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# Glendenning Road Data Centre

# Air Quality Impact Assessment

# Issued for Public Exhibition – SSDA 73761707

| | |
|---|---|
| Addressee(s): | LCI Consultants |
| Site Address: | 2 Glendenning Road, Glendenning |
| Report Reference: | 24.1104.FR1V3 |
| Date: | 24 October 2025 |
| Status: | Revised Final |
| Client Reference: | GRDC86-NOR-00-XX-RP-SSDA-Y-0000 |

**air quality | environment | sustainability**

## Quality Control

| Report | Reference | Status | Prepared by | Checked by | Authorised by |
|---|---|---|---|---|---|
| Glendenning Road Data Centre - Air Quality Impact Assessment | 24.1104.FR1V3 | Final | Northstar | GCG | MD |

## Report Status

| Northstar References | | Report Status | Report Reference | Version |
|---|---|---|---|---|
| Year | Job Number | (Draft: Final) | (R*x*) | (V*x*) |
| 2024 | 1104 | Revised Final | R1 | V3 |
| Based upon the above, the specific reference for this version of the report is: | | | | 24.1104.FR1V3 |

## 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.

**M Doyle** **24th October 2025**

# NON-TECHNICAL SUMMARY

Northstar Air Quality Pty Ltd was engaged by LCI Consultants to perform an air quality impact assessment for the proposed construction and operation of a datacentre, to be located at 2 Glendenning Road, Glendenning NSW. The assessment has considered the potential impacts on air quality associated with the construction and operation of the datacentre.

During the construction phase, the potential dust soiling and human health risks are assessed as being manageable through appropriate implementation of the recommended mitigation measures.

Under the justified worst-case emergency back-up generator operational scenario with all generators operating at the same time at full (100 %) load, a number of additional exceedances of the air quality criteria for a number of pollutants are predicted. With reference to published power supply reliability statistics, the probability of both the interruption to the power supply, and an exceedance of the relevant air quality criteria occurring was calculated through the multiplication of the probability of each event occurring, with values indicating the chance of an additional exceedance of the air quality criteria during a power outage is low.

Predicted incremental concentrations for a realistic emissions scenario during routine maintenance of the back-up generators show that minor exceedances of the short-term particulate matter (as $PM_{2.5}$) criterion are predicted, although this is based on the assumption of continuous testing between the hours of 6:00 am and 10:00 pm. Limiting of the number of hours of this testing each day, and/or the adoption of generators with a lower particulate emission rate than the worst-case assumptions used in this assessment would be sufficient to ensure that no exceedances would be predicted to occur at any surrounding receptors for all assessed pollutants.

Nonetheless, a number of additional mitigation measures considered to be Best Available Technology have been reviewed to provide context for how air quality impacts may be further reduced, if required in due course.

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# 1. INTRODUCTION

LCI Consultants (LCI, the Proponent) has commissioned Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA) to accompany a State Significant Development Application (SSDA) for the Glendenning Road Data Centre (the Project) at 2 Glendenning Road, Glendenning NSW 2761 (the Project site).

The AQIA has been performed to support the SSDA to be submitted to NSW Department of Planning, Housing, and Infrastructure (NSW DPHI) and has been performed in accordance with the NSW Environment Protection Authority (NSW EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (the Approved Methods) (NSW EPA, 2022).

This AQIA identifies and examines potential air quality (including odour) impacts associated with the construction and operation of the Project, aligning with the industry specific NSW Planning Secretary's Environmental Assessment Requirements (SEARs) for data storage centres, and outlines mitigation and monitoring requirements commensurate with those anticipated impacts to ensure that air quality criteria are achieved at surrounding sensitive receptor locations.

## 1.1. Purpose of the Report

The purpose of this report is to examine and identify whether the impacts of the construction and operation of the Project may adversely impact on air quality in the surrounding area.

To allow assessment of the level of risk associated with the Project in relation to air quality, the AQIA has been performed in accordance with and due reference to:

- *Protection of the Environment Operations Act* 1997 (POEO Act);
- Protection of the Environment Operations (Clean Air) Regulation 2022 (POEO CAR);
- Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2024); and,
- Approved Methods for Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2022).

Appendix A presents a common list of abbreviations, nomenclature and specified units referenced within this AQIA.

## 1.2. Secretary Environmental Assessment Requirements

This report has been prepared to address the specific requirements outlined in the SEARs for data storage centres[1], which have been provided to the Proponent on 25 July 2024, issued for the SSDA (SSD-73761707).

Table 1 details the SEARs coverage and indicates where each requirement has been addressed within this AQIA.

**Table 1 Coverage of industry specific SEARs for data storage centres (SSD-73761707)**

| Issue | Requirements | Addressed |
|---|---|---|
| Air Quality | Provide an assessment of air quality impacts, prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. | Section 2.4<br>Section 6<br>Section 7 |
| | The assessment must address construction works… | Section 5.1<br>Section 6 |
| | … and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) … | Section 5.2<br>Section 7<br>Section 8 |
| | … and a peak emission and air pollutant scenario … | Section 5.2<br>Section 7.1<br>Section 8.2.1 |
| | … and outline the proposed mitigation, management and monitoring measures that would be implemented. | Section 8.2.4<br>Section 8.2.5<br>Appendix B<br>Appendix F |

Section 9 of the Approved Methods (NSW EPA, 2022) outlines the NSW EPA's requirements for the information to be included in an AQIA. Table 2 summarises each requirement relevant to this type of development proposal and outlines where this information can be located in the AQIA.

**Table 2 NSW EPA Approved Methods – impact assessment reporting requirements**

| Assessment component | Addressed |
|---|---|
| **9.1 Site Plan** | |
| Layout of the site clearly showing all unit operations | Figure 2 |
| All emissions sources clearly identified | Figure 6<br>Figure 7<br>Section 5.2.3 |
| Plant boundary | Figure 1 |
| Sensitive receptors (e.g. nearest residences) | Section 4.2 |

[1] https://www.planning.nsw.gov.au/sites/default/files/2023-03/sears-data-storage-centres.pdf

| Assessment component | Addressed |
|---|---|
| Topography | Section 4.5<br>Section 5.2.1.3 |
| **9.2 Description of the activities carried out on the site** | |
| A detailed discussion of all unit operations carried out on the site, including all possible operational variability | Section 2.2<br>Section 2.3.2 |
| A detailed list of all process inputs and outputs | Section 2.2<br>Section 2.3.2 |
| Plans, process flow diagrams and descriptions that clearly identify and explain all pollution control equipment and techniques for all processes on the premises | Section 8.2.4<br>Section 8.2.5<br>Appendix F |
| A description of all aspects of the air emission control system, with particular regard to any fugitive emission capture systems (e.g. hooding, ducting), treatment systems (e.g. scrubbers, bag filters) and discharge systems (e.g. stacks) | Section 8.2.4<br>Section 8.2.5<br>Appendix F |
| The operational parameters of all emission sources, including all operational variability, i.e. location, release type (stack, volume or area) and release parameters (e.g. stack height, stack diameter, exhaust velocity, temperature, emission concentration and rate) | Section 5.2.3 |
| **9.3 Emissions Inventory** | |
| A detailed discussion of the methodology used to calculate the expected pollutant emission rates for each source | Section 5.2 |
| Detailed calculation of pollutant emission rates for each source | Section 5.2.3 |
| Tables showing all release parameters of stack and fugitive sources (e.g. temperature, exit velocity, stack dimensions, and emission concentrations and rates)… | Section 5.2.3 |
| …and all pollutant emission concentrations with a comparison of the emission concentrations against the relevant requirements of the Regulation | Section 8.2.3 |
| **9.4 Meteorological data** | |
| A detailed discussion of the prevailing dispersion meteorology at the proposed site. The report should typically include wind rose diagrams, an analysis of wind speed, wind direction, stability class, ambient temperature and mixing height; and joint frequency distributions of wind speed and wind direction as a function of stability class | Section 4.3<br>Appendix C |
| Demonstration that the site-representative data adequately describes the expected meteorological patterns at the site under investigation (e.g. wind speed, wind direction, ambient temperature, atmospheric stability class, inversion conditions and katabatic drift) | Appendix C |
| A description of the techniques used to prepare the meteorological data into a format for use in the dispersion modelling | Section 5.2.1.2<br>Appendix C |
| A quality assurance and quality control analysis of the meteorological data used in the dispersion modelling. Provide and discuss any relevant results of this analysis | Appendix C |
| **9.5 Background air quality data** | |
| A detailed discussion of the methodology used to calculate the background concentrations for each pollutant | Section 4.4<br>Appendix D |
| Tables summarising the ambient monitoring data | Section 4.4<br>Appendix D |

| Assessment component | Addressed |
|---|---|
| **9.6 Dispersion modelling** | |
| A detailed discussion and justification of all parameters used in the dispersion modelling and the manner in which topography, building wake effects and other site-specific peculiarities that may affect plume dispersion have been treated | Section 5.2.1 |
| A detailed discussion of the methodology used to account for any atmospheric pollutant formation and chemistry | Section 5.2.6 |
| A detailed discussion of air quality impacts for all relevant pollutants, based on predicted ground-level concentrations at the plant boundary and beyond, and at all sensitive receptors | Section 7 |
| Ground-level concentrations, hazard index and risk isopleths (contours) and tables summarising the predicted concentrations of all relevant pollutants at sensitive receptors | Section 7 |

# 2. THE PROJECT

The following provides a description of the context, location and scale of the Project, and a description of the processes and development activities on site. It also identifies the potential for emissions to air associated with the Project.

## 2.1. Environmental Setting

The Project site is located at 2 Glendenning Road, Glendenning NSW and is legally described as Lot 2 of Deposited Plan (DP) 1137162. It is zoned as E4 (General Industrial) under the Blacktown Local Environmental Plan 2015 (BLEP2015).

The Project site comprises a total area of 10.44 hectares (ha) and exhibits a primary frontage to Glendenning Road at the western boundary for approximately 295 metres (m). A secondary frontage to Woodstock Avenue is located along the southern boundary, for a length of approximately 335 m.

The Project site comprises three (3) existing warehouse buildings that undertake various operations, including storage and logistics and a transport vehicle centre. The buildings are positioned toward the Glendenning Road frontage and cover approximately one half of the Project site. The remainder of the Project site to the rear is vacant and contains a mix of grass, native vegetation and sporadic trees. A patch of mature native vegetation exists along the southern boundary, which is identified as outstanding biodiversity value. An established landscaping strip is located along the Glendenning Road frontage, providing some screening of the existing buildings.

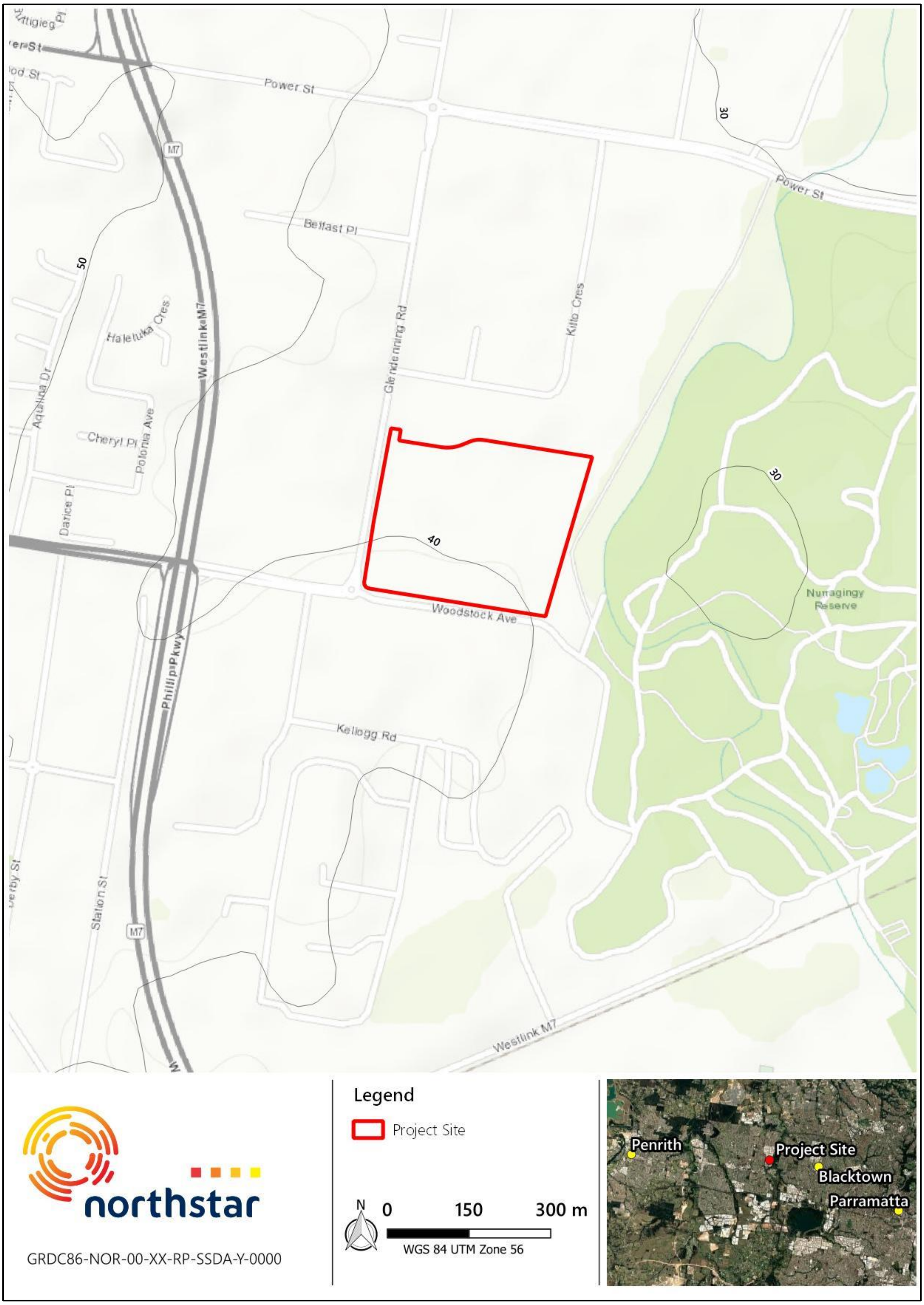
Vehicle access is obtained via four (4) vehicle crossings off Glendenning Road, which provide separate access for the two (2) large tenants. Vehicle access is also provided off Woodstock Avenue for the southern tenant.

The Project site is traversed by overhead 132 kilovolt (kV) transmission lines and towers, managed by Endeavour Energy. A drainage reserve also exists directly north of the Project site, which is managed by Blacktown City Council.

The Project site is surrounded by industrial land uses to the north, west and south. Directly adjoining the Project site to the east is the Nurragingy Reserve, which falls under the jurisdiction of the Western Sydney Parklands. The closest residential area is located approximately 400 m to the west of the Project site on the opposite side of the Westlink M7 Motorway.

A map showing the location of the Project site 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 Project site location




**Source**: Northstar

## 2.2. Project Overview

The Project is known as the Glendenning Road Data Centre and includes the construction and operation of 3 no. data centre buildings and associated infrastructure, with a total power generation capacity of 267.2 megawatts (MW), and an IT data capacity of 193.6 MW.

The Project seeks SSDA approval for the following:

- Site preparation and establishment works including:
  - Bulk earthworks to create proposed site levels;
  - In-ground building services and utility work;
  - Clearance of trees and vegetation within the proposed development extent;
- Construction of 3 no. data centre buildings, referenced as DC01, DC02 and DC03, comprising:
  - A total gross floor area (GFA) of 50 233 square metres ($m^2$) (DC01 – 19 985 $m^2$, DC02 – 10 263 $m^2$ and DC03 – 19 985 $m^2$);
  - A maximum building height of 45.3 m, including five (5) storeys for each building;
  - 3 no. internal substations;
  - A total IT data capacity of approximately 193.6 MW (DC01 – 79.2 MW, DC02 – 35.2 MW and DC03 – 79.2 MW);
- Total diesel fuel storage of 2 338 430 litres (L) within underground bulk and generator day tanks;
- 97 no. back-up diesel-fuelled generators across the full development (DC01-DC03);
- External plant and equipment (including water tanks and pump rooms);
- Installation of evaporative cooling units;
- Three (3) vehicle crossovers to Glendenning Road and internal access roads;
- Security fencing surrounding the Project site, including a controlled entry and exit point;
- 165 no. on-site car parking spaces (including six (6) accessible and 12 EV parking spaces);
- Landscaping across the subject site; and
- Hours of operation being on a 24 hours per day, seven (7) days per week basis.

The Project would be constructed in three stages, as follows:

- **Stage 1** – The first stage would include the construction of DC01, located at the rear of the Project site. The three (3) existing site buildings would be demolished.
- **Stage 2** – The second stage would involve the construction of DC02.
- **Stage 3** – The final stage would involve the construction of DC03.

It is noted that the Project does not include any demolition of the existing buildings at the Project site. Demolition works will be subject to a separate approval pathway.

Figure 2 provides the construction staging plan for stage 3.

## 2.3. Identification of Emissions to Atmosphere

Given the nature of the Project, emission to air would be likely to be generated as described below.

### 2.3.1. Construction Phase

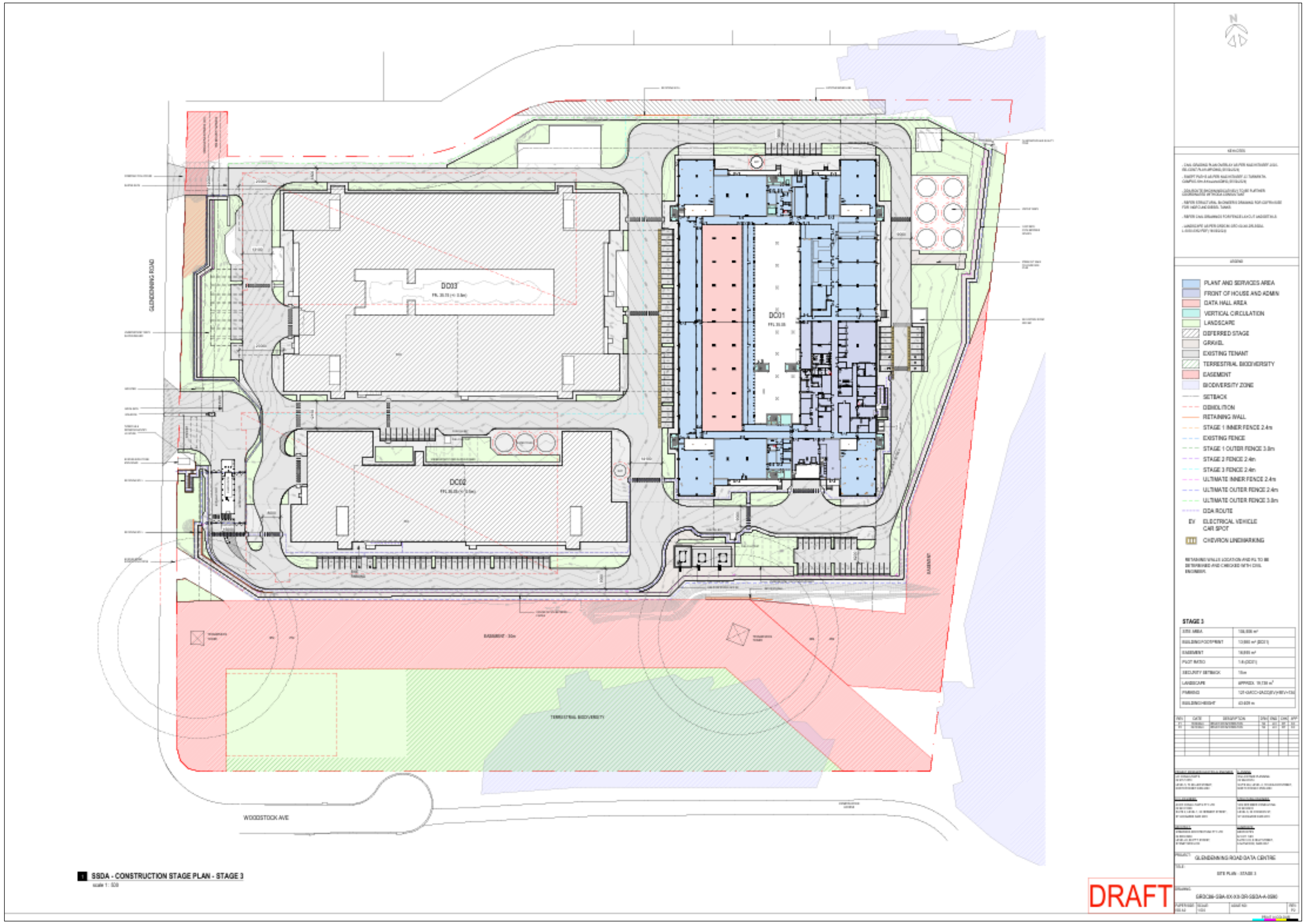
Construction of the Project would involve bulk earthworks, construction of 3 no. data centre buildings and associated infrastructure, car parking and access roads. The construction of the Project is anticipated to be completed in a staged approach as outlined in Section 2.2.

