	71-55-6	2.19E-08
1,3-Butadiene	106-99-0	4.39E-08
1,4-Dichlorobenzene	106-46-7	6.77E-09
2-Butanone	78-93-3	1.51E-08
2-Methylphenol	95-48-7	3.91E-09
4-Methyl-2-pentanone	108-10-1	8.44E-07
Acetophenone	98-86-2	1.89E-08
Acrolein	107-02-8	4.70E-07
Aniline	62-53-3	6.66E-08
Benzene	71-43-2	9.96E-06
Biphenyl	92-52-4	6.63E-09
bis(2-Ethylhexyl)phthalate	117-81-7	1.99E-08
Carbon Disulfide	75-15-0	6.77E-07
Chloromethane	74-87-3	7.12E-09
Chromium (Cr) Compounds	-	3.79E-08
Cobalt (Co) Compounds	-	8.74E-09

Analyte Name	CAS #	Retread 30800153 Lb/lb rubber processed
Di-n-butylphthalate	84-74-2	3.87E-08
Isophorone	78-59-1	6.46E-09
m-Xylene + p-Xylene	-	5.36E-08
Methylene Chloride	75-09-2	1.67E-07
Naphthalene	91-20-3	2.11E-08
Nickel (Ni) Compounds	-	1.78E-08
o-Xylene	95-47-6	4.17E-08
Phenol	108-95-2	3.04E-07
Styrene	100-42-5	9.86E-08
Tetrachloroethene	127-18-4	7.58E-09
Toluene	108-88-3	3.82E-07

Paved Roads

Emissions of particulate matter resulting from the movement of materials on paved roads have been estimated using the emission factors presented in Section 13.2.1 (Paved Roads) of AP-42 (US EPA, 2011).

The emission factor in Section 13.2.1.3 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$EF_{(kg.VKT^{-1})} = k \times (\frac{s}{2})^{0.65} \times (\frac{W}{3})^{1.5}$$

where:

$EF_{(k\ .VKT^{-1})}$ = emission factor (kg per vehicle kilometre travelled) multiplied by 0.2819 to convert from lb per vehicle mile travelled.

k = particle size multiplier (dimensionless).

s = surface material silt content (%).

W = mean vehicle weight (tons) multiplied by 0.907185 to convert from metric tonnes.

The particle size multipliers for TSP, PM_{10} and $PM_{2.5}$ (k) are provided in (US EPA, 2011).

The quality rating for this application is rated B for TSP, B for PM_{10} and B for $PM_{2.5}$.

The silt content of paved haul roads at the premises has been taken to be 7.4 g·m^{-2} which equates to a plant road on a municipal solid waste landfill (Table 13.2.1-3 of (US EPA, 2011)).

The mean weight of vehicles has been calculated based on the use of 22.5 t rigid and semi-trailer vehicles, accounting for material import / export, 3.7 t for bobcat movements and 4 t for forklifts.

Materials Handling

Emissions for material handling have been characterised using the factor outlined in Section 13.2.4.3 of AP-42 for batch drop processes (US EPA, 2006a).

The equation is:

$$EF\ (kg \cdot tonne^{-1}) = k(0.0016)\ \frac{\left(\frac{U\ (m \cdot s^{-1})}{2.2}\right)^{1.3}}{\left(\frac{M\ (\%)}{2}\right)^{1.4}}$$

where:

$EF_{TSP\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

$EF_{PM_{10}\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

k_{TSP} = 0.74 for particles less than 30 micrometres aerodynamic diameter

$k_{PM_{10}}$ = 0.35 for particles less than 10 micrometres aerodynamic diameter

$k_{PM_{2.5}}$ = 0.053 for particles less than 2.5 micrometres aerodynamic diameter

U = mean wind speed ($m \cdot s^{-1}$) (assumed at 0.5 $m \cdot s^{-1}$))

M = material moisture content (% by weight) (assumed 1 %)

The quality rating for this application is rated A.

Wind Erosion (Exposed Areas)

Emissions of particulate matter resulting from the wind erosion of exposed areas have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factors within Table 11.9-4 have been adopted for the operations outlined above. The emission factor applies to the materials: seeded land, stripped overburden and graded overburden. The emission factor is:

$$EF_{TSP}\ (tonne.(hectare.year)^{-1}) = 0.85$$

where:

$EF_{TSP}\ (tonne.(hectare.year)^{-1})$= emission factor for total suspended particulate matter

PM_{10} and $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 50% of TSP for PM_{10} and, 7.5% of TSP for $PM_{2.5}$ as per Section 13.2.5 of AP-42 for industrial wind erosion (US EPA, 2006b).

The quality rating for the emission factor is C.