An indicative list of plant and equipment that may be used during the construction of the Project includes:

- Excavators and front-end loaders (FEL);
- Graders;
- Light -and heavy-duty vehicles;
- Drills and pneumatic hand or power tools; and
- Cranes and elevated working platforms.

The assessment of the potential local air quality risks from construction phase activities is presented in Section 6, while the risk assessment methodology is presented in Appendix B.

**Figure 2 Project site – construction staging plan – stage 3**




**Source:** Greenbox Architecture – GRDC86-GBA-XX-XX-DR-SSDA-A-0590

### 2.3.2. Operational Phase

Operational emissions from the data centre on a day-to-day basis would be anticipated to be negligible, with the exception of potential emissions from diesel-fuelled back-up generators during periodic maintenance testing or during a power outage event.

The Project will have 97 no. back-up generators with a total power generation capacity of 267.2 MW comprised of:

- 39 no. generators at DC01, with a capacity of 107.9 MW;
- 19 no. generators at DC02, with a capacity of 51.4 MW; and
- 39 no. generators at DC03, with a capacity of 107.9 MW.

Note that the above capacity includes all generators, and not just the IT data capacity indicated in Section 2.2.

The back-up generator models to be installed at the Project site is not currently finalised, however two candidate generator sets to be used are listed below:

- CAT model 3516E diesel-fuelled generators each with a capacity of 2 800 ekW and a fuel consumption rate of 750.9 litres per hour ($L \cdot hr^{-1}$) at 100 % load; or
- MTU 20V4000 G94F diesel-fuelled generators each with a capacity of 3 088 kW and a fuel consumption rate of 756 $L \cdot hr^{-1}$ at 100 % load.

Note that other generators may be selected for installation as part of the Project.

During a power outage event, the first back up (or remediation) is that of the dual redundant power supply. If this also suffers a failure, the second back up is to utilise the generators to power the site. Essentially, the back-up generators serve as a back-up to the primary provision of a dual redundant power supply, and as such their use is designed to be minimal.

During periods when the back-up generators may be required to provide power during mains power outage events, short-term emissions of combustion related pollutants may be generated. Emissions from diesel-fuelled back-up generators may include various air pollutants, as listed in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (NPI EETM) for combustion engines (NPI, 2008). The pollutants of concern from the operation of the back-up generators includes (in no order):

- Particulate matter (PM);
- Oxides of nitrogen ($NO_X$);
- Carbon monoxide (CO);
- Sulphur dioxide ($SO_2$);
- Polycyclic aromatic hydrocarbons (PAHs);
- Volatile organic compounds (VOCs), as benzene ($C_6H_6$), toluene ($C_7H_8$) and xylene ($C_8H_{10}$); and

- Formaldehyde ($CH_2O$).

For standby generators to be ready to operate should an unexpected interruption to mains power occur, a regular maintenance schedule is required. Maintenance testing of standby generators is anticipated to occur during the daytime period , from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm (Sundays and public holidays). The generators to be used at the Project site are proposed to be tested under the following indicative routine maintenance arrangement:

- Up to 20 no generators being tested in parallel under no-load (0 % load) conditions; and
- Up to three (3) no generator being tested at any given time, under full load (100 % load) conditions.

The preliminary generator testing schedule is understood to have a cumulative total of not more than the 200-hour exemption limit outlined in Schedule 1 Clause 17 of the NSW *Protection of the Environment Operations Act* 1997 (refer to Section 3.1), in addition to Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation 2022 (refer Section 3.2).

The Project includes on-site fuel storage, which may contribute to air emissions through fugitive VOCs during filling and dispensing of fuel, as well as from potential accidental spillages and leaks that may occur. The tank design is expected to incorporate adequate containment (e.g. double walled / secondary containment) and automated leak detection measures in compliance with applicable Australian Standard / New Zealand Standard (AS/NZS) such as AS/NZS 1940:2017 ("Storage and Handling of Flammable and Combustible Liquids") and AS/NZS 1692:2006 ("Steel Tanks for Flammable and Combustible Liquids") with low sulphur content diesel fuel utilised for the standby generators. In addition to containment of tanks, spill containment will be provided around tank fill connections, pumps, and filters, where required, and given the low potential for fugitive emissions, these emissions have not been considered further in this AQIA.

### 2.3.3. Odour

Construction phase activities may include the operation of plant and machinery, that may pose an insignificant risk of odour in the event of accidental fuel spillage, however this risk is very minor and can be effectively managed through the provision of spill kits to promptly manage any spillages.

Operational phase activities will not result in any air emissions, with the exception of potential accidental loss of containment of fuel, and the periodic operation of the diesel-fuelled generators for testing and back-up power generation purposes only, as outlined above.

Air emissions of VOCs from the standby generators have been assessed as benzene ($C_6H_6$) as a principal toxic air pollutant, with anticipated emissions of toluene ($C_7H_8$) and xylene ($C_8H_{10}$) assessed and compared against the relevant odour impact assessment criteria.

## 2.4. Alternative Options for Power Generation

Currently, alternatives to diesel generators are not feasible for large-scale data centres, which depend on diesel for reliability, quick startup, and robust power delivery. While emerging technologies[2] like HVO100 renewable diesel, hydrogen fuel cells, microgrids, and battery storage show promise, they are not yet technologically or financially viable for widespread use. It is noted that the Proponent would seek to procure HVO ready generators, which enables HVO use when a supply chain exists.

Due to the high load density and steady load profile, solar panels covering the entire roof would only meet a small portion of the site's power needs, and mechanical equipment further limits available space for solar installations.

While batteries could provide short-term backup, the fuel needed for 24-hour autonomy to maintain critical services during extended outages is significant. Using batteries for the same duration would be prohibitively expensive and space-intensive, also posing similar risks to diesel, such as chemical spills and fire hazards

As a consequence, diesel generators will continue to be essential for the data centre industry until feasible alternatives are commercially available.

[2] https://www.datacenterdynamics.com/en/opinions/is-it-time-to-replace-diesel-backup-generators/

# 3. LEGISLATION, REGULATION AND GUIDANCE

The following provides an overview of the legislation and air quality criteria which are applicable to the activities being performed at the Project site.

## 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 (scheduled activities) and a range of air pollution offences and penalties.

Schedule 1, Part 1 of the POEO Act provides definitions for scheduled activities, and the associated threshold activity rates. For the Project, the thresholds associated with electricity generation (clause 17) and chemical storage (clause 9) are most relevant, given the use of backup diesel-fuelled generators as part of the Project:

> *17 Electricity generation*
>
> *(1) This clause applies to the following activities:*
>
> *…*
>
> *metropolitan electricity works (internal combustion engines), meaning the generation of electricity by means of electricity plant:*
>
> *(a) that is based on, or uses, an internal combustion engine, and*
>
> *(b) that is situated in the metropolitan area or in the local government area of Port Stephens, Maitland, Cessnock, Singleton, Wollondilly, or Kiama.*
>
> *(1A) However, this clause does not apply to the generation of electricity by means of electricity plant that is emergency stand-by plant operating for less than 200 hours per year.*
>
> *(2) Each activity referred to in Column 1 of the Table to this clause is declared to be a scheduled activity if it meets the criteria set out in Column 2 of that Table.*

and

> *9 Chemical storage*
>
> *(1) This clause applies to the following activities--*

*"general chemicals storage", meaning the storage or packaging in containers, bulk storage facilities or stockpiles of any chemical substance classified as a dangerous good in the Transport of Dangerous Goods Code , other than the following--*

*...*

*"petroleum products storage", meaning the storage or packaging of petroleum or petroleum products in containers, bulk storage facilities or stockpiles.*

*(2) Each activity referred to in Column 1 of the Table to this clause is declared to be a scheduled activity if it meets the criteria set out in Column 2 of that Table.*

*Table*

| ***Column 1*** | ***Column 2*** |
|---|---|
| *Activity* | *Criteria* |
| *...* | |
| *petroleum products storage* | *capacity to store more than 200 tonnes (liquified gases) or 2,000 tonnes (chemicals in any other form)* |

During times of stable external supply of electricity, the back-up generators will only operate during scheduled maintenance events (refer Section 2.3.2). On this basis, the Project is highly unlikely to exceed the 200-hour limit, on the generation of electricity by means of electricity plant that is emergency stand-by plant and is not deemed to be a scheduled activity under Schedule 1, Part 1, Clause 17 of the POEO Act.

Further, the Project may be deemed to be a scheduled activity due to the quantity of diesel fuel stored at the Project site. Should the Project have the capacity to store more than 2 000 tonnes (t) of diesel fuel (equivalent to 2 350 kilolitres (kL) assuming a fuel density of 850.8 $kg \cdot m^{-3}$), then the Project may be deemed to be a scheduled activity under Schedule 1, Part 1 Clause 9 of the POEO Act.

As outlined in Section 2.2, the Project (DC01, DC02 and DC03) includes the capacity to store over 2 338 kL of diesel fuel. Given the discussion provided above, the Project would therefore not be considered to be a scheduled activity and correspondingly, an Environment Protection Licence (EPL) would not be required.

Part 5.4 of the POEO Act outlines a number of requirements associated with air pollution. These requirements generally relate to the appropriate maintenance of plant and equipment in an efficient condition and dealing with materials in a manner as to not cause air pollution.

## 3.2. Protection of the Environment Operations (Clean Air) Regulation

The Protection of the Environment Operations (POEO) (Clean Air) Regulation 2022 (POEO CAR) establishes requirements and concentration standards for air emissions from industrial activities in NSW. It regulates air quality issues related to various sources, including burning activities, motor vehicle fuels, fuel usage and transfer, air impurities from activities and plants, and the storage of volatile organic liquids.

Part 5 of the POEO CAR specifically addresses air impurities from activities and plant, referring to Schedule 2 to set concentration standards for both scheduled and non-scheduled premises. The standards are in-stack emission limits and are the maximum emissions permissible.

Clause 73, Part 5, Division 6 of the POEO CAR provides the following in regard to the regulation of emissions from emergency electricity generation:

> *73 Exemption relating to emergency electricity generation*
>
> *Emergency standby plant is exempt from the air impurities standard for nitrogen dioxide and nitric oxide specified in Schedule 2, Part 2, Division 3 for the plant if –*
>
> *(a) the plant comprises a stationary reciprocating internal combustion engine for generating electricity, and*
>
> *(b) it is used for a total of not more than 200 hours per year.*

As outlined in Section 2.3.2, the generators would be operated for less than 200 hours per year, and the exemption above would therefore apply to the Project.

The standards of concentration, and whether they are applicable to the Project, are summarised in Table 3.

Table 3 POEO CAR standards of concentrations for applicable air impurities

| Air impurity | Activity or plant | Concentration | Applicable |
|---|---|---|---|
| **Schedule 2, Part 2, Division 2 – Electricity generation (Group 6)** | | | |
| Solid particles (Total) | An activity or plant using a liquid or solid standard fuel or a non-standard fuel | 50 mg·Nm$^{-3}$ (A) | No. Would not be a scheduled activity |
| Nitrogen dioxide ($NO_2$) or nitric oxide (NO) or both, as $NO_2$ equivalent | A turbine operating on a fuel other than gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more | 90 mg·Nm$^{-3}$ (A) | No. Not a scheduled activity and would operate for <200 hrs·year$^{-1}$. |
| **Schedule 2, Part 2, Division 3 - Scheduled premises (Group 6)** | | | |
| Solid particles (Total) | An activity or plant | 50 mg·Nm$^{-3}$ (A) | No. Would not be a scheduled activity |
| Nitrogen dioxide ($NO_2$) or nitric oxide (NO) or both, as $NO_2$ equivalent | Stationary reciprocating internal combustion engines | 450 mg·Nm$^{-3}$ (A) | No. Not a scheduled activity and would operate for up to 200 hours per year. |
| Volatile organic compounds (VOCs), as n-propane | A stationary reciprocating internal combustion engine using a liquid fuel | 1 140 mg·Nm$^{-3}$ (A) VOCs *or* 5 880 mg·Nm$^{-3}$ (A) CO | No. Would not be a scheduled activity |
| Smoke | An activity or plant in connection with which liquid or gaseous fuel is burnt | 20 % opacity | No. Would not be a scheduled activity |
| **Schedule 2, Part 3 – Non-scheduled premises (Group C)** | | | |
| Solid particles (Total) | An activity or plant | 100 mg·Nm$^{-3}$ (B) | Yes |
| Smoke | An activity or plant in connection with which liquid or gaseous fuel is burnt | 20 % opacity | Yes |

**Notes** (A) POEO CAR Sch2, Pt 3, Div 1: dry, 273 K, 101.3 kPa, 7 % $O_2$
(B) POEO CAR Sch2, Pt 3, Div 2: dry, 273 K, 101.3 kPa, 7 % $O_2$

Part 4 Clause 20 of the POEO CAR requires that motor vehicles do not emit excessive air impurities which may be visible for a continuous period of more than 10-seconds when determined in accordance with the relevant standard.

All vehicles, plant and equipment to be used either at the Project site or to transport materials to and from the Project site will be maintained regularly and in accordance with manufacturers' requirements, where these vehicles are under the operational control of the Proponent.

## 3.3. NSW EPA Approved Methods

State air quality guidelines are prescribed by the NSW EPA in the Approved Methods (NSW EPA, 2022) which has been consulted during the preparation of this AQIA (see Section 1.2, Table 2).

The Approved Methods lists the statutory methods that are to be used to assess emissions of criteria air pollutants in NSW. Section 7.1 and Section 7.2 of the Approved Methods clearly outlines the impact assessment criteria for those key pollutants of interest and both individual and principal toxic air pollutants. Principal toxic air pollutants are defined in the Approved Methods 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 National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], and World Health Organisation [WHO]).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW for relevant individual air pollutants are presented in Table 4.

To assess the potential impact of emissions of Total Volatile Organic Compounds (VOC) (which is a complex mixture of hydrocarbons), the 1-hour impact assessment criterion for benzene ($C_6H_6$) of 0.029 mg·m$^{-3}$ (29 µg·m$^{-3}$) as outlined in table 12 of the Approved Methods (NSW EPA, 2022) has been adopted.

Benzene ($C_6H_6$) is one of the primary components of TVOC emissions resulting from diesel combustion engines and correspondingly, compliance with the benzene ($C_6H_6$) criterion (refer Table 4) would generally result in compliance with all VOC components from a health-perspective. Formaldehyde ($CH_2O$) is assessed as a discrete VOC.

VOC emissions have additionally been assessed against the 1-hour odour impact assessment criteria for toluene ($C_7H_8$) of 0.36 mg·m$^{-3}$ (360 µg·m$^{-3}$) and xylene ($C_8H_{10}$) of 0.19 mg·m$^{-3}$ (190 µg m$^{-3}$) to address odour.

Table 5 provides a summary of impact assessment criteria for principal toxic, and both individual odorous and toxic pollutants that are referenced within this AQIA, as outlined in Section 7.2 of the Approved Methods.

Table 4 NSW EPA impact assessment criteria

| Pollutant | Averaging period | Criterion µg·m-3 (a) | | Notes |
|---|---|---|---|---|
| | | ppm (c) | mg·m-3, (d) | |
| Sulphur dioxide ($SO_2$) | 1 hour | 286 | | Numerically equivalent to the AAQ NEPM (b) standards and goals |
| | 24 hours | 57 | | |
| Nitrogen dioxide ($NO_2$) | 1 hour | 164 | | |
| | Annual | 31 | | |
| Particulates (as $PM_{10}$) | 24 hours | 50 | | |
| | 1 year | 25 | | |
| Particulates (as $PM_{2.5}$) | 24 hours | 25 | | |
| | 1 year | 8 | | |
| Particulates (as TSP) | 1 year | 90 | | |
| Carbon monoxide (CO) | 15 minutes | 87 | 100 | Numerically equivalent to the AAQ NEPM (b) standards and goals |
| | 1 hour | 25 | 30 | |
| | 8 hours | 9 | 10 | |

**Notes:** (a): micrograms per cubic metre of air

(b): National Environment Protection (Ambient Air Quality) Measure

(c): parts per million ($10^6$)

(d): milligrams per cubic metre of air

Table 5 NSW EPA impact assessment criteria for principal and individual toxic pollutants

| Pollutant | Averaging period | Criterion | | Notes |
|---|---|---|---|---|
| | | ppm (a) | mg·m-3 (b) | |
| Polycyclic Aromatic Hydrocarbon (PAH) as benzo(a)pyrene | 1 hour | n/a | 0.0004 | |
| Benzene ($C_6H_6$) | 1 hour | 0.009 | 0.029 | |
| Toluene ($C_7H_8$) | 1 hour | 0.06 | 0.36 | Odour |
| Xylene ($C_8H_{10}$) | 1 hour | 0.04 | 0.19 | Odour |
| Formaldehyde ($CH_2O$) | 1 hour | 0.018 | 0.02 | |

**Notes**: (a): parts per million ($10^6$)

(b): milligrams per cubic metre of air

## 3.4. Blacktown Local Environmental Plan 2015

The Blacktown Local Environmental Plan 2015 (BLEP2015) provides the legislative framework for developments and land use within the Blacktown LGA. Specifically, the aims of the BLEP2015 are as follows:

> *(aa) to protect and promote the use and development of land for arts and cultural activity, including music and other performance arts,*
>
> *(a) to recognise the role of the urban renewal precincts as the major locations for higher density residential and employment development for the city,*
>
> *(b) to ensure that appropriate housing opportunities are provided for all current and future residents through diversity of housing choice,*
>
> *(c) to provide land for community facilities, public purposes and recreational pursuits,*
>
> *(d) to encourage development opportunities for business and industry so as to deliver local and regional employment growth,*
>
> *(e) to minimise risk to the community by restricting development in sensitive areas that are subject to flooding and other hazards,*
>
> *(f) to provide for infrastructure to maintain and meet demands arising from housing and employment growth,*
>
> *(g) to conserve and enhance Blacktown's built, natural and cultural heritage,*
>
> *(h) to conserve, restore and enhance biological diversity and ecosystem health, particularly threatened species, populations and communities.*

It is noted that the BLEP2015 does not outline any specific requirements for the development of data centres with regard to air quality and correspondingly, potential air quality impacts would be managed under the requirements of the POEO Act, POEO CAR and the Approved Methods (NSW EPA, 2022).

## 3.5. Blacktown Development Control Plan

The Blacktown Development Control Plan (DCP) 2015 provides guidance regarding the operation and design of developments within the Blacktown LGA to achieve the aims and objectives of the BLEP2015.

Requirements of the Blacktown DCP 2015 with reference to air quality include:

> *Part E (Development in the Industrial Zones)*
>
> *Section 7.2.1 Air pollution:*

*The emission of air impurities, as defined under the Protection of the Environment Operations Act 1997, is to be controlled to the satisfaction of Council at all times. Approval may be required from the Office of Environment and Heritage for some development.*

*Section 4.3 Consideration of adjoining land*

*Where development is proposed on major traffic routes or on land near to or adjoining a residential zone, a RE1 Public Recreation zone, or sensitive uses such as schools, Council will have particular regard to the following:*

..

*- The likely level of air pollution (both odour and chemical content) to be emitted by the development. Approval may be required from the NSW Office of Environment and Heritage for some development*

## 3.6. 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 POEO Act and POEO CAR. 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 the Project 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

The following information provides context around the location of sensitive receptor locations surrounding the Project site, the prevailing meteorology and air quality of the surrounding area and identifies other sources of air pollutants which have the potential to impact cumulatively with the Project.

## 4.1. Surrounding Land Sensitivity

The Project site is situated within an E4 General Industrial zone according to the BLEP2015[3].

The land use immediately surrounding the Project site also includes E4 General Industrial land use as well as RE1 Public Recreation to the southwest, with R2 Low Density Residential land use located further to the east along Knox Road and west along Polonia Avenue. Unzoned land is adjacent to the Project site's eastern boundary.

## 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 defines a sensitive receptor location to be:

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

It is noted that the assessment criteria applied to particulates and sulphur dioxide ($SO_2$) (refer Table 4) are for a 24-hour averaging period, and as such the predicted impacts need to be interpreted at commercial and industrial receptor locations with care. It is considered to be atypical for a person to be at those locations for a complete 24-hour period and as such, the exposure risks associated with those pollutants at those locations would be over-estimated by adoption of those locations in the modelling assessment.

It is important to note that the selection of discrete receptor locations is not intended to represent a fully inclusive selection of all sensitive receptors across the study area. The location selected should be considered to be representative of its broader location and may be reasonably assumed to be representative of the immediate environs. In some instances, several viable receptor locations may be identified in a small area, for example a school neighbouring a medical centre. In this instance the receptor closest to the potential

[3] https://maps.blacktown.nsw.gov.au/

sources to be modelled would generally be selected and would be used to assess the risk to other sensitive land uses in the area.

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 that is sensitive to changes in air quality, does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

In accordance with the requirements of the Approved Methods, several receptors have been identified and the receptors adopted for use within this AQIA are presented in Table 6 and illustrated in Figure 3.

Table 6 is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations, that are used to characterise larger areas, or selected as they represent more sensitive locations, which may represent people who are more susceptible to changes in air pollution.

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 (refer Figure 3).

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.

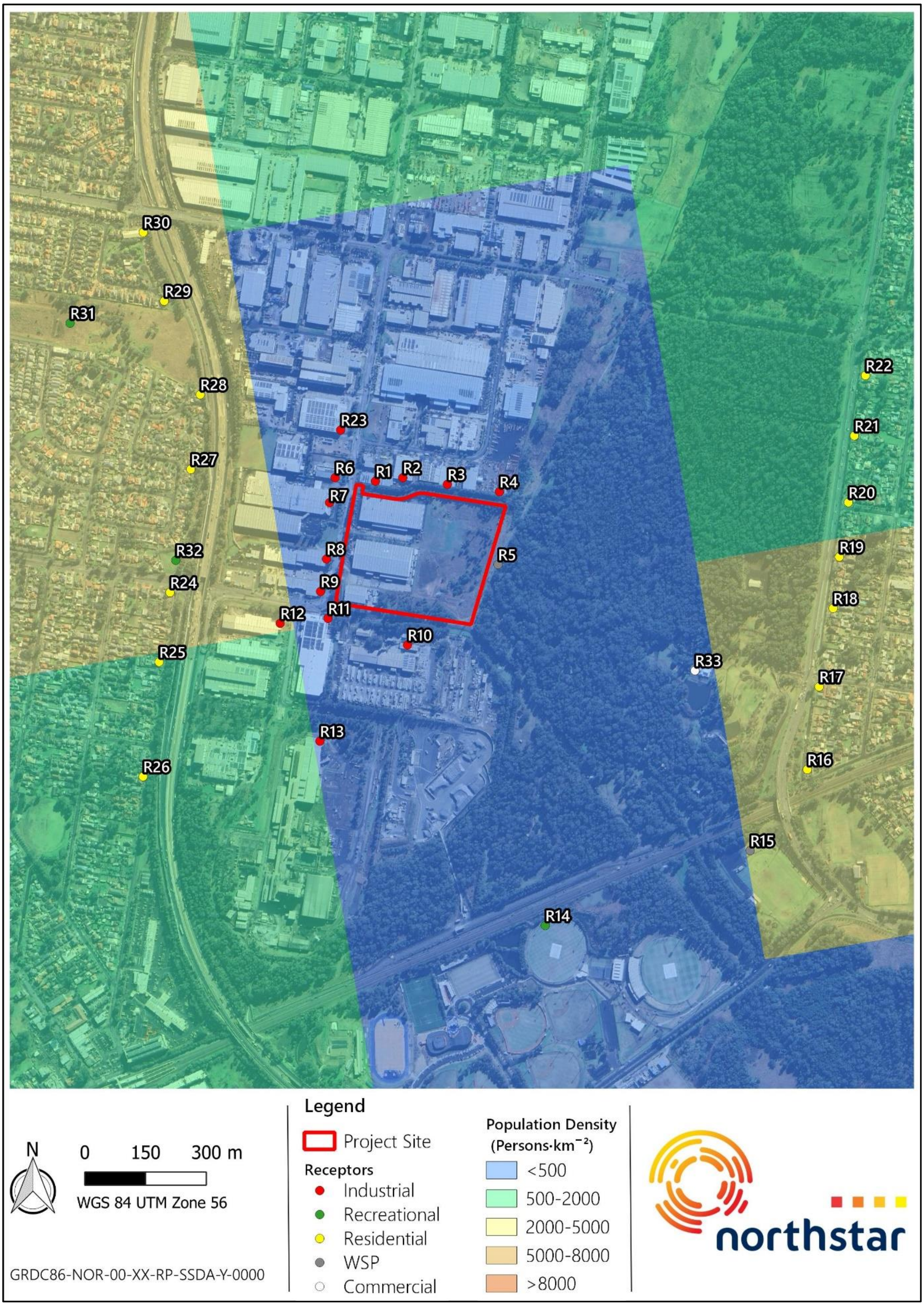
Using the ABS data in a GIS, the population density in the area around the Project site is categorised as very low (i.e. less than 500 persons·$km^{-2}$), indicating a predominantly industrial area. Further to the east and west the population density increases to a low-medium range (between 500 and 5 000 persons·$km^{-2}$).

Table 6 Discrete sensitive receptor locations

| Receptor ID | Location | Land use | Coordinates (UTM) | |
|---|---|---|---|---|
| | | | mE | mS |
| R1 | Glendenning Road, Glendenning | Industrial | 301 036 | 6 262 574 |
| R2 | Kilto Crescent, Glendenning | Industrial | 301 103 | 6 262 583 |
| R3 | Kilto Crescent, Glendenning | Industrial | 301 214 | 6 262 567 |
| R4 | Kilto Crescent, Glendenning | Industrial | 301 342 | 6 262 549 |
| R5 | Western Sydney Parklands, Glendenning | Recreational | 301 338 | 6 262 369 |
| R6 | Glendenning Road, Glendenning | Industrial | 300 936 | 6 262 583 |
| R7 | Glendenning Road, Glendenning | Industrial | 300 923 | 6 262 522 |
| R8 | Glendenning Road, Glendenning | Industrial | 300 915 | 6 262 383 |
| R9 | Glendenning Road, Glendenning | Industrial | 300 900 | 6 262 302 |
| R10 | Woodstock Avenue, Glendenning | Industrial | 301 115 | 6 262 170 |
| R11 | Woodstock Avenue, Glendenning | Industrial | 300 919 | 6 262 236 |
| R12 | Woodstock Avenue, Glendenning | Industrial | 300 801 | 6 262 224 |
| R13 | Kellogg Road, Rooty Hill | Industrial | 300 899 | 6 261 933 |
| R14 | Blacktown International Sportspark | Recreational | 301 455 | 6 261 478 |
| R15 | Western Sydney Parklands, Doonside | Recreational | 301 961 | 6 261 663 |
| R16 | Coghlan Crescent, Doonside | Residential | 302 102 | 6 261 863 |
| R17 | Cross Street, Doonside | Residential | 302 131 | 6 262 067 |
| R18 | Knox Road, Doonside | Residential | 302 166 | 6 262 261 |
| R19 | Knox Road, Doonside | Residential | 302 181 | 6 262 388 |
| R20 | Knox Road, Doonside | Residential | 302 204 | 6 262 522 |
| R21 | Knox Road, Doonside | Residential | 302 218 | 6 262 687 |
| R22 | Knox Road, Doonside | Residential | 302 246 | 6 262 835 |
| R23 | Glendenning Road, Glendenning | Industrial | 300 950 | 6 262 701 |
| R24 | Woodstock Avenue, Rooty Hill | Residential | 300 529 | 6 262 300 |
| R25 | Station Street, Rooty Hill | Residential | 300 502 | 6 262 128 |
| R26 | Station Street, Rooty Hill | Residential | 300 462 | 6 261 845 |
| R27 | Polonia Avenue, Plumpton | Residential | 300 580 | 6 262 604 |
| R28 | Haleluka Crescent, Plumpton | Residential | 300 603 | 6 262 788 |
| R29 | Parkwood Street, Plumpton | Residential | 300 515 | 6 263 019 |
| R30 | Power Street, Plumpton | Residential | 300 463 | 6 263 189 |
| R31 | Carroll Crescent, Plumpton | Recreational | 300 282 | 6 262 965 |
| R32 | Darice Place, Plumpton | Recreational | 300 543 | 6 262 379 |
| R33 | The Colebee Function Venue | Commercial | 301 825 | 6 262 107 |

**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 Sensitive receptors surrounding the Project site




**Source**: Northstar

## 4.3. Meteorology

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

Two AWS have been identified within a 20 km radius of the Project site. A summary of the relevant AWS is provided in Table 7 (listed by proximity).

**Table 7 Details of meteorological monitoring surrounding the Project site**

| Site name | Station # Source | Approximate location | | Approximate distance (km) |
|---|---|---|---|---|
| | | mE | mS | |
| Horsley Park Equestrian Centre AWS | 067119 BoM | 301 708 | 6 252 298 | 9.9 |
| Penrith Lake AWS | 067113 BoM | 284 871 | 6 266 524 | 16.6 |

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

It is considered that data collected at Horsley Park Equestrian Centre AWS is most likely to represent the conditions at the Project site, based upon its proximity. The meteorological conditions measured at Horsley Park Equestrian Centre AWS for the period 2019 to 2023 (most recent five years of completed data) are presented in Appendix C.

The wind roses presented in Appendix C indicate that from 2019 to 2023, winds at Horsley Park Equestrian Centre AWS show similar distribution patterns across the years assessed, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at Horsley Park Equestrian Centre AWS between 2019 and 2023 are generally in the range 0.5 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 from mostly north-westerly directions. Winds of this speed are rare and occur during 0.2 % of the observed hours during the years. Calm winds (less than 0.5 $m{\cdot}s^{-1}$) are more common and occur during 20.3 % of hours on average across the years between 2019 and 2023.

An analysis of the correlation coefficients between each year for wind speed, wind direction and particulate matter data distribution was performed to select a representative year for the meteorological modelling (refer Appendix C). Following this analysis, the year 2023 was selected as the most representative year for further assessment.

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

## 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. These 'background' (sometimes called 'baseline') air quality conditions will vary depending on the pollutants to be assessed and can often be characterised by using representative air quality monitoring data.

Two air quality monitoring stations (AQMS) have been identified within a 10 km radius of the Project site, operated by NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). These locations (listed by proximity) are summarised in Table 8.

**Table 8 NSW DCCEEW AQMS surrounding the Project site**

| AQMS | Distance to Project site (km) | 2023 data | Measurements | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | $PM_{10}$ | $PM_{2.5}$ | TSP | $NO_2$ | CO | $SO_2$ |
| Prospect | 6.6 | ✓ | ✓ | ✓ | × | ✓ | ✓ | ✓ |
| St Marys | 8.7 | ✓ | ✓ | ✓ | × | ✓ | × | × |

The closest representative AQMS with data available for the year 2023 (the selected representative year consistent with the meteorological modelling [refer Appendix C]) is noted to be located at Prospect.

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

Prospect AQMS recorded $PM_{2.5}$ concentrations above the NEPM AAQ standard and NSW EPA impact assessment criterion on two days in 2023 driven by 'exceptional events' (related to bushfires, hazard reduction burns, or dust storms) (NSW DPE, 2024).

It is noted that neither of the AQMS identified in Table 8 measure concentrations of TSP. This pollutant is of relevance to the expected emissions from the Project site. Other sources of data have been adopted to allow representation of the TSP environment in the area surrounding the Project site, and a full discussion is provided in Appendix D.

It is noted that a number of pollutants assessed as part of this AQIA are not routinely monitored at AQMS locations in NSW including:

- PAH;
- Benzene ($C_6H_6$);
- Formaldehyde ($CH_2O$);
- Toluene ($C_7H_8$); and
- Xylene ($C_8H_{10}$).

For the purposes of this assessment, it has been assumed that background concentrations of the abovementioned pollutants are negligible. In any case, section 7 of the Approved Methods (NSW EPA, 2022) only requires the assessment of the 99.9$^{th}$ percentile incremental impacts for the pollutants outlined above.

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 9. It is noted that although impacts of ozone ($O_3$) have not been considered in this assessment, $O_3$ data have been adopted to assist in calculating the conversion of $NO_X$ to $NO_2$ for the dispersion modelling assessment (refer Section 5.2.6).

**Table 9 Summary of background air quality data used in the AQIA**

| Pollutant | Averaging period | Units | Measured value | Notes |
|---|---|---|---|---|
| Particles (as TSP) | Annual | $\mu g{\cdot}m^{-3}$ | 34.5 | 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 2023 was 44.4 $\mu g{\cdot}m^{-3}$ |
| | Annual | $\mu g{\cdot}m^{-3}$ | 16.8 | |
| Particles (as $PM_{2.5}$) | 24-hour | $\mu g{\cdot}m^{-3}$ | Daily varying | The 24-hour maximum $PM_{2.5}$ concentration in 2023 was 29.6 $\mu g{\cdot}m^{-3}$ |
| | Annual | $\mu g{\cdot}m^{-3}$ | 7.4 | |
| Nitrogen dioxide ($NO_2$) | 1-hour | $\mu g{\cdot}m^{-3}$ | Hourly varying | Hourly maximum 1-hour average in 2023 was 92.1 $\mu g{\cdot}m^{-3}$ |
| | Annual | $\mu g{\cdot}m^{-3}$ | 14.9 | Annual average in 2023 |
| Carbon monoxide (CO) | 15-minutes | $mg{\cdot}m^{-3}$ | 2.1 | Calculated from 1-hour data as per Section 5.2.7. |
| | 1-hour | $mg{\cdot}m^{-3}$ | 1.6 | Hourly maximum 1-hour average in 2023 |
| | 8-hour | $mg{\cdot}m^{-3}$ | 1.2 | Maximum 8-hour average in 2023 |
| Sulphur dioxide ($SO_2$) | 1-hour | $\mu g{\cdot}m^{-3}$ | 62.9 | Hourly maximum 1-hour average in 2023 |
| | 24-hour | $\mu g{\cdot}m^{-3}$ | 10.5 | 24-hour maximum in 2023 |

**Note**: Reference should be made to Appendix D

## 4.5. Topography

The elevation of the Project site ranges between approximately 32 m and 47 m Australian Height Datum (AHD) (refer Figure 1). The topography between the Project site and nearest sensitive receptor locations is uncomplicated (from an AQIA perspective).

Nonetheless, the influence of topography has been included in the dispersion modelling assessment as described in Section 5.2.1.3.

## 4.6. Potential for Cumulative Impacts

### 4.6.1. Review of Potential Sources of Cumulative Impact

The background air quality dataset, as described in Section 4.4 is likely to include the impact of regional sources of air pollutants (e.g. bushfires, dust storms), and sources which are local to the AQMS (e.g. commercial / industrial operations, and transport emissions). Given the separation distance between that AQMS and the Project site (approximately 6.6 km), that data may not adequately include the impacts of sources of air pollutants which are in closer proximity to the Project site. These sources may include existing, approved (but not yet operational), and proposed developments that could contribute to cumulative impacts at identified sensitive receptors.

A desktop survey has been conducted to identify nearby sources with similar emissions profiles that could contribute to cumulative impacts at sensitive receptors. The survey included a review of the National Pollutant Inventory (NPI), NSW POEO EPL, and NSW Government Major Projects registers to identify existing, recently approved, and proposed developments in proximity to the Project site.

The initial screening identified 62 facilities within the Blacktown LGA that have the potential to contribute to cumulative impacts with the Project.

To provide further context, statewide separation distance guidelines (SDGs) were reviewed to determine appropriate buffer distances between these facilities and sensitive land uses. These SDGs offer land use planning recommendations to minimise impacts on air quality by ensuring adequate separation between pollution sources and sensitive receptors. While NSW EPA does not publish SDGs, the Environment Protection Authority Victoria (EPA VIC) released SDGs for air emissions in August 2024 (EPA VIC, 2024). Where a relevant category is not covered in the EPA VIC guidelines, the ACT Environmental, Planning and Sustainable Development Directorate (EPSDD) guidelines (ACT EPSDD, 2018)) have been used, and both are considered appropriate for this desktop survey.

The identified separation distances have been used as an initial screening tool to determine which facilities may realistically contribute to potential cumulative impacts. It is noted that SDGs provide a conservative, screening-level assessment to indicate whether further, more detailed assessment may be required.

Following this review, 10 facilities have been identified as having the potential for cumulative impacts with the Project, based on applicable separation distances. These facilities are identified in Table 10 and illustrated in Figure 4 with further evaluation provided in Section 4.6.2. While some facilities' separation distance buffers do not extend to the Project site boundary, they may still impact common sensitive receptors and have been assessed accordingly. Table 10 includes the Marsden Park Data Centre and Minchinbury Community Hospital, which lack specific separation distance guidelines, but have been included due to their relevance i.e. Marsden Park Data Centre for the similar operational characteristics and Minchinbury Community Hospital for the high level of sensitivity of land uses. Their potential impacts are discussed below.