Crumb Rubber and TDF Processing Emissions

Source	Type	Co-ordinates		Start	Stop	Activity	EFu (PM)	EFu (HAP)	ERu (PM)	ERu (HAP)	CF	ERc (PM)	ERc (HAP)	Height	Vs	Ts
		mE	mS	hrs	hrs	$t.day^{-1}$	$kg.kg^{-1}$	$kg.kg^{-1}$	$g.s^{-1}$	$g.s^{-1}$	%	$g.s^{-1}$	$g.s^{-1}$	m AGL	$m.s^{-1}$	K
Crumb Rubber Plant	POINT	315983	6242874	7:00	18:00	3	-	-	1.40E-02	8.17E-02	70, 0	4.21E-03	2.45E-02	4.8	0.1	298
Shredder (1)	POINT	315983	6242874	7:00	18:00	33	9.09E-07	1.33E-05	1.39E-03	1.02E-02	70, 0	4.18E-04	3.07E-03	5.8	15	298
Shredder (2)	POINT	316056	6242872	7:00	18:00	62	9.09E-07	1.33E-05	1.30E-03	1.91E-02	0, 0	1.30E-03	1.91E-02	7.9	15	298
Shredder (3)	POINT	316054	6242857	7:00	18:00	37	9.09E-07	1.33E-05	7.81E-04	1.15E-02	0, 0	7.81E-04	1.15E-02	7.9	15	298

Mobile Shredder Combustion Emissions

Source	Type	Co-ordinates		Start	Stop	EF (NOx)	EF (PM)	Power Rat	ER (NOx)	ER (PM)	CF	Height	Vs	Ts
		mE	mS	hrs	hrs	g·kWh	g·kWh	kW	$g.s^{-1}$	$g.s^{-1}$	%	m AGL	$m.s^{-1}$	K
Shredder (2)	POINT	316056	6242872	7:00	18:00	3.5	0.045	597	5.80E-01	7.46E-03	0	3.4	15	373
Shredder (3)	POINT	316054	6242857	7:00	18:00	4.0	0.2	399	4.43E-01	2.22E-02	0	3.2	15	373

Batch Drop Emissions

Source	Type	Co-ordinates		Start	Stop	W.Spd	M	ERu(TSP)	ERu(PM10)	ERu(PM2.5)	CF	ERc (TSP)	ERc (PM10)	ERc(PM2.5)
		mE	mS	hrs	hrs	$m{\cdot}s^{-1}$	%	$g.s^{-1}$	$g.s^{-1}$	$g.s^{-1}$	%	$g.s^{-1}$	$g.s^{-1}$	$g.s^{-1}$
Tyre dropoff (1)	VOL	316042	6242868	7:00	18:00	0.5	1.0	7.09E-04	3.35E-04	5.08E-05	30, 0	4.96E-04	2.35E-04	3.55E-05
Tyre dropoff (2)	VOL	316041	6242863	7:00	18:00	0.5	1.0	4.25E-04	2.01E-04	3.05E-05	30, 0	2.98E-04	1.41E-04	2.13E-05

Vehicle Emissions (Paved)

Source	Type	Co-ordinates		Start	Stop	Silt	W	Activity	Distance	ERu(TSP)	ERu(PM10)	ERu(PM2.5)	CF	ERc (TSP)	ERc (PM10)	ERc(PM2.5)
		mE	mS	hrs	hrs	sL	t	$no.day^{-1}$	km	$g.s^{-1}$	$g.s^{-1}$	$g.s^{-1}$	%	$g.s^{-1}$	$g.s^{-1}$	$g.s^{-1}$
Delivery Vehicles	VOL	(D)	(D)	6:00	23:00	7.4	26.9	22	0.2	1.02E-01	1.96E-02	4.70E-03	85, 0	1.54E-02	2.95E-03	7.04E-04
Forklift	AREA	315949	6242900	6:00	23:00	7.4	4.0	1	2.5	3.53E-03	6.77E-04	1.62E-04	85, 0	5.30E-04	1.02E-04	2.43E-05
Bobcat	AREA	315949	6242900	6:00	18:00	7.4	3.7	1	2.5	4.39E-03	8.41E-04	2.01E-04	85, 0	6.58E-04	1.26E-04	3.02E-05
Staff Vehicles	VOL	(D)	(D)	6:00	23:00	7.4	4.5	20	0.1	2.36E-03	4.53E-04	1.08E-04	85, 0	3.55E-04	6.80E-05	1.63E-05

Fugitive Wind-Generated Emissions

Source	Type	Co-ordinates		Start	Stop	Activity	EFu (TSP)	EFu (PM10)	EFu (PM2.5)	CF	ERc (TSP)	ERc (PM10)	ERc(PM2.5)
		mE	mS	hrs	hrs	ha	$t.ha^{-1}.yr^{-1}$	$t.ha^{-1}.yr^{-1}$	$t.ha^{-1}.yr^{-1}$	%	$g.s^{-1}$	$g.s^{-1}$	$g.s^{-1}$
Proposal site	AREA	(D)	(D)	0:00	23:00	0.30	0.85	0.425	0.06375	0, 0	8.11E-03	4.05E-03	6.08E-04

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.
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