The Minchinbury Community Hospital is a private facility offering surgical, rehabilitation, and mental health services. It is currently seeking approval for an expansion that includes a new eight-story building and ancillary works. While construction activities may cause short-term air quality impacts (e.g. dust), the UK Institute of Air Quality Management (IAQM) construction dust assessment methodology (refer Section 5.1) assesses such impacts within a conservative 250 m radius of the construction site.

Operational emissions associated with the Minchinbury Community Hospital have not yet been assessed, as this project is in the early stages of planning. It is unclear whether standby diesel generators will be required to supply heat and power demand during a power outage event, but it is potentially likely that such provisions will be provided.

Given that the Project site is approximately 3 km from the Minchinbury Community Hospital, cumulative impacts from both construction and operation activities are unlikely. The developments at Minchinbury Community Hospital and the Project site are anticipated to implement mitigation measures to manage air quality risks during construction, ensuring no significant cumulative risks to surrounding sensitive areas. Although an air quality impact assessment (AQIA) is expected to be carried out to inform planning and ensure appropriate emission control measures to be applied, the distance between the Minchinbury Community Hospital and the Project site makes it unlikely to pose a cumulative air quality risk.

The Marsden Park Data Centre is seeking approval for a 504 MW data centre located approximately 4 km from the Project site. Given this distance, any cumulative air quality impacts on surrounding sensitive areas near the Project site are likely to be limited. Nonetheless, due to the nature of operations for both sites i.e. data centres, the AQIA conducted for the Marsden Park Data Centre (Todoroski Air Sciences, 2024) has been reviewed. The AQIA found that routine generator testing resulted in incremental increases of less than 0.1 µg $m^{-3}$ for 24-hour average $PM_{10}$ and $PM_{2.5}$ during annual testing, and less than 1.5 µg $m^{-3}$ during monthly testing activities. Additionally, 1-hour average $NO_2$ concentrations remained below the respective criteria at the considered receptors. These conservative scenarios assumed continuous generator operation from 9:00 am to 4:00 pm over the entire modelling year, which is an unlikely occurrence, and the closest receptor relative to the Project site is over 3.5 km away. Consequently, cumulative impacts from the Marsden Park Data Centre are unlikely during operations.

Figure 4 Air emissions sources and separation distances


**Source**: Northstar

Table 10 Facilities screened for potential cumulative air emissions impacts

| Facility Name | Location | Category | Separation distance guidelines (m) | Approximate distance (m) from Project site boundary |
|---|---|---|---|---|
| Humes Blacktown | 604 Woodstock Avenue, Rooty Hill | Concrete manufacturing | 100[(a)] | 50 |
| Rooty Hill Materials Recycling Facility | 600 Woodstock Avenue, Rooty Hill | Materials recycling | 300[(b)] | 50 |
| Rooty Hill Regional Distribution Centre | 21 Kellogg Road, Rooty Hill | Processing and distribution of construction materials. | 300[(b)] | 280 |
| InfraBuild Steel Mill | 22 Kellogg Road, Rooty Hill | Steel manufacturing including casting | 1 000[(a)] | 340 |
| Pacmetal Services | 194 Power Street, Glendenning | Metal coating | 200[(a)] | 410 |
| Independent Cement | 200 Power Street, Glendenning | Cement or lime handling | 500[(a)] | 520 |
| Cleanaway Industries Pty Ltd | 6/8 Rayben Street, Glendenning | Liquid waste facility | 500[(a)] | 920 |
| Glendenning Liquid Waste Facility | 7 Rayben Street, Glendenning | Liquid waste facility | 500[(a)] | 920 |
| Minchinbury Community Hospital | 120 Rupertswood Road, Rooty Hill | Hospital | -[(c)] | 3 035 |
| Marsden Park Data Centre | 105 & 113 Hollinsworth Road, Marsden Park | Data Centre | -[(c)] | 4 050 |

**Notes:** (a) Source (EPA VIC, 2024)

(b) Source (ACT EPSDD, 2018)

(c) No applicable separation distance provided

### 4.6.2. Assessment of Potential for Cumulative Impact

The remaining eight facilities, which have established separation distances, have been further assessed for their potential cumulative air emissions impacts with the Project site. Their locations, distances to the Project site and receptors, and the influence of prevailing wind conditions are presented in Figure 5.

As outlined in Section 2.3.2, day-to-day operational emissions from the Project site are expected to be minimal, except for potential emissions from diesel-fuelled backup generators during maintenance testing or during a power outage event. Operational emission impacts have therefore been assessed only for these scenarios.

The evaluation covers both short-term (24-hour $PM_{10}$ and $PM_{2.5}$ and 1-hour $NO_2$) and long-term (annual) impacts for $NO_2$, TSP, $PM_{10}$ and $PM_{2.5}$ for the maintenance testing scenario (Scenario 2), and short-term impacts only for the worst-case scenario (Scenario 1) i.e. when a power outage event occurs, as per the scenarios in the modelling assessment (refer Section 7). These are presented in Section 4.6.2.1 and Section 4.6.2.2 respectively.

The cumulative impact assessment considers sources that may jointly impact sensitive receptors, using conservative separation distances as buffers between facilities and sensitive land uses.

Additionally, to evaluate the potential cumulative impacts, the emission profiles of each facility were reviewed to identify overlaps in emissions between these facilities and the Project site. The review found that the identified facilities generate varying scales of emissions including $NO_2$, TSP, $PM_{10}$ and $PM_{2.5}$, which coincide with emissions of concern from the Project site, but at different operational parameters and activity rates.

Since the surrounding area around the Project site is predominantly industrial, a lower level of sensitivity would be deemed appropriate given that any relevant exposure would occur during working hours and limited occupancy across the day. Although residential areas are situated to the east and west, with the closest residential receptor sited approximately 400 m to the west, predominant north-easterly and south-westerly prevailing winds (refer Figure C5, Appendix C) occur. Correspondingly, the areas in these wind directions are most likely to experience air emission impacts. Consequently, significant annual impacts are unlikely, though short-term impacts from 1-hour $NO_2$ and 24-hour $PM_{10}$ and $PM_{2.5}$ may arise.

Figure 5 Facilities with potential for cumulative air quality impacts with the Project


**Source:** Northstar

#### 4.6.2.1. Worst-case scenario (Scenario 1)

**Assessment of short-term impacts**

To assess the potential for cumulative impacts during a power outage event, the probability of emissions being produced at the Project site has been estimated. This analysis evaluates the frequency of short-term emissions from the Project site contributing to cumulative impacts when combined with emissions from the surrounding facilities.

The probability of the data centre operating under an emergency scenario is tied to the reliability of the power feed, which is provided by the same distributor for the Greater Western Sydney region. According to the latest DAPR (Endeavour Energy, 2023)., the average unplanned outage duration per year per customer from financial-year 2013 to financial-year 2023 equates to approximately 82.0 minutes (approximately 1.4 hours), although exact duration of power outages requiring standby generators cannot be determined. Correspondingly, the probability ($p$) of power interruptions occurring is approximately 0.016% ($p$ = 0.00016) of the time per year (82.0 / (8 760 × 60)), (where $p$=0 is an impossible event and $p$=1 is a certain event).

To assess the short-term impacts during a possible power outage, the dispersion modelling results for 24-hour $PM_{10}$ and $PM_{2.5}$ impacts and 1-hour $NO_2$ impacts have been reviewed. The results indicated a number of additional exceedances of the short-term air quality criteria for $PM_{10}$, $PM_{2.5}$, and $NO_2$. However, as outlined in Section 8.2.1, this scenario assumes that all 97 no. generators would be operational at one time. The assessment of the probability of an exceedance of the relevant short-term $PM_{10}$, $PM_{2.5}$ and $NO_2$ criteria has been performed and presented in Section 7.1.4 which showed that, as a maximum across all receptors, the probability of an exceedance of the $PM_{10}$, $PM_{2.5}$ and $NO_2$ criterion in any year is as follows:

- $PM_{10}$: $p$ = 0.08;
- $PM_{2.5}$: $p$ = 0.21; and
- $NO_2$: $p$ = 0.01.

As discussed above, the probability of exceedances under the worst-case scenario is dependent on the reliability of the power transmission feed to the Project site. The review of the latest relevant power outage information indicates that on any year the probability of a power outage is to occur is approximately 0.016 % of the time per year. Correspondingly the probability of both the interruption to the power supply, and an exceedance of the relevant air quality impact assessment criteria occurring can be estimated through the multiplication of the probability of each event occurring. As outlined in Section 8.2.1, these values are incredibly small and have been placed into context by calculating the percentage that the event could occur in a number of years. These calculations are provided in Table 33, with the chance of an exceedance during a power outage in 100 years presented below.:

- $PM_{10}$: 0.12 %;
- $PM_{2.5}$: 0.32 %; and

- $NO_2$: 0.01 %.

The results indicate that the chance of an additional exceedance of the air quality criteria during a power outage is extremely low.

For this assessment, it has been assumed that the surrounding identified facilities operate 24 hours a day, seven days a week, and therefore to facilitate this assessment a probability of $p$ = 1 has been assumed. This assumption accounts for the fact that, while the operational characteristics of these facilities may vary (e.g. some are daytime-only, others are enclosed, or have different activity rates), they are either subject to regulation through the NSW EPA licensing regime and/or appropriate air quality management strategies aimed at reducing air emissions through operations. As these facilities are not directly comparable to data centres, this assumption provides a conservative basis for the assessment.

Correspondingly, the potential for cumulative impacts between the surrounding facilities and the Project site during a power outage remains the same as the probability of an additional exceedance of the air quality criteria during a power outage at the Project site, given that the probability of the surrounding facilities has been assumed to be $p$ = 1. Since the chance of an additional exceedance of the air quality criteria during a power outage is extremely low, cumulative impacts between the Project site and surrounding facilities during the power outage scenario would therefore also be considered extremely low.

### 4.6.2.2. Maintenance testing scenario (Scenario 2)

To evaluate potential cumulative impacts with surrounding facilities during maintenance testing, the total number of hours in a year when the Project site will emit air pollutants has been calculated. As detailed in Section 7.3, the Project site's maintenance testing regime totals 170 hours per year, which equates to air emissions occurring for approximately 1.9 % of the time per year (170 / 8 760).

**Assessment of short-term impacts**

To assess the short-term impacts during the maintenance testing, the dispersion modelling results for 24-hour $PM_{10}$ and $PM_{2.5}$ impacts and 1-hour $NO_2$ impacts have been reviewed. As previously discussed, the duration of a testing event is to be less than 24-hours, and as such the assessment of 24-hour average impacts would be highly conservative and unlikely to represent the cumulative impacts that may occur between the facilities and the Project site.

The dispersion modelling results showed no exceedances of the criteria for 1-hour $NO_2$ and 24-hour $PM_{10}$ concentrations at all considered receptors however it was noted that there were exceedances of the 24-hour $PM_{2.5}$ criterion at nine locations (refer Table 31). However, as outlined in Section 8.2.2, the results are viewed as conservative and the assessment of 24-hour average impacts are unlikely to represent the cumulative impacts that may occur between the facilities and the Project site, with 1-hour $NO_2$ impacts more likely to represent the air quality impacts to be experienced in the surrounding areas.

Additionally, these short-term air emissions would only be emitted for 1.9 % of the time per year. Correspondingly, emissions being produced by the Project site would be unlikely to have significant cumulative risk of air quality impacts with the identified facilities on the surrounding areas.

### Assessment of long-term impacts

As discussed above, the Project site's air emissions from maintenance testing occur for only 1.9 % of the year. Therefore, it is expected that long-term impacts of $NO_2$, TSP, $PM_{10}$ and $PM_{2.5}$ emissions from the site would be minimal, as any significant impacts would be limited to the short-term testing period.

Nevertheless, dispersion modelling results for annual average particulate matter concentrations (as TSP, $PM_{10}$ and $PM_{2.5}$) and $NO_2$ during maintenance testing have been reviewed. The predicted incremental concentrations of $NO_2$, TSP, $PM_{10}$ and $PM_{2.5}$ at all receptor locations were shown to be extremely low (less than 0.5 % of the annual average TSP, $PM_{10}$, $PM_{2.5}$ and $NO_2$ criteria) (refer Table 23 and Table 27).

Correspondingly, even though the Project site is located in a highly industrial area, the extremely low increments produced from the Project site suggest that the likelihood of the Project site causing annual average exceedances with the surrounding industrial facilities is extremely low.

# 5. APPROACH TO ASSESSMENT

This report provides a qualitative assessment of dust impacts (soiling and human health) during the construction phase, adapted from (IAQM, 2024) and a quantitative assessment aligned with (NSW EPA, 2022) for evaluating operational phase air quality impacts.

## 5.1. Construction Phase

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine-exhaust emissions from construction machinery and vehicles may also be experienced but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

Modelling of dust from construction projects is generally not considered appropriate as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly, depending upon local conditions. In lieu of a modelling assessment, the construction-phase impacts associated with the Project have been assessed using a risk-based assessment procedure. The advantage of this approach is that it determines the activities that pose the greatest risk, which allows the Construction Environmental Management Plan (CEMP) to focus controls to manage that risk appropriately and reduce the impact through proactive management.

For this risk assessment, Northstar has adapted the *Guidance on the Assessment of Dust from Demolition and Construction published by the Institute of Air Quality Management* (IAQM, 2024) in the United Kingdom. The IAQM construction phase assessment approach is commonly used for evaluating fugitive dust and particulate matter emissions from construction activities in development projects across NSW and Australia. Reference should be made to Appendix B for the methodology.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities, and to identify key activities for control as outlined in Appendix B.

## 5.2. Operational Phase

### 5.2.1. Dispersion Modelling Approach

The air emissions assessment for the operational phase of the Project has utilised quantitative dispersion modelling techniques. This section outlines the approach taken in the AQIA for the operational phase of the Project.

#### 5.2.1.1. Dispersion Model

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF Atmospheric Dispersion Model. CALPUFF is a Lagrangian Gaussian (steady-state) plume dispersion model, recognised in the Approved Methods as a widely accepted model for regulatory applications in NSW. It is used to predict pollutant concentrations from various sources typically found at industrial facilities.

The CALPUFF model uses hourly meteorological data to define conditions for plume rise, transport, diffusion, and deposition. It estimates concentrations or deposition values for each source-receptor combination on an hourly basis and calculates user-selected short-term averages. CALPUFF also accounts for local terrain, making it well-suited for modelling complex terrains, including slope flows, valley flows, terrain blocking, and kinematic effects.

Since most air quality standards are based on averages or percentiles, CALPUFF enables further analysis of results for comparison. The CALPUFF-percent post-processing utility calculates the maximum concentration of a pollutant at a specific percentile over a given period, across all receptors. This percentile approach helps omit unusual short-term meteorological events that may cause elevated concentrations, providing a more accurate representation of likely average pollutant concentrations over the averaging period.

Table 11 provides the model input configuration to assess the impact of generator emissions from the Project, in consideration of the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods (Barclay & Scire, 2011).

**Table 11 General model parameters for CALPUFF dispersion modelling**

| Model parameter | Input |
|---|---|
| Model mode | CALPUFF Refined Mode<br>CALMET No-Observations (No-Obs) Mode |
| Meteorological data | Prognostic Data (TAPM) |
| Terrain topography | SRTM3 |
| Model / Grid domain size | 5 km × 5 km × 4 km |
| Grid resolution / spacing | 0.2 km |

(Barclay & Scire, 2011) recommend using CALMET No-Obs mode for regulatory screening when good-quality gridded prognostic meteorological data are available, which has been applied in the dispersion modelling process.

Given the variable topography, the terrain radius of influence was set at 3 km, with a minimum of 0.1 km. Terrain data with a 3 arc-second resolution (approximately 90 m) were used, in consideration of (Barclay & Scire, 2011). The dispersion model was run over a large grid (10 km × 10 km) at ground level, encompassing the nearest sensitive receptors (see Section 4.2), covering all potentially impacted nearby land uses. The dispersion model was run over a large grid (5 km × 5 km) at ground level, encompassing the nearest sensitive receptors (see Section 4.2), covering all potentially impacted nearby land uses.

### 5.2.1.2. Meteorological Modelling

Section 4 of the Approved Methods requires one-year of site-specific meteorological data or site-representative meteorological data, in the absence of site-specific data, to be used for dispersion modelling.

The 3-D meteorological dataset was derived using gridded prognostic data generated from The Air Pollution Model (TAPM, v 4.0.5) as developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), in conjunction with CALMET (refer Appendix C). Section 4.5 of the Approved Methods identifies TAPM as a commonly used prognostic meteorological model in NSW.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater 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.

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

Further discussion on the meteorological model configuration and input parameters are provided in Appendix C.

### 5.2.1.3. Terrain Effects

The CALPUFF model incorporates terrain information with heights being applied to all receptors and sources. In order to account for the potential influence on pollution dispersion and varying receptor elevations across the modelling domain, a gap filled and filtered (vegetation and obstacles removed) topography file with 3 second resolution (approximately 90 m) derived from the Shuttle Radar Topography Mission (SRTM) data was obtained from Geoscience Australia and was processed for use in CALPUFF.

#### 5.2.1.4. Building Downwash

For dispersion modelling assessments, the influence of surrounding buildings on emission transport is a material consideration. Nearby buildings can create turbulence and a building wake that affect pollutant dispersion, particularly through a phenomenon known as building downwash. The ratio of stack height to building height also impacts this effect; if the stack is significantly taller than the building, downwash is minimal.

Section 5.3 of the Approved Methods outlines the following requirements for determining which buildings to consider within a dispersion modelling assessment:

> *"The location and dimensions of buildings located within a distance of 5L (where L is the lesser of the height or width of the building) from each release point for buildings with a height greater than 0.4 times the stack height…"*

The Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) uses building heights and corner locations near the stack to simulate effective dimensions. The BPIP-PRIME downwash algorithm computes these dimensions in ten-degree intervals, allowing CALPUFF to assess the impact on plume dispersion and ground-level concentrations. While simplified, this building geometry offers a reasonable estimate of how structures disrupt wind flow nearby.

Therefore, to analyse downwash effects from point sources mimicking air emissions, the buildings surrounding the Project site were incorporated into the CALPUFF model.

With reference to the requirements outlined in the Approved Methods, Figure 6 and Figure 7 illustrates the locations of the buildings included in the BPIP-PRIME model for downwash calculations, which are subsequently incorporated into the CALPUFF dispersion modelling process. Also shown are the emission discharge points for each scenario modelled (refer Section 5.2.2). Note that the modelled emission points under the regular maintenance scenario (Scenario 2) are located at all ends of the datacentre buildings, which provides confidence that the actual impacts would be accounted for under this modelled configuration.

It is noted that the BPIP-PRIME model has a number of limitations. It identifies a single influencing building/tier for 36 wind directions, and depending on the wind direction, the algorithm selects the largest of the building width or length, which effectively overrides any intricacies in the buildings which may be presented in the model. The main components are the largest of the length, width and height of the building. Even with the adoption of tiered structures, the algorithm has analytical and logical relationships that merge buildings and ultimately calculate one effective, width, length, height and position to represent all buildings relative to the stack(s).

The BPIP-PRIME algorithm has been shown in some studies to result in the overprediction of concentrations by a factor two to eight for certain building types, whilst result in underpredictions for certain building and terrain configurations (Petersen, 2017). In conclusion, the use of the BPIP-PRIME algorithm is required by the Approved Methods, although is not an advanced method, such as computational fluid dynamics, or wind tunnel modelling. Any minor disparities in building length, height, width and stack locations are most likely within the large margin of error associated with the use of the BPIP-PRIME algorithm.

Figure 6 Buildings and discharge points considered in dispersion modelling (Scenario 1)


**Source**: Northstar

Figure 7 Buildings and discharge points considered in dispersion modelling (Scenario 2)


**Source**: Northstar

### 5.2.2. Modelling Scenarios

The following modelling scenarios have been completed to determine the potential impact under the anticipated operational conditions of the emergency standby generators.

- **Scenario 1 – justified worst case scenario** – Operating all 97 no. generators at 100 % load at the Project site.
  - This is an unlikely scenario which would result from an unexpected power outage event. However, given that the Project includes up to 97 no. generators, this AQIA has assessed the potential impact of those generators operating concurrently.
  - In reality, a component of the installed capacity of 97 no. generators is provided as design redundancy, and a full load would be equivalent to *typically* 80 % of the installed capacity. As such the AQIA is highly conservative in this assumption that all generators would be operating with no redundancy factored in.
  - Each generator has been modelled as operating for all 8 760 hours of the year. Should such a power outage event occur, this is likely to be for a period of 10 to 15 minutes, and therefore the modelling presents a conservative assessment of the potential impacts.
  - Given that the likely duration of operation of the back-up generators would be short-term in nature, only assessment of impacts against short-term criteria has been performed, and no assessment against annual average criteria is presented, as the results would be essentially meaningless.
  - This AQIA provides context around how likely any exceedances of air quality criteria would be, given the likelihood of such catastrophic failure.

- **Scenario 2 - realistic operations (maintenance testing)** – The on-duty standby generators would undergo routine maintenance and testing to ensure they would be operational if required during a power outage. Routine maintenance follows a prescribed testing regime as outlined in Section 2.3.2. For the Project, it is anticipated that up to 20 no. generators would be tested concurrently at any one time under 'no-load', and up to 3 no. generator to be tested under 100% load.
- Notwithstanding the above, the dispersion modelling for this maintenance testing scenario has assessed the potential impacts of 20 no. generators operating at 100 % load for each operating hour between the hours of 7:00 am and 6:00 pm, and 1 no. generator operating at 100 % load for each operating hour between the hours of 6:00 pm and 10:00 pm. This scenario has been modelled to be consistent with that assessed in the acoustic assessment.
  - The back-up generators being tested under this modelled scenario have been assumed to be distributed across the three datacentre buildings. The exhaust flues associated with the generators modelled to be tested at one time are shown in Figure 7. This is considered to

represent an appropriate approximation of potential maximum impacts on surrounding sensitive receptors.

- Comparison of impacts against short- and longer-term criteria is performed, with concentrations predicted based on all 20 no. generators being tested for all hours between 7:00 am and 6:00 pm, and 1 no. generator between the hours of 6:00 pm and 10:00 pm on each and every day of the year. This is highly conservative and not likely to occur in reality. Further discussion is provided in Section 8.2.2.
- This modelled testing regime has been informed by the findings of the acoustic assessment for the Project, which indicated that this testing program can be performed to result in compliance with the relevant noise criteria at surrounding locations. The acoustic assessment indicated that no generator testing could be performed during nighttime hours (i.e. 10:00 pm to 7:00 am), and therefore the air quality assessment has been performed to reflect that conclusion.

### 5.2.3. Generator Emission Rates and Source Characteristics

As previously described, the specific make and model of generators to be included as part of the Project have not yet been selected, although two candidate generator specifications have been provided. To ensure that the worst-case impacts associated with the choice of either generator are presented within this AQIA, the most conservative parameters from each option (CAT 3516E or MTI 20V4000 G94F) have been selected for use in the quantitative assessment.

The lowest emission velocity and emission temperature from the two generators has been adopted, and the highest of the calculated emission rates from each generator have been selected for dispersion modelling. For clarity, the modelled impacts do not reflect the impacts anticipated from either generator but reflect the worst-case components of both. In this regard, the results can be viewed as conservative.

A summary of the standby generator stack design components used to model each scenario is provided in Table 12. Details of the technical specifications for the standby generators are provided in Appendix E.

The values adopted in the dispersion modelling assessment are highlighted.

The locations of the modelled emissions sources at the Project site under Scenario 1 and Scenario 2 are illustrated in Figure 6 and Figure 7 (refer Section 5.2.1.4).

Table 12 Back-up generator emissions and stack parameters

| Parameter | Units | Scenario 1 (Justified worst case) | | Scenario 2 (Realistic case) | |
|---|---|---|---|---|---|
| | | Emergency operations | | Maintenance testing | |
| Hour start | Hr | 00:00 | | 07:00 | |
| Hour end | Hr | 24:00 | | 18:00 (20 no generators) or 20:00 (1 no. generator) | |
| % load | % | 100 | | 100 | |
| **Emergency generator model** | | **OPTION 1 MTU 20V4000 G94F** | **OPTION 2 CAT 3516E** | **OPTION 1 MTU 20V4000G94F** | **OPTION 2 CAT 3516E** |
| Number of generators active | no. | 97 | 97 | 20 | 20 |
| Diesel consumption rate (per gen) | L·hr$^{-1}$ | 756 | 750.9 | 756 | 750.9 |
| Power | kW | 3 090 | 2 800 | 3 090 | 2 800 |
| Stack height[g] | m AGL | 44.2 or 43.3 | 44.2 or 43.3 | 44.2 or 43.3 | 44.2 or 43.3 |
| Stack diameter | mm | 600 | 600 | 600 | 600 |
| Stack CSA | m$^2$ | 0.283 | 0.283 | 0.283 | 0.283 |
| Actual discharge rate | Am$^3$·s$^{-1}$ | 11.1 | 10.7 | 11.1 | 10.7 |
| Exit temperature | °C | 550 | 491 | 550 | 491 |
| Exit velocity | m·s$^{-1}$ | 39.3 | 37.7 | 39.3 | 37.7 |
| **Generator emission specification** | | | | | |
| $NO_X$ | g·kWh$^{-1}$ | 6.46 | 6.32[f] | 6.46 | 6.32[f] |
| CO | g·kWh$^{-1}$ | 0.23 | 1.37[f] | 0.23 | 1.37[f] |
| TVOC | g·kWh$^{-1}$ | 0.07 | 0.09[f] | 0.07 | 0.09[f] |
| PM | g·kWh$^{-1}$ | 0.019 | 0.09[f] | 0.019 | 0.09[f] |
| $SO_2$ | g·kWh$^{-1}$ | 0.003 | - | 0.003 | - |

| Parameter | Units | Scenario 1 (Justified worst case) | | Scenario 2 (Realistic case) | |
|---|---|---|---|---|---|
| | | Emergency operations | | Maintenance testing | |
| **Pollutant emission rates** | | | | | |
| $NO_x$ (a) | $g \cdot s^{-1}$ | 5.54E+00 | 4.91E+00 | 5.54E+00 | 4.91E+00 |
| CO (a) | $g \cdot s^{-1}$ | 1.97E-01 | 1.06E-01 | 1.97E-01 | 1.06E-01 |
| TVOC (a) | $g \cdot s^{-1}$ | 6.01E-02 | 7.30E-02 | 6.01E-02 | 7.30E-02 |
| PM ($PM_{10}$ and $PM_{2.5}$) (a)(d) | $g \cdot s^{-1}$ | 1.63E-02 | 7.30E-02 | 1.63E-02 | 7.30E-02 |
| $SO_2$ | $g \cdot s^{-1}$ | 2.58E-03 | 1.74E-06 (C) | 2.58E-03 | 1.74E-06 (C) |
| Benzene (b) | $g \cdot s^{-1}$ | 5.83E-04 | 7.08E-04 | 5.83E-04 | 7.08E-04 |
| Toluene (b) | $g \cdot s^{-1}$ | 2.10E-04 | 2.56E-04 | 2.10E-04 | 2.56E-04 |
| Xylene (b) | $g \cdot s^{-1}$ | 1.47E-04 | 1.78E-04 | 1.47E-04 | 1.78E-04 |
| PAH emission(b) | $g \cdot s^{-1}$ | 8.56E-09 | 1.05E-08 | 8.56E-09 | 1.05E-08 |
| Formaldehyde emission(b) | $g \cdot s^{-1}$ | 5.92E-05 | 7.19E-05 | 5.92E-05 | 7.19E-05 |

**Notes**: (a): Emission rates based on values contained in technical specifications (refer Appendix E).

(b): Emission rates based on emission factors from Table 43 of (NPI, 2008). See Section 5.2.4.

(c): Based on sulphur content of fuel.

(d): 100 % of PM is emitted as $PM_{2.5}$, and $PM_{2.5}$ = $PM_{10}$.

(e) Both assessment scenarios assume that each and every back-up generator assessed within the scenario is operating at 100 % load, consistent with the emission data within the technical specifications presented in Appendix E.

(f) Converted from $g \cdot hp\text{-}h^{-1}$

(g) Stack height dependent on location – taken from plans

### 5.2.4. Speciated VOCs

The technical specification documents presented in Appendix E presents data for total VOCs, which includes a range of speciated VOCs. To appropriately factor the emissions for benzene, toluene and xylene, reference has been made to the emission factors (EF) presented in table 43 of (NPI, 2008) which relate to stationary large (more than 450 kW) diesel engines and fuel consumption rates of between 513.3 $L \cdot hr^{-1}$ and 256.0 $L \cdot hr^{-1}$ respectively.

The emission factors for TVOC and the respective speciated VOCs have been factored to calculate the mass fractions of those species within TVOC. Table 13 presents the speciated VOC fraction assumptions that are used for this assessment. The impacts of odorants (toluene ($C_7H_8$) and xylene($C_8H_{10}$)) have been similarly assessed on a *pro-rata* basis as a fraction of TVOC as published in the NPI (NPI, 2008) multiplied by the measured source-specific TVOC emission rate. As indicated in Table 12, the emission rates adopted in this AQIA are the maximum of the candidate generators, which are highlighted for clarity.

**Table 13 Speciated VOC fractions**

| Substance | EF % (of TVOC) (NPI, 2008) | EF $g \cdot s^{-1}$ | |
|---|---|---|---|
| | | MTU 20V4000G94F | CAT 3516E |
| TVOC | 100 % | 6.01E-02 | 7.30E-02 |
| Benzene | 0.97 % | 5.83E-04 | 7.08E-04 |
| Toluene (odour) | 0.35 % | 2.10E-04 | 2.56E-04 |
| Xylene (odour) | 0.24 % | 1.47E-04 | 1.78E-05 |

### 5.2.5. Particle Size Fractions

In regard to particulates from diesel combustion, a large proportion of diesel particles are less than 1 µm in diameter (i.e. $PM_1$) and consequently particulates from diesel combustion are assessed as $PM_{2.5}$. In this AQIA, the emission rate of $PM_{2.5}$ will be numerically identical to $PM_{10}$, as all of the $PM_{10}$ particles are assessed as being ≤ 2.5 µm in diameter ($PM_{2.5}$).

### 5.2.6. $NO_x$ 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 is necessary to appropriately assess potential $NO_2$ impacts.

$NO_X$ from a combustion process will be emitted as NO and $NO_2$. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions with atmospheric ozone ($O_3$) 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 need to account for the conversion of NO to $NO_2$ to enable a comparison against the air quality criteria for $NO_2$. The Approved Methods outlines various methods of assessment, which range from the simple to the more detailed (NSW EPA, 2022). The three methods outlined in the Approved Methods are briefly outlined below:

- **Method 1 - 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.
- **Method 2 - 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.
- **Method 3 – NO to $NO_2$ conversion using empirical relationship**: an empirical relationship between NO and $NO_2$ may be used to derive 'steady state' relationships. A relationship has been developed by (Janssen, Van Wakeren, Van Duuren, & Elshout, 1988) associated with power plant plumes.

Section 8.1 of the Approved Methods (NSW EPA, 2022) outlines the approach to $NO_2$ assessment, which clearly indicates that each stage should be performed sequentially. That is, Method 1, Level 1 should be performed first and *'if the impact assessment criteria are exceeded, a more refined assessment should be undertaken and/or additional management practices or emission controls applied'* (NSW EPA, 2022).

If exceedances are predicted, then Method 1, Level 2 should be performed, with the same assessment of the potential for exceedance of the 1-hour $NO_2$ criterion applied. The process then continues through Method 2 (Level 1 and Level 2), and Method 3 (Level 1 and Level 2).

This AQIA utilises Method 3 to approximate the conversion of $NO_X$ to $NO_2$, in accordance with the empirical equation described in (NSW EPA, 2022):

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

Where:

$x$ = distance from the source

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

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. Results are presented in Section 7.1.2 and Section 7.2.3 for the maximum predicted incremental $NO_X/NO_2$ concentration and the maximum predicted cumulative $NO_2$ concentration using the relevant $NO_X/NO_2$ conversion method(s)..

### 5.2.7. Short Term Pollutant Concentrations

With reference to criteria air pollutants with sub-hourly criteria (CO, refer Section 3.3), hourly dispersion model outputs have been adjusted using the following Power Law adjustment[4]:

$$C_{p,t} = C_{p,60}\left[\frac{60}{t}\right]^{0.2}$$

Where:

$C_{p,t}$ = concentration of pollutant ($p$) at averaging time (mins) ($t$)

$C_{p,60}$ = concentration of pollutant ($p$) at averaging time (60 mins)

$t$ = time (mins)

[4] http://www.epa.vic.gov.au/~/media/Publications/1551.pdf

# 6. CONSTRUCTION PHASE RISK ASSESSMENT

Northstar have adapted the methodology from the IAQM construction dust guidance (IAQM, 2024) to assess construction phase risk. This approach employed a six-step process to evaluate the risks associated with dust impact from construction activities (refer Appendix B). It considers receptor sensitivity and potential impact magnitude to identify key control measures, as detailed in Section 5.1.

## 6.1. Risk (Pre-Mitigation)

Given the sensitivity of the identified receptors is classified as medium for dust soiling, and low for health impacts, and the dust emission magnitudes for the various construction phase activities as presented in Appendix B, the resulting risk of air quality impacts (without mitigation) is as presented in Table 14. Note dust emission magnitudes are presented for all stages of the Project.

As outlined in Section 2.2, demolition works have not been considered within this Project.

**Table 14 Risk of air quality impacts from construction activities**

| Sensitivity of area | Dust emission magnitude | | | | | Preliminary risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Demolition | Earthworks | Construction | Track-out | Const. traffic | Demolition | Earthworks | Construction | Track-out | Const. traffic |
| **Stage 1** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Med. | Large | Med. | Large | N/A | Med. | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Med. | Large | Med. | Large | N/A | Low | Low | Low | Low |
| **Stage 2** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Small | Large | Med. | Large | N/A | Low | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Small | Large | Med. | Large | N/A | Neg. | Low | Low | Low |
| **Stage 3** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Med. | Large | Med. | Large | N/A | Med. | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Med. | Large | Med. | Large | N/A | Low | Low | Low | Low |

**Note**: Med. = Medium, Neg. = Negligible

The risks summarised in Table 14 show that Stage 1 and Stage 3 are assessed as having the highest risks, with dust soiling impacts associated with medium risks for other construction phase activities while human health impacts are associated with low risks for other activities.

Although it would be possible to apply low and medium risk mitigation measures during Stage 2 of the construction phase of the Project, (refer Table 14), the application of a consistent set of controls across the entire Project site is preferable operationally, as it would ensure the CEMP is more easily adopted and followed by contractors.

Consequently, the mitigation measures presented in Appendix B are commensurate with the risks associated for Stage 1 and Stage 3 of the Project and are recommended to be applied during all construction stages to ensure construction dust will be adequately managed.

## 6.2. Risk (Post-Mitigation)

The adapted methodology emphasises the aim of preventing significant effects on receptors during construction activities through the implementation of effective mitigation measures. Experience demonstrates that achieving this goal is feasible. Considering the size of the Project site, the distance to sensitive receptors, and the nature of activities involved, residual impacts related to fugitive dust emissions from the Project are expected to be 'negligible' if the mitigation measures outlined in Appendix B are implemented appropriately.

Note that, as discussed above, mitigation measures associated with Stage 1 dust emission magnitudes are presented to ensure construction dust will be managed in an adequate manner and thus these measures are recommended to be adopted during all three construction stages (refer Appendix B).

# 7. OPERATIONAL PHASE 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 as a result of the operation of the Project in isolation.
- **Cumulative impact** – relates to the incremental concentrations predicted as a result of the operation of the Project PLUS the 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 facility 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 |
|---|---|---|

## 7.1. Scenario 1 – Justified Worst-Case

The following presents the results of the modelling assessment under the assumptions of Scenario 1 (refer Section 5.2.2), with all 97 no. stand-by generators operating at 100 % load and consideration of the background pollutant concentrations (refer Section 4.4), where appropriate.

Results are presented in this section for short term criteria only (i.e. ≤ 24 hours).

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of back-up generators for an entire 24-hour period).

**Note:** The assessment against annual average criteria is essentially meaningless, given that the generators would only be operational for a small number of hours, during the justified worst-case scenario. Operation of those generators over an entire year would not occur.

Assessment of potential impacts against annual average criteria is presented under Scenario 2 (realistic operations).

### 7.1.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter ($PM_{10}$ and $PM_{2.5}$) associated with Scenario 1. The averaging periods associated with the criteria for these pollutants is 24-hour as specified in Table 4 The emissions adopted for Scenario 1 reflect the operational profile of the Project over that averaging period (refer Section 5.2.2).

#### 7.1.1.1. Maximum 24-Hour $PM_{10}$ and $PM_{2.5}$

Table 15 presents the maximum 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the assumptions under Scenario 1. No background concentrations are included within this table.

**Table 15 Predicted maximum incremental 24-hour $PM_{10}$ and $PM_{2.5}$ concentrations – Scenario 1**

| Receptor | Maximum incremental 24-hour average concentration (µg·m$^{-3}$) | |
|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ |
| Criterion | 50 | 25 |
| Max. % of criterion | 116.1 | 232.2 |
| R1 | 24.4 | 24.4 |
| R2 | 22.3 | 22.3 |
| R3 | 20.8 | 20.8 |
| R4 | 31.7 | 31.7 |
| R5 | 21.2 | 21.2 |
| R6 | 23.4 | 23.4 |
| R7 | 20.8 | 20.8 |
| R8 | 21.4 | 21.4 |
| R9 | 35.8 | 35.8 |
| R10 | 58.1 | 58.1 |
| R11 | 38.9 | 38.9 |
| R12 | 34.5 | 34.5 |
| R13 | 28.5 | 28.5 |
| R14 | 13.3 | 13.3 |
| R15 | 7.3 | 7.3 |
| R16 | 8.9 | 8.9 |
| R17 | 7.1 | 7.1 |
| R18 | 8.0 | 8.0 |
| R19 | 8.5 | 8.5 |
| R20 | 11.5 | 11.5 |
| R21 | 11.5 | 11.5 |
| R22 | 13.9 | 13.9 |
| R23 | 29.1 | 29.1 |

| Receptor | Maximum incremental 24-hour average concentration ($\mu g \cdot m^{-3}$) | |
|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ |
| R24 | 23.3 | 23.3 |
| R25 | 24.2 | 24.2 |
| R26 | 19.2 | 19.2 |
| R27 | 25.9 | 25.9 |
| R28 | 33.7 | 33.7 |
| R29 | 22.8 | 22.8 |
| R30 | 25.0 | 25.0 |
| R31 | 23.9 | 23.9 |
| R32 | 28.7 | 28.7 |
| R33 | 9.8 | 9.8 |

**Note**: All PM is assumed to be < 1 µm in diameter, and therefore assessed as $PM_{2.5}$. In this instance, emissions of $PM_{2.5}$ will be the same as $PM_{10}$ ($PM_{2.5}$ is a subset of $PM_{10}$) and therefore the results will be consistent between $PM_{10}$ and $PM_{2.5}$.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. reflective of the operation of back-up generators for an entire 24-hour period).

Table 15 indicates that the highest 24-hour average $PM_{10}$ and $PM_{2.5}$ incremental concentrations related to the Project are predicted at receptor R10.

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 monitored background concentration, in accordance with Section 11.2.3(b) of the Approved Methods (NSW EPA, 2022).

Table 16 and Table 17 present the predicted maximum 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations resulting from the operation of the Project through Scenario 1, with the corresponding background included for each day.

Results are presented in Table 16 and Table 17 for those receptors at which the greatest impacts have been predicted (see Table 15).

The left side of the tables show the predicted maximum cumulative impacts (typically the days with the highest regional background), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations respectively.

Table 16 Summary of contemporaneous 24-hour $PM_{10}$ concentrations – Scenario 1

| Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | | Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | |
|---|---|---|---|---|---|---|---|
| | Incr. | Bkg. | Cumul. | | Incr. | Bkg. | Cumul. |
| 19/09/2023 | 58.1 | 20.8 | 78.9 | 19/09/2023 | 58.1 | 20.8 | 78.9 |
| 3/10/2023 | 49.4 | 25.8 | 75.2 | 3/10/2023 | 49.4 | 25.8 | 75.2 |
| 9/12/2023 | 39.6 | 30.6 | 70.2 | 28/04/2023 | 47.9 | 16.3 | 64.2 |
| 19/12/2023 | 24.0 | 44.4 | 68.4 | 29/10/2023 | 43.7 | 12.1 | 55.8 |
| 19/03/2023 | 35.0 | 31.3 | 66.3 | 11/11/2023 | 41.2 | 15.9 | 57.1 |
| 28/04/2023 | 47.9 | 16.3 | 64.2 | 5/12/2023 | 40.6 | 18.6 | 59.2 |
| 11/02/2023 | 37.1 | 26.1 | 63.2 | 5/03/2023 | 39.9 | 14.0 | 53.9 |
| 4/08/2023 | 33.5 | 27.7 | 61.2 | 9/12/2023 | 39.6 | 30.6 | 70.2 |
| 8/12/2023 | 33.5 | 27.5 | 61.0 | 11/02/2023 | 37.1 | 26.1 | 63.2 |
| 13/12/2023 | 35.9 | 24.5 | 60.4 | 15/04/2023 | 36.4 | 10.2 | 46.6 |
| These data represent the highest Cumulative Impact 24-hour $PM_{10}$ predictions (outlined in red) as a result of the operation of the Project | | | | These data represent the highest Incremental Impact 24-hour $PM_{10}$ predictions (outlined in blue) as a result of the operation of the Project. | | | |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 17 Summary of contemporaneous 24-hour $PM_{2.5}$ concentrations – Scenario 1

| Date | 24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | | Date | 24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | |
|---|---|---|---|---|---|---|---|
| | Incr. | Bkg. | Cumul. | | Incr. | Bkg. | Cumul. |
| 19/09/2023 | 58.1 | 10.2 | 68.3 | 19/09/2023 | 58.1 | 10.2 | 68.3 |
| 3/10/2023 | 49.4 | 9.2 | 58.6 | 3/10/2023 | 49.4 | 9.2 | 58.6 |
| 9/12/2023 | 39.6 | 15.4 | 55.0 | 28/04/2023 | 47.9 | 7.0 | 54.9 |
| 28/04/2023 | 47.9 | 7.0 | 54.9 | 29/10/2023 | 43.7 | 5.0 | 48.7 |
| 14/09/2023 | 20.9 | 29.6 | 50.5 | 11/11/2023 | 41.2 | 8.3 | 49.5 |
| 4/08/2023 | 33.5 | 16.6 | 50.1 | 5/12/2023 | 40.6 | 6.5 | 47.1 |
| 11/11/2023 | 41.2 | 8.3 | 49.5 | 5/03/2023 | 39.9 | 2.8 | 42.7 |
| 15/09/2023 | 28.4 | 20.8 | 49.2 | 9/12/2023 | 39.6 | 15.4 | 55.0 |
| 11/02/2023 | 37.1 | 12.0 | 49.1 | 11/02/2023 | 37.1 | 12.0 | 49.1 |
| 7/09/2023 | 32.7 | 16.0 | 48.7 | 15/04/2023 | 36.4 | 5.7 | 42.1 |
| These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Project. | | | | These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Project. | | | |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. reflective of the operation of back-up generators for an entire 24-hour period).

For $PM_{10}$ the maximum cumulative impact (the left-hand side of Table 16) and the maximum incremental impact (the right-hand side of Table 16) is predicted at receptor R10.

Table 16 highlights that exceedances associated with the highest cumulative impacts are mostly driven by the addition of incremental impacts to background concentrations, however some exceedances are due to elevated background air quality concentrations. Note that whilst the background air quality concentrations in Table 16 are not in exceedance of the $PM_{10}$ criterion, a number of them are greater than 60 % of the criterion, thus with the addition of the incremental impacts, they result in cumulative impact exceedances.

For $PM_{2.5}$, the maximum cumulative impact (the left-hand side of Table 17) and the maximum incremental impact (the right-hand side of Table 17) is predicted at receptor R10.

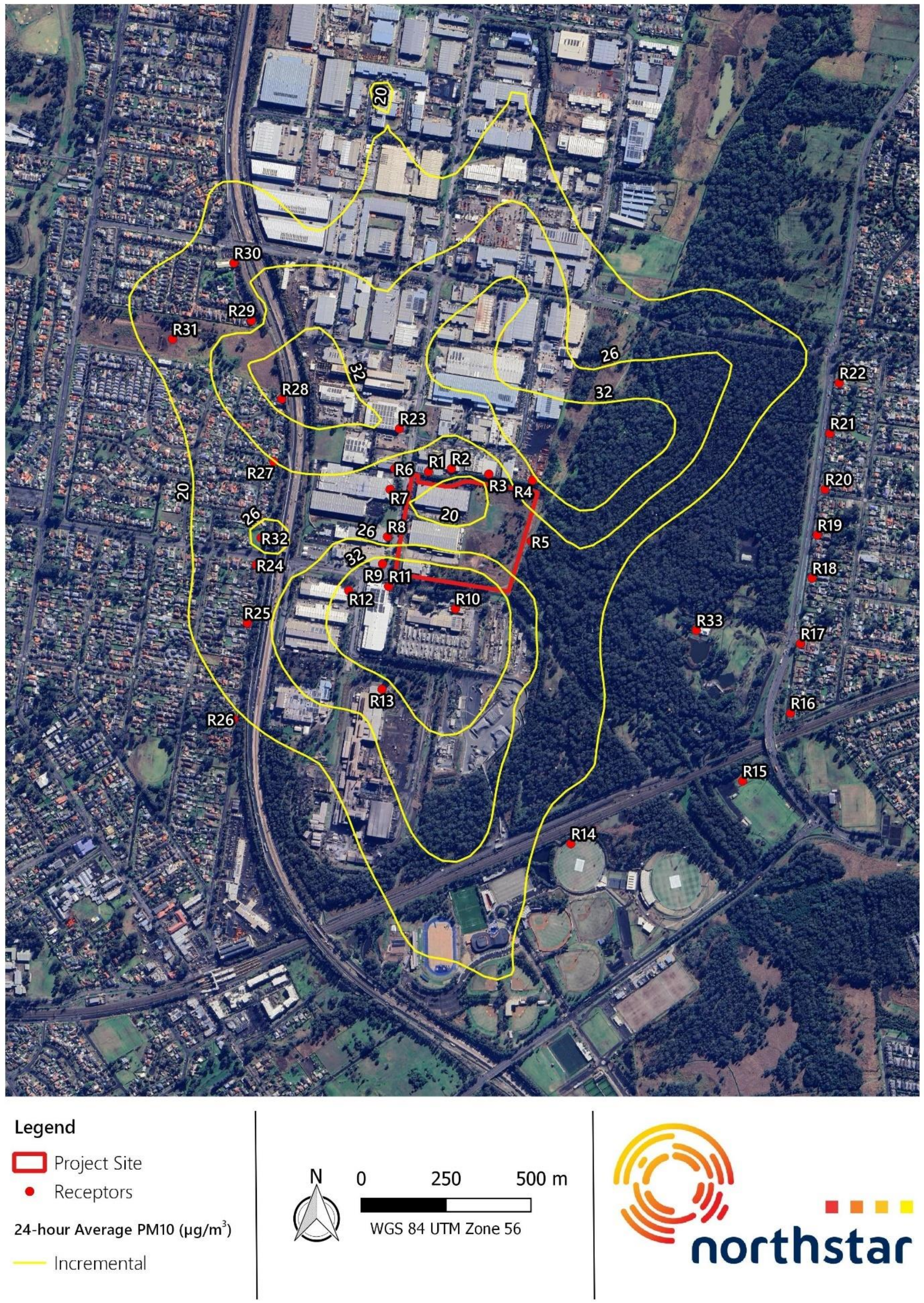
Table 17 indicates that exceedances associated with the highest cumulative impacts are again mostly driven by the addition of incremental impacts to the background concentrations. One exceedance is noted to be due to an elevated background air quality concentration of 29.6 $\mu g \cdot m^{-3}$. There is currently no published NSW Air Quality Compliance Report for 2023, however the NSW annual air quality statement for 2023 (NSW DPE, 2024) notes that the Prospect AQMS measured two exceedances of the 24-hour $PM_{2.5}$ criterion in 2023, both due to exceptional events (events related to bushfires, hazard reduction burns and continental-scale dust storms). It is additionally noted that in NSW, exceedances due to exceptional events are not counted towards the NEPM goal of 'no days exceeding the particle standards in a year'.

Contour plots of the predicted incremental 24-hour $PM_{10}$ concentrations associated with the Project are presented in Figure 8 to allow examination of the distribution of particulate matter in the area surrounding the Project.

The number of additional exceedances of the 24-hour $PM_{10}$ and $PM_{2.5}$ criteria predicted at various receptors resulting from emergency generator operation is presented in Section 7.1.4.

Further analysis and interpretation of the above predictions are discussed in Section 8.2.

Figure 8 Predicted maximum incremental 24-hour $PM_{10}$ impacts – Scenario 1




Source: Northstar

### 7.1.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide ($NO_2$) under the assumptions of Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for $NO_2$ is 1-hour as specified in Table 4. Note that impacts have not been compared with the annual average criterion for $NO_2$ as the generators would not be operating for an entire year, and the results would be meaningless.

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. Within this assessment, the Janssen method (Method 3) has been adopted as outlined in Section 5.2.6.

The predicted maximum 1-hour average $NO_2$ concentrations resulting from the Project operations under Scenario 1 are presented in Table 18.

**Table 18 Predicted 1-hour $NO_2$ concentrations – Scenario 1**

| Receptor | Nitrogen dioxide ($NO_2$) concentration ($\mu g \cdot m^{-3}$) | | |
|---|---|---|---|
| | 1-hour average | | |
| | Incr. | Bkg. | Cumul. |
| Criterion | 164 | | |
| Max % of criterion | 236.2 | 29.8 | 243.4 |
| R1 | 37.6 | 15.0 | 52.7 |
| R2 | 65.9 | 15.0 | 81.0 |
| R3 | 30.1 | 5.6 | 35.8 |
| R4 | 46.0 | 20.7 | 66.7 |
| R5 | 34.3 | 1.9 | 36.2 |
| R6 | 87.0 | 5.6 | 92.7 |
| R7 | 86.5 | 5.6 | 92.1 |
| R8 | 70.4 | 1.9 | 72.3 |
| R9 | 107.5 | 1.9 | 109.4 |
| R10 | 194.9 | 3.8 | 198.7 |
| R11 | 119.2 | 11.3 | 130.5 |
| R12 | 169.7 | 3.8 | 173.4 |
| R13 | 321.1 | < 0.1 | 319.2 |
| R14 | 224.9 | 15.0 | 239.9 |
| R15 | 171.3 | 28.2 | 199.5 |
| R16 | 225.2 | 9.4 | 234.6 |
| R17 | 277.4 | 37.6 | 315.0 |
| R18 | 289.1 | 37.6 | 326.7 |
| R19 | 279.1 | 15.0 | 294.1 |
| R20 | 310.9 | 48.9 | 359.7 |
| R21 | 350.3 | 48.9 | 399.2 |

| Receptor | Nitrogen dioxide ($NO_2$) concentration (µg·m$^{-3}$) | | |
|---|---|---|---|
| | 1-hour average | | |
| | Incr. | Bkg. | Cumul. |
| R22 | 295.5 | < 0.1 | 295.5 |
| R23 | 123.5 | 3.8 | 127.3 |
| R24 | 241.4 | < 0.1 | 241.4 |
| R25 | 315.6 | 13.2 | 328.7 |
| R26 | 281.9 | 9.4 | 291.3 |
| R27 | 201.9 | 7.5 | 209.5 |
| R28 | 239.2 | 1.9 | 241.1 |
| R29 | 377.9 | 1.9 | 379.8 |
| R30 | 387.3 | 1.9 | 389.2 |
| R31 | 310.5 | 11.3 | 321.8 |
| R32 | 242.4 | < 0.1 | 242.4 |
| R33 | 251.1 | 37.6 | 288.7 |

**Notes**: Incr. – Incremental, Bkg. – Background, Cumul. – Cumulative.

The results indicate that there are a number of exceedances associated with cumulative concentrations of $NO_2$ under Scenario 1.

A contour plot of the predicted maximum 1-hour incremental $NO_2$ impact is presented in Figure 9.

The number of additional exceedances of the 1-hour $NO_2$ criterion predicted at each receptor resulting from emergency generator operation is presented in Section 7.1.4. These values are discussed further in Section 8.2.

Figure 9 Predicted maximum incremental 1-hour $NO_2$ impacts – Scenario 1


**Source:** Northstar

### 7.1.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Scenario 1 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 19 to Table 21 are the predicted concentrations of CO, $SO_2$, PAHs, VOCs and formaldehyde at varying averaging periods (≤ 24 hours) at the surrounding receptors.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. reflective of the operation of back-up generators for an entire 24-hour period).

The predicted cumulative concentrations for CO are below the relevant criteria for all averaging periods at all receptors as shown in Table 19.

The results presented in Table 20 indicate that predicted incremental impacts of $SO_2$ at all receptors are less than 4 % of the relevant criteria for all averaging periods. The addition of background concentrations does not result in any exceedances at any receptor.

Results presented in Table 21 show no exceedances of the 1-hour criteria for benzene are predicted at any identified receptors. The maximum predicted impact for benzene is experienced at receptor R4 (5.1 % of the relevant criterion).

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 10.

Table 19 Predicted 15-minutes, 1-hour and 8-hour average CO concentrations – Scenario 1

| Receptor | Carbon monoxide (CO) concentration ($mg \cdot m^{-3}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15-minute | | | 1-hour | | | 8-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| Criterion | 100 | | | 30 | | | 10 | | |
| Max. % of criterion | <0.1 | 16.5 | 16.6 | <0.1 | 41.7 | 41.8 | <0.1 | 64.0 | 64.5 |
| R1 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R2 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R3 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R4 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R5 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R6 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R7 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R8 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R9 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R10 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R11 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R12 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R13 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R14 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R15 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R16 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R17 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R18 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R19 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R20 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R21 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |

| Receptor | Carbon monoxide (CO) concentration (mg·m$^{-3}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15-minute | | | 1-hour | | | 8-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| R22 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R23 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R24 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R25 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R26 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R27 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R28 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R29 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R30 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R31 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R32 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R33 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 20 Predicted 1-hour and 24-hour $SO_2$ concentrations – Scenario 1

| Receptor | Sulphur dioxide ($SO_2$) concentration (µg·m$^{-3}$) | | | | | |
|---|---|---|---|---|---|---|
| | 1-hour | | | 24-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| Criterion | 286 | | | 57 | | |
| Max. % of criterion | 1.6 | 34.0 | 35.6 | 3.3 | 27.5 | 30.8 |
| R1 | 3.2 | 97.2 | 100.4 | 0.8 | 15.7 | 16.5 |
| R2 | 3.3 | 97.2 | 100.5 | 0.7 | 15.7 | 16.4 |
| R3 | 3.3 | 97.2 | 100.5 | 0.7 | 15.7 | 16.4 |
| R4 | 4.5 | 97.2 | 101.7 | 1.0 | 15.7 | 16.7 |
| R5 | 3.5 | 97.2 | 100.7 | 0.7 | 15.7 | 16.4 |
| R6 | 3.7 | 97.2 | 100.9 | 0.7 | 15.7 | 16.4 |
| R7 | 3.2 | 97.2 | 100.4 | 0.7 | 15.7 | 16.4 |
| R8 | 3.5 | 97.2 | 100.7 | 0.7 | 15.7 | 16.4 |
| R9 | 3.9 | 97.2 | 101.1 | 1.1 | 15.7 | 16.8 |
| R10 | 3.6 | 97.2 | 100.8 | 1.9 | 15.7 | 17.6 |
| R11 | 3.2 | 97.2 | 100.4 | 1.2 | 15.7 | 16.9 |
| R12 | 2.4 | 97.2 | 99.6 | 1.1 | 15.7 | 16.8 |
| R13 | 2.6 | 97.2 | 99.8 | 0.9 | 15.7 | 16.6 |
| R14 | 1.8 | 97.2 | 99.0 | 0.4 | 15.7 | 16.1 |
| R15 | 1.3 | 97.2 | 98.5 | 0.2 | 15.7 | 15.9 |
| R16 | 1.7 | 97.2 | 98.9 | 0.3 | 15.7 | 16.0 |
| R17 | 2.2 | 97.2 | 99.4 | 0.2 | 15.7 | 15.9 |
| R18 | 2.5 | 97.2 | 99.7 | 0.3 | 15.7 | 16.0 |
| R19 | 2.6 | 97.2 | 99.8 | 0.3 | 15.7 | 16.0 |
| R20 | 2.4 | 97.2 | 99.6 | 0.4 | 15.7 | 16.1 |
| R21 | 2.7 | 97.2 | 99.9 | 0.4 | 15.7 | 16.1 |
| R22 | 2.3 | 97.2 | 99.5 | 0.4 | 15.7 | 16.1 |
| R23 | 2.7 | 97.2 | 99.9 | 0.9 | 15.7 | 16.6 |
| R24 | 2.0 | 97.2 | 99.2 | 0.7 | 15.7 | 16.4 |
| R25 | 2.2 | 97.2 | 99.4 | 0.8 | 15.7 | 16.5 |
| R26 | 2.0 | 97.2 | 99.2 | 0.6 | 15.7 | 16.3 |
| R27 | 2.3 | 97.2 | 99.5 | 0.8 | 15.7 | 16.5 |
| R28 | 2.1 | 97.2 | 99.3 | 1.1 | 15.7 | 16.8 |
| R29 | 2.4 | 97.2 | 99.6 | 0.7 | 15.7 | 16.4 |
| R30 | 2.3 | 97.2 | 99.5 | 0.8 | 15.7 | 16.5 |
| R31 | 1.8 | 97.2 | 99.0 | 0.8 | 15.7 | 16.5 |
| R32 | 2.1 | 97.2 | 99.3 | 0.9 | 15.7 | 16.6 |
| R33 | 2.9 | 97.2 | 100.1 | 0.3 | 15.7 | 16.0 |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 21 Predicted maximum incremental 1-hour PAH, benzene and formaldehyde concentrations – Scenario 1

| Receptor | Maximum 1-hour average concentration (mg·m$^{-3}$) | | | | |
|---|---|---|---|---|---|
| | PAH | Benzene | Toluene (odour) | Xylene (odour) | Formaldehyde |
| Criterion | 0.0004 | 0.029 | 0.36 | 0.19 | 0.02 |
| Max. % of criterion | <0.1 | 5.1 | 0.1 | 0.2 | 0.8 |
| R1 | 1.60E-08 | 1.08E-03 | 3.88E-04 | 2.71E-04 | 1.09E-04 |
| R2 | 1.65E-08 | 1.11E-03 | 4.01E-04 | 2.80E-04 | 1.13E-04 |
| R3 | 1.62E-08 | 1.09E-03 | 3.93E-04 | 2.74E-04 | 1.11E-04 |
| R4 | 2.21E-08 | 1.49E-03 | 5.37E-04 | 3.75E-04 | 1.51E-04 |
| R5 | 1.70E-08 | 1.15E-03 | 4.14E-04 | 2.88E-04 | 1.16E-04 |
| R6 | 1.81E-08 | 1.22E-03 | 4.39E-04 | 3.06E-04 | 1.24E-04 |
| R7 | 1.58E-08 | 1.07E-03 | 3.85E-04 | 2.68E-04 | 1.08E-04 |
| R8 | 1.71E-08 | 1.15E-03 | 4.16E-04 | 2.90E-04 | 1.17E-04 |
| R9 | 1.90E-08 | 1.28E-03 | 4.62E-04 | 3.22E-04 | 1.30E-04 |
| R10 | 1.75E-08 | 1.18E-03 | 4.26E-04 | 2.97E-04 | 1.20E-04 |
| R11 | 1.59E-08 | 1.07E-03 | 3.86E-04 | 2.69E-04 | 1.09E-04 |
| R12 | 1.19E-08 | 8.00E-04 | 2.89E-04 | 2.01E-04 | 8.12E-05 |
| R13 | 1.31E-08 | 8.80E-04 | 3.18E-04 | 2.21E-04 | 8.94E-05 |
| R14 | 8.87E-09 | 5.98E-04 | 2.16E-04 | 1.50E-04 | 6.07E-05 |
| R15 | 6.33E-09 | 4.27E-04 | 1.54E-04 | 1.07E-04 | 4.33E-05 |
| R16 | 8.25E-09 | 5.56E-04 | 2.01E-04 | 1.40E-04 | 5.64E-05 |
| R17 | 1.08E-08 | 7.26E-04 | 2.62E-04 | 1.83E-04 | 7.38E-05 |
| R18 | 1.23E-08 | 8.31E-04 | 3.00E-04 | 2.09E-04 | 8.44E-05 |
| R19 | 1.27E-08 | 8.54E-04 | 3.08E-04 | 2.15E-04 | 8.67E-05 |
| R20 | 1.20E-08 | 8.11E-04 | 2.93E-04 | 2.04E-04 | 8.24E-05 |
| R21 | 1.32E-08 | 8.88E-04 | 3.21E-04 | 2.24E-04 | 9.02E-05 |
| R22 | 1.11E-08 | 7.50E-04 | 2.71E-04 | 1.89E-04 | 7.62E-05 |
| R23 | 1.31E-08 | 8.84E-04 | 3.19E-04 | 2.22E-04 | 8.98E-05 |
| R24 | 9.95E-09 | 6.70E-04 | 2.42E-04 | 1.69E-04 | 6.81E-05 |
| R25 | 1.11E-08 | 7.47E-04 | 2.70E-04 | 1.88E-04 | 7.59E-05 |
| R26 | 9.75E-09 | 6.57E-04 | 2.37E-04 | 1.65E-04 | 6.67E-05 |
| R27 | 1.16E-08 | 7.81E-04 | 2.82E-04 | 1.96E-04 | 7.93E-05 |
| R28 | 1.02E-08 | 6.90E-04 | 2.49E-04 | 1.74E-04 | 7.01E-05 |
| R29 | 1.20E-08 | 8.10E-04 | 2.92E-04 | 2.04E-04 | 8.23E-05 |
| R30 | 1.16E-08 | 7.80E-04 | 2.82E-04 | 1.96E-04 | 7.92E-05 |
| R31 | 8.98E-09 | 6.05E-04 | 2.18E-04 | 1.52E-04 | 6.14E-05 |
| R32 | 1.03E-08 | 6.94E-04 | 2.51E-04 | 1.75E-04 | 7.05E-05 |
| R33 | 1.44E-08 | 9.69E-04 | 3.50E-04 | 2.44E-04 | 9.84E-05 |

Figure 10 Predicted maximum incremental 1-hour benzene impacts – Scenario 1


**Source:** Northstar

### 7.1.4. Assessment of Criteria Exceedances

Presented in Table 22 is a summary of the number of additional exceedances of the short-term $PM_{10}$, $PM_{2.5}$ and $NO_2$ criteria, and those values presented as a probability (*p*) (*p*=0 being impossible, *p*=1 being certain). These values are discussed further in Section 8.2.

**Table 22 Assessment of the number of additional exceedances**

| Receptor | Number of additional exceedances of the criterion | | | Probability that an exceedance predicted in one year | | |
|---|---|---|---|---|---|---|
| | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ |
| R1 | 1 | 12 | - | 0.0027 | 0.0329 | - |
| R2 | 1 | 12 | - | 0.0027 | 0.0329 | - |
| R3 | 3 | 14 | - | 0.0082 | 0.0384 | - |
| R4 | 3 | 33 | - | 0.0082 | 0.0904 | - |
| R5 | 1 | 9 | - | 0.0027 | 0.0247 | - |
| R6 | 1 | 10 | - | 0.0027 | 0.0274 | - |
| R7 | 1 | 5 | - | 0.0027 | 0.0137 | - |
| R8 | 2 | 10 | - | 0.0055 | 0.0274 | - |
| R9 | 8 | 39 | - | 0.0219 | 0.1068 | - |
| R10 | 29 | 76 | 3 | 0.0795 | 0.2082 | 0.0082 |
| R11 | 15 | 52 | - | 0.0411 | 0.1425 | - |
| R12 | 6 | 32 | 1 | 0.0164 | 0.0877 | 0.0027 |
| R13 | 5 | 33 | 24 | 0.0137 | 0.0904 | 0.0658 |
| R14 | - | 3 | 13 | - | 0.0082 | 0.0356 |
| R15 | - | - | 4 | - | - | 0.0110 |
| R16 | - | - | 4 | - | - | 0.0110 |
| R17 | - | - | 6 | - | - | 0.0164 |
| R18 | - | - | 7 | - | - | 0.0192 |
| R19 | - | - | 10 | - | - | 0.0274 |
| R20 | - | - | 15 | - | - | 0.0411 |
| R21 | - | - | 25 | - | - | 0.0685 |
| R22 | - | 1 | 23 | - | 0.0027 | 0.0630 |
| R23 | - | 13 | - | - | 0.0356 | - |
| R24 | - | 5 | 10 | - | 0.0137 | 0.0274 |
| R25 | 1 | 7 | 27 | 0.0027 | 0.0192 | 0.0740 |
| R26 | 1 | 6 | 70 | 0.0027 | 0.0164 | 0.1918 |
| R27 | - | 11 | 7 | - | 0.0301 | 0.0192 |
| R28 | - | 4 | 29 | - | 0.0110 | 0.0795 |
| R29 | - | 3 | 44 | - | 0.0082 | 0.1205 |
| R30 | - | 2 | 48 | - | 0.0055 | 0.1315 |
| R31 | - | 2 | 65 | - | 0.0055 | 0.1781 |
| R32 | - | 6 | 9 | - | 0.0164 | 0.0247 |

| Receptor | Number of additional exceedances of the criterion | | | Probability that an exceedance predicted in one year | | |
|---|---|---|---|---|---|---|
| | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ |
| R33 | - | 1 | 2 | - | 0.0027 | 0.0055 |

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of back-up generators for an entire 24-hour period).

## 7.2. Scenario 2 – Realistic Case

Presented below are the results of the modelling assessment under the assumptions of Scenario 2 (refer Section 5.2.2) with 20 no. generators operating at 100 % load for each operating hour between the hours of 7:00 am and 6:00 pm, and 1 no. generator operating at 100 % load for each operating hour between the hours of 6:00 pm and 10:00 pm. Note that these results are presented assuming that the generator testing would be performed continuously during that period. Further discussion is provided in Section 8.2.2

### 7.2.1. Particulate Matter

### 7.2.2. Annual Average TSP, $PM_{10}$ and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, $PM_{10}$ and $PM_{2.5}$) resulting from Scenario 2 operations are presented in Table 23. Table 23 shows that predicted incremental concentrations of TSP, $PM_{10}$ and $PM_{2.5}$ at all receptor locations are low (<1 % of the annual average TSP, $PM_{10}$ and $PM_{2.5}$ criteria).

**Table 23 Predicted annual average TSP, $PM_{10}$ and $PM_{2.5}$ concentrations – Scenario 2**

| Receptor | Annual average concentration (μg·m$^{-3}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TSP | | | $PM_{10}$ | | | $PM_{2.5}$ | | |
| | Incr. | Bg. | Cumul. | Incr. | Bg. | Cumul. | Incr. | Bg. | Cumul. |
| Criterion | 90 | | | 25 | | | 8 | | |
| Max. % of criterion | <0.1 | 38.3 | 38.4 | 0.1 | 67.2 | 67.4 | 0.4 | 92.5 | 93.1 |
| R1 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R2 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R3 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R4 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R5 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R6 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R7 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |

| Receptor | Annual average concentration (µg·m⁻³) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TSP | | | $PM_{10}$ | | | $PM_{2.5}$ | | |
| | Incr. | Bg. | Cumul. | Incr. | Bg. | Cumul. | Incr. | Bg. | Cumul. |
| R8 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R9 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R10 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R11 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R12 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R13 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R14 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R15 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R16 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R17 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R18 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R19 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R20 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R21 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R22 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R23 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R24 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R25 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R26 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R27 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R28 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R29 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R30 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R31 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R32 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |
| R33 | <0.1 | 34.5 | 34.6 | <0.1 | 16.8 | 16.9 | <0.1 | 7.4 | 7.5 |

**Notes:** Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

#### 7.2.2.1. Maximum 24-Hour $PM_{10}$ and $PM_{2.5}$

Table 24 presents the maximum 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Project operations under Scenario 2. No background concentrations are included within this table.

Table 24 Predicted maximum incremental 24-hour $PM_{10}$ and $PM_{2.5}$ concentrations – Scenario 2

| Receptor | Maximum incremental 24-hour average concentration (µg·m$^{-3}$) | |
|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ |
| Criterion | 50 | 25 |
| Max. % of criterion | 13.8 | 27.6 |
| R1 | 4.7 | 4.7 |
| R2 | 4.7 | 4.7 |
| R3 | 4.2 | 4.2 |
| R4 | 6.2 | 6.2 |
| R5 | 3.9 | 3.9 |
| R6 | 4.7 | 4.7 |
| R7 | 4.2 | 4.2 |
| R8 | 4.2 | 4.2 |
| R9 | 6.7 | 6.7 |
| R10 | 6.9 | 6.9 |
| R11 | 6.5 | 6.5 |
| R12 | 5.4 | 5.4 |
| R13 | 3.9 | 3.9 |
| R14 | 1.4 | 1.4 |
| R15 | 1.1 | 1.1 |
| R16 | 1.0 | 1.0 |
| R17 | 1.1 | 1.1 |
| R18 | 1.4 | 1.4 |
| R19 | 1.5 | 1.5 |
| R20 | 1.5 | 1.5 |
| R21 | 1.7 | 1.7 |
| R22 | 1.6 | 1.6 |
| R23 | 5.4 | 5.4 |
| R24 | 4.3 | 4.3 |
| R25 | 4.3 | 4.3 |
| R26 | 3.0 | 3.0 |
| R27 | 5.3 | 5.3 |
| R28 | 5.4 | 5.4 |
| R29 | 3.5 | 3.5 |
| R30 | 3.3 | 3.3 |
| R31 | 3.6 | 3.6 |
| R32 | 5.7 | 5.7 |
| R33 | 1.4 | 1.4 |

**Note**: All PM is assumed to be < 1 µm in diameter, and therefore assessed as $PM_{2.5}$. In this instance, emissions of $PM_{2.5}$ will be the same as $PM_{10}$ ($PM_{2.5}$ is a subset of $PM_{10}$) and therefore the results will be consistent between $PM_{10}$ and $PM_{2.5}$.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a testing event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the testing of back-up generators for an entire 15-hour period).

Table 24 indicates that the highest 24-hour average $PM_{10}$ and $PM_{2.5}$ incremental concentrations related to the Project are predicted at receptor R10.

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 monitored background concentration, in accordance with Section 11.2.3(b) of the Approved Methods (NSW EPA, 2022).

Table 25 and Table 26 present the predicted maximum 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations resulting from operation of the Project through Scenario 2, with corresponding background included for each day.

Results are presented in Table 25 and Table 26 for those receptors at which the greatest impacts have been predicted (see Table 24).

The left side of the tables show the predicted maximum cumulative impacts (typically the days with the highest regional background), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations respectively.

**Table 25 Summary of contemporaneous 24-hour $PM_{10}$ concentrations – Scenario 2**

| Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | | Date | 24-hour average $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | |
|---|---|---|---|---|---|---|---|
| | Incr. | Bkg. | Cumul. | | Incr. | Bkg. | Cumul. |
| 19/12/2023 | 4.8 | 44.4 | 49.2 | 29/01/2023 | 6.9 | 21.4 | 28.3 |
| 14/09/2023 | 3.4 | 38.4 | 41.8 | 5/12/2023 | 6.7 | 18.6 | 25.3 |
| 25/10/2023 | <0.1 | 41.3 | 41.4 | 11/03/2023 | 6.6 | 24.8 | 31.4 |
| 12/11/2023 | 1.9 | 37.5 | 39.4 | 29/08/2023 | 6.3 | 16.3 | 22.6 |
| 2/10/2023 | 0.3 | 38.0 | 38.3 | 23/03/2023 | 6.0 | 16.4 | 22.4 |
| 19/03/2023 | 5.9 | 31.3 | 37.2 | 10/02/2023 | 6.0 | 19.2 | 25.2 |
| 18/12/2023 | 1.3 | 35.1 | 36.4 | 19/03/2023 | 5.9 | 31.3 | 37.2 |
| 24/10/2023 | 4.3 | 31.0 | 35.3 | 29/10/2023 | 5.4 | 12.1 | 17.5 |
| 15/09/2023 | 3.3 | 31.6 | 34.9 | 16/02/2023 | 5.2 | 17.3 | 22.5 |
| 9/12/2023 | 4.3 | 30.6 | 34.9 | 25/09/2023 | 4.9 | 15.8 | 20.7 |
| These data represent the highest Cumulative Impact 24-hour $PM_{10}$ predictions (outlined in red) as a result of the operation of the Project | | | | These data represent the highest Incremental Impact 24-hour $PM_{10}$ predictions (outlined in blue) as a result of the operation of the Project. | | | |

**Notes:** Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 26 Summary of contemporaneous 24-hour $PM_{2.5}$ concentrations – Scenario 2

| Date | 24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R11 | | | Date | 24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – R10 | | |
|---|---|---|---|---|---|---|---|
| | Incr. | Bkg. | Cumul. | | Incr. | Bkg. | Cumul. |
| 14/09/2023 | 3.6 | 29.6 | 33.2 | 29/01/2023 | 6.9 | 11.8 | 18.7 |
| 12/09/2023 | <0.1 | 29.0 | 29.1 | 5/12/2023 | 6.7 | 6.5 | 13.2 |
| 11/06/2023 | 2.4 | 23.7 | 26.1 | 11/03/2023 | 6.6 | 5.5 | 12.1 |
| 12/06/2023 | 1.9 | 22.4 | 24.3 | 29/08/2023 | 6.3 | 10.6 | 16.9 |
| 19/12/2023 | 1.5 | 22.6 | 24.1 | 23/03/2023 | 6.0 | 5.2 | 11.2 |
| 11/09/2023 | <0.1 | 22.7 | 22.8 | 10/02/2023 | 6.0 | 8.6 | 14.6 |
| 13/09/2023 | <0.1 | 22.1 | 22.2 | 19/03/2023 | 5.9 | 11.4 | 17.3 |
| 15/09/2023 | 0.3 | 20.8 | 21.1 | 29/10/2023 | 5.4 | 5.0 | 10.4 |
| 29/07/2023 | 0.5 | 19.4 | 19.9 | 16/02/2023 | 5.2 | 5.6 | 10.8 |
| 7/09/2023 | 2.6 | 16.0 | 18.6 | 25/09/2023 | 4.9 | 7.3 | 12.2 |
| 18/12/2023 | 5.6 | 12.7 | 18.3 | 9/10/2023 | 4.8 | 4.2 | 9.0 |
| 4/08/2023 | 1.6 | 16.6 | 18.2 | 19/12/2023 | 4.8 | 22.6 | 27.4 |
| These data represent the highest Cumulative Impact 24-hour $PM_{10}$ predictions (outlined in red) as a result of the operation of the Project | | | | These data represent the highest Incremental Impact 24-hour $PM_{10}$ predictions (outlined in blue) as a result of the operation of the Project. | | | |

**Notes:** Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a testing event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. reflective of testing of back-up generators for an entire 15-hour period).

For $PM_{10}$ the maximum cumulative impact (the left-hand side of Table 25) and the maximum incremental impact (the right-hand side of Table 25) is predicted at receptor R10. Table 25 indicates no exceedances associated with cumulative impacts for $PM_{10}$.

For $PM_{2.5}$, the maximum cumulative impact (the left-hand side of Table 26) is predicted at receptor R11 and the maximum incremental impact (the right-hand side of Table 26) is predicted at receptor R10.

Table 26 indicates that exceedances associated with the highest cumulative impacts are driven by elevated background concentrations.

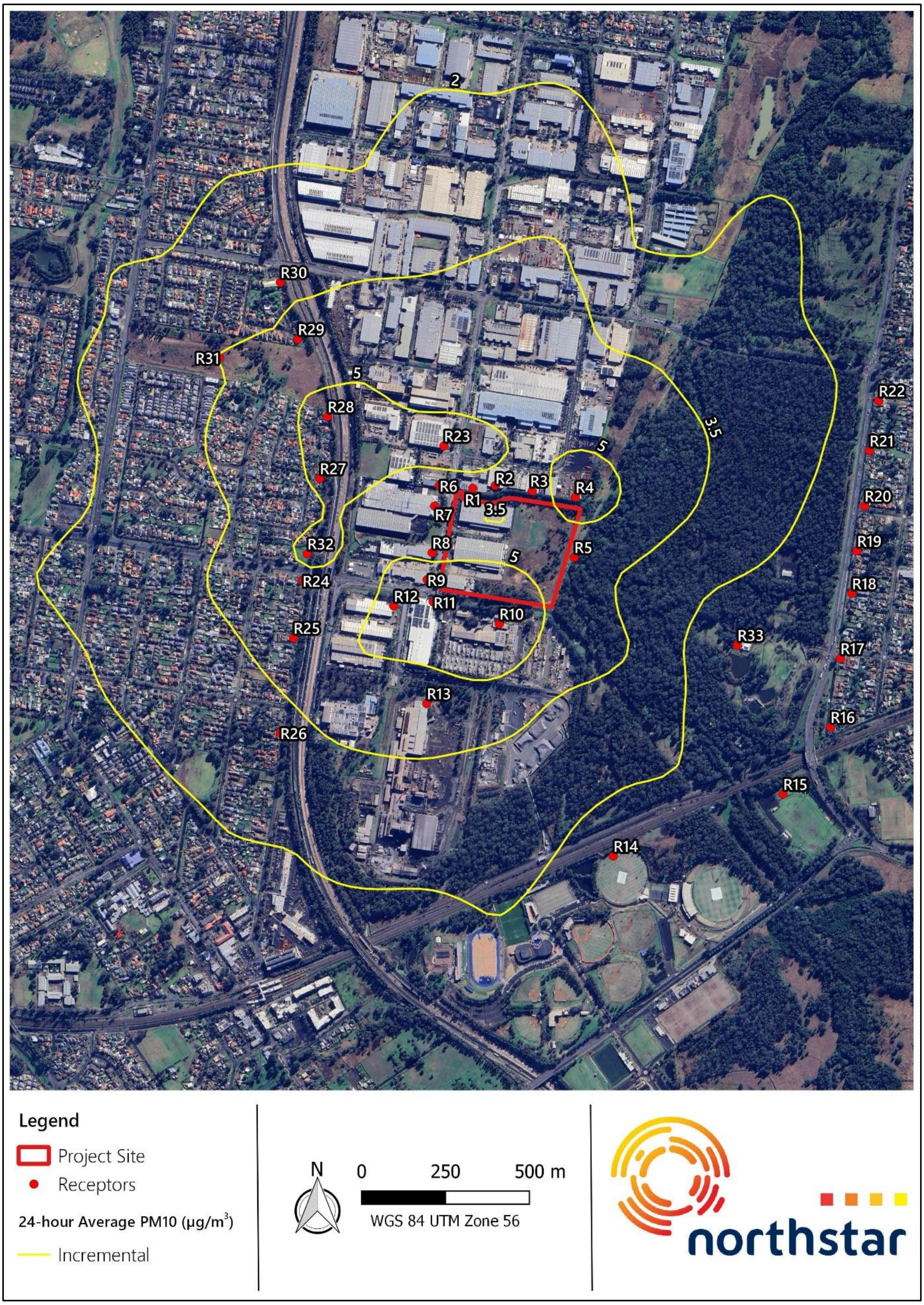
Two exceedances are noted to be due to an elevated background air quality concentration of 29.6 $\mu g \cdot m^{-3}$ and 29.0 $\mu g \cdot m^{-3}$ respectively. There is currently no published NSW Air Quality Compliance Report for 2023, however the NSW annual air quality statement for 2023 (NSW DPE, 2024) notes that Prospect measured two maximum daily $PM_{2.5}$ concentrations in 2023, both due to exceptional events (events related to bushfires, hazard reduction burns and continental-scale dust storms). It is additionally noted that in NSW, exceedances due to exceptional events are not counted towards the NEPM goal of 'no days exceeding the particle standards in a year'.

The other two exceedances are noted to be due to the addition of incremental impacts for the dates 11 June 2023 and 19 December 2023. Scenario 2 is associated with the testing of 20 no. generators at the Project site to be tested at any one time, between the hours of 7:00 am and 6:00 pm, and 1 no. generator to be tested between the hours of 6:00 pm and 10:00 pm i.e. continuously for a total period of 15 hours.

Further discussion relating to these potential exceedances, and how they can be managed is presented in Section 8.2.2.

Contour plots of the predicted incremental 24-hour $PM_{10}$ concentrations associated with the Project under Scenario 2 are presented in Figure 11 to allow examination of the distribution of particulate matter in the area surrounding the Project site.

Figure 11 Predicted maximum incremental 24-hour $PM_{10}$ impacts – Scenario 2




**Source:** Northstar

### 7.2.3. Nitrogen Dioxide

Results are presented in this section for the predictions of $NO_2$ under Scenario 2. The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 4

The predicted maximum 1-hour and annual average $NO_2$ concentrations resulting from the assumptions under Scenario 2, are presented in Table 27.

The results indicate that predicted incremental and cumulative $NO_2$ concentrations are below the criteria at all surrounding receptor locations.

The performance of the Project under Scenario 2 does not result in any exceedances of the criteria for $NO_2$.

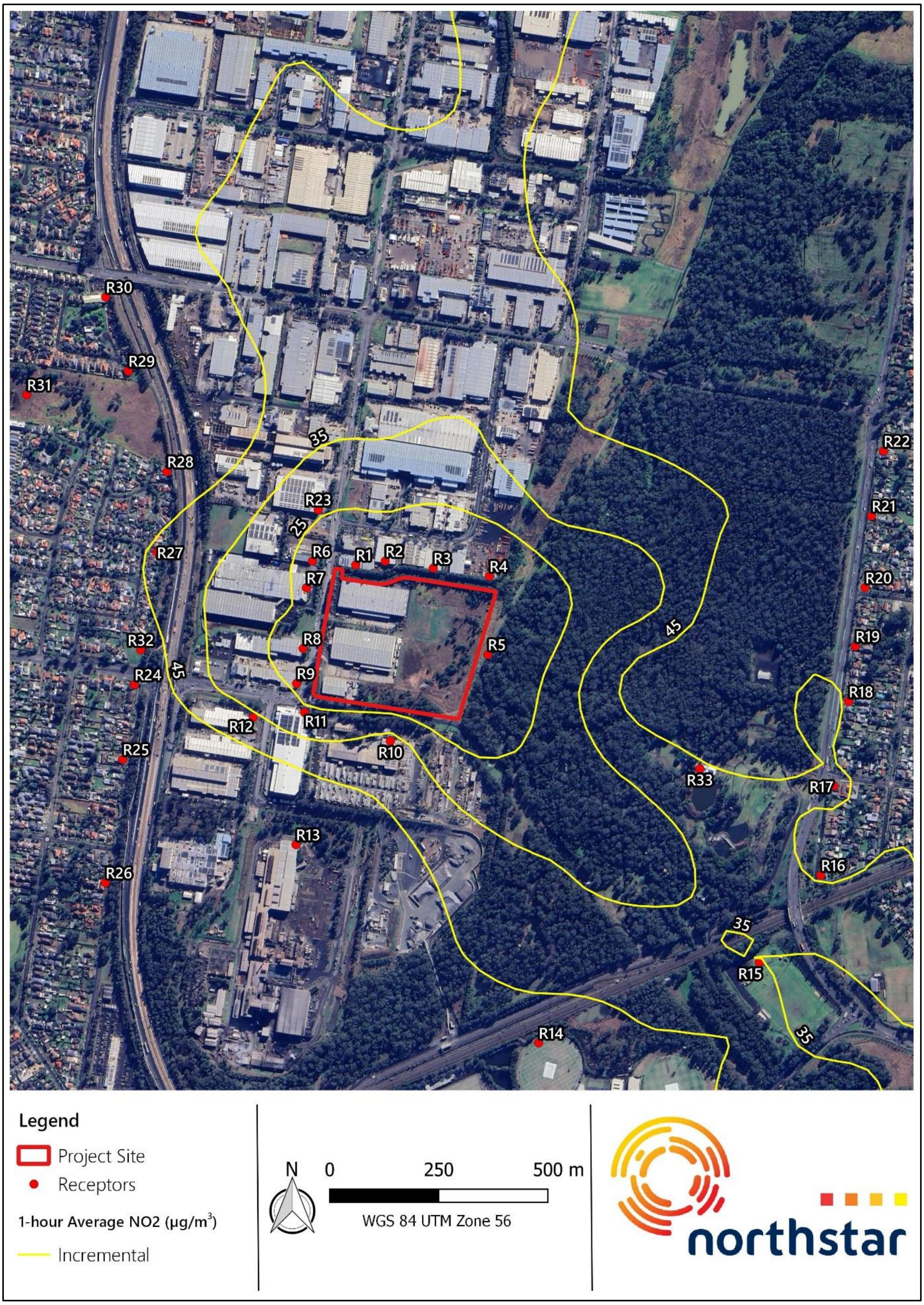
A contour plot of the predicted maximum 1-hour incremental $NO_2$ impact is presented in Figure 12.

Table 27 Predicted 1-hour and annual average $NO_2$ concentrations – Scenario 2

| Receptor | 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 | 49.0 | 29.8 | 67.6 | 0.2 | 48.1 | 48.2 |
| R1 | 8.1 | 15.0 | 23.2 | <0.1 | 14.9 | 15.0 |
| R2 | 13.4 | 15.0 | 28.5 | <0.1 | 14.9 | 15.0 |
| R3 | 6.9 | 5.6 | 12.5 | <0.1 | 14.9 | 15.0 |
| R4 | 10.4 | 1.9 | 12.2 | <0.1 | 14.9 | 15.0 |
| R5 | 7.0 | 7.5 | 14.5 | <0.1 | 14.9 | 15.0 |
| R6 | 20.8 | 5.6 | 26.5 | <0.1 | 14.9 | 15.0 |
| R7 | 19.5 | 5.6 | 25.1 | <0.1 | 14.9 | 15.0 |
| R8 | 16.3 | 1.9 | 18.2 | <0.1 | 14.9 | 15.0 |
| R9 | 23.9 | 1.9 | 25.7 | <0.1 | 14.9 | 15.0 |
| R10 | 40.6 | 3.8 | 44.3 | <0.1 | 14.9 | 15.0 |
| R11 | 25.9 | 11.3 | 37.2 | <0.1 | 14.9 | 15.0 |
| R12 | 36.5 | 3.8 | 40.2 | <0.1 | 14.9 | 15.0 |
| R13 | 55.8 | 7.5 | 63.3 | <0.1 | 14.9 | 15.0 |
| R14 | 46.9 | 15.0 | 62.0 | <0.1 | 14.9 | 15.0 |
| R15 | 35.1 | 28.2 | 63.3 | <0.1 | 14.9 | 15.0 |
| R16 | 46.5 | 9.4 | 55.9 | <0.1 | 14.9 | 15.0 |
| R17 | 43.8 | 37.6 | 81.4 | <0.1 | 14.9 | 15.0 |
| R18 | 45.7 | 16.9 | 62.6 | <0.1 | 14.9 | 15.0 |
| R19 | 52.4 | 15.0 | 67.5 | <0.1 | 14.9 | 15.0 |
| R20 | 62.2 | 15.0 | 77.2 | <0.1 | 14.9 | 15.0 |
| R21 | 61.9 | 48.9 | 110.8 | <0.1 | 14.9 | 15.0 |
| R22 | 49.1 | 1.9 | 51.0 | <0.1 | 14.9 | 15.0 |
| R23 | 26.3 | 3.8 | 30.0 | <0.1 | 14.9 | 15.0 |
| R24 | 51.1 | <0.1 | 51.1 | <0.1 | 14.9 | 15.0 |
| R25 | 60.4 | 7.5 | 67.9 | <0.1 | 14.9 | 15.0 |
| R26 | 59.0 | 9.4 | 68.4 | <0.1 | 14.9 | 15.0 |
| R27 | 42.3 | 7.5 | 49.8 | <0.1 | 14.9 | 48.2 |
| R28 | 50.6 | 1.9 | 52.5 | <0.1 | 14.9 | 15.0 |
| R29 | 79.4 | 1.9 | 81.3 | <0.1 | 14.9 | 15.0 |
| R30 | 80.4 | 1.9 | 82.2 | <0.1 | 14.9 | 15.0 |
| R31 | 54.1 | <0.1 | 54.1 | <0.1 | 14.9 | 15.0 |
| R32 | 51.3 | <0.1 | 51.3 | <0.1 | 14.9 | 15.0 |
| R33 | 44.3 | 37.6 | 81.9 | <0.1 | 14.9 | 15.0 |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Figure 12 Predicted maximum incremental 1-hour $NO_2$ impacts – Scenario 2




**Source:** Northstar

### 7.2.4. All Other Pollutants

The following presents the predicted ground level concentrations associated with Scenario 2 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 28 to Table 30 are the predicted concentrations of CO, $SO_2$, PAHs, VOCs and formaldehyde at varying averaging periods at the surrounding receptors.

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 12.

The predicted incremental concentrations for all of the abovementioned pollutants are below the relevant criteria for all averaging periods at all receptors.

Table 28 Predicted 15-minute, 1-hour and 8-hour average CO concentrations – Scenario 2

| Receptor | Carbon monoxide (CO) concentration (mg·m$^{-3}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15-minute | | | 1-hour | | | 8-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| Criterion | 100 | | | 30 | | | 10 | | |
| Max. % of criterion | <0.1 | 16.5 | 16.6 | <0.1 | 41.7 | 41.8 | <0.1 | 64.0 | 64.5 |
| R1 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R2 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R3 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R4 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R5 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R6 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R7 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R8 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R9 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R10 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R11 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R12 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R13 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R14 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R15 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R16 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R17 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R18 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R19 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R20 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R21 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |

| Receptor | Carbon monoxide (CO) concentration (mg·m$^{-3}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15-minute | | | 1-hour | | | 8-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| R22 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R23 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R24 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R25 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R26 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R27 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R28 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R29 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R30 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R31 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R32 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |
| R33 | <0.1 | 16.5 | 16.6 | <0.1 | 12.5 | 12.6 | <0.1 | 6.4 | 6.5 |

**Notes**: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 29 Predicted 1-hour and 24-hour $SO_2$ concentrations – Scenario 2

| Receptor | Sulphur dioxide ($SO_2$) concentration (µg·m$^{-3}$) | | | | | |
|---|---|---|---|---|---|---|
| | 1-hour | | | 24-hour | | |
| | Incr. | Bkg. | Cumul. | Incr. | Bkg. | Cumul. |
| Criterion | 286 | | | 57 | | |
| Max. % of criterion | 0.3 | 34.0 | 34.3 | 0.4 | 27.5 | 27.9 |
| R1 | 0.7 | 97.2 | 97.9 | 0.2 | 15.7 | 15.9 |
| R2 | 0.7 | 97.2 | 97.9 | 0.2 | 15.7 | 15.9 |
| R3 | 0.7 | 97.2 | 97.9 | 0.1 | 15.7 | 15.8 |
| R4 | 0.9 | 97.2 | 98.1 | 0.2 | 15.7 | 15.9 |
| R5 | 0.7 | 97.2 | 97.9 | 0.1 | 15.7 | 15.8 |
| R6 | 0.8 | 97.2 | 98.0 | 0.1 | 15.7 | 15.8 |
| R7 | 0.8 | 97.2 | 98.0 | 0.1 | 15.7 | 15.8 |
| R8 | 0.8 | 97.2 | 98.0 | 0.1 | 15.7 | 15.8 |
| R9 | 0.8 | 97.2 | 98.0 | 0.2 | 15.7 | 15.9 |
| R10 | 0.7 | 97.2 | 97.9 | 0.2 | 15.7 | 15.9 |
| R11 | 0.7 | 97.2 | 97.9 | 0.2 | 15.7 | 15.9 |
| R12 | 0.5 | 97.2 | 97.7 | 0.2 | 15.7 | 15.9 |
| R13 | 0.4 | 97.2 | 97.6 | 0.1 | 15.7 | 15.8 |
| R14 | 0.4 | 97.2 | 97.6 | <0.1 | 15.7 | 15.8 |
| R15 | 0.3 | 97.2 | 97.5 | <0.1 | 15.7 | 15.8 |
| R16 | 0.3 | 97.2 | 97.5 | <0.1 | 15.7 | 15.8 |
| R17 | 0.4 | 97.2 | 97.6 | <0.1 | 15.7 | 15.8 |
| R18 | 0.5 | 97.2 | 97.7 | <0.1 | 15.7 | 15.8 |
| R19 | 0.5 | 97.2 | 97.7 | <0.1 | 15.7 | 15.8 |
| R20 | 0.5 | 97.2 | 97.7 | <0.1 | 15.7 | 15.8 |
| R21 | 0.6 | 97.2 | 97.8 | <0.1 | 15.7 | 15.8 |
| R22 | 0.5 | 97.2 | 97.7 | <0.1 | 15.7 | 15.8 |
| R23 | 0.6 | 97.2 | 97.8 | 0.2 | 15.7 | 15.9 |
| R24 | 0.4 | 97.2 | 97.6 | 0.1 | 15.7 | 15.8 |
| R25 | 0.5 | 97.2 | 97.7 | 0.1 | 15.7 | 15.8 |
| R26 | 0.4 | 97.2 | 97.6 | <0.1 | 15.7 | 15.8 |
| R27 | 0.5 | 97.2 | 97.7 | 0.2 | 15.7 | 15.9 |
| R28 | 0.4 | 97.2 | 97.6 | 0.2 | 15.7 | 15.9 |
| R29 | 0.4 | 97.2 | 97.6 | 0.1 | 15.7 | 15.8 |
| R30 | 0.4 | 97.2 | 97.6 | 0.1 | 15.7 | 15.8 |
| R31 | 0.4 | 97.2 | 97.6 | 0.1 | 15.7 | 15.8 |
| R32 | 0.4 | 97.2 | 97.6 | 0.2 | 15.7 | 15.9 |
| R33 | 0.5 | 97.2 | 97.7 | <0.1 | 15.7 | 15.8 |

**Notes:** Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 30 Predicted maximum incremental 1-hour PAH, benzene and formaldehyde concentrations – Scenario 2

| Receptor | Maximum 1-hour average concentration ($mg{\cdot}m^{-3}$) | | | | |
|---|---|---|---|---|---|
| | PAH | Benzene | Toluene (odour) | Xylene (odour) | Formaldehyde |
| Criterion | 0.0004 | 0.029 | 0.36 | 0.19 | 0.02 |
| Max. % of criterion | <0.1 | 1.1 | <0.1 | <0.1 | 0.2 |
| R1 | 3.28E-09 | 2.21E-04 | 7.99E-05 | 5.57E-05 | 2.25E-05 |
| R2 | 3.40E-09 | 2.29E-04 | 8.27E-05 | 5.76E-05 | 2.33E-05 |
| R3 | 3.33E-09 | 2.24E-04 | 8.10E-05 | 5.64E-05 | 2.28E-05 |
| R4 | 4.57E-09 | 3.08E-04 | 1.11E-04 | 7.75E-05 | 3.13E-05 |
| R5 | 3.47E-09 | 2.34E-04 | 8.43E-05 | 5.88E-05 | 2.37E-05 |
| R6 | 3.80E-09 | 2.56E-04 | 9.25E-05 | 6.45E-05 | 2.60E-05 |
| R7 | 4.13E-09 | 2.78E-04 | 1.00E-04 | 7.00E-05 | 2.83E-05 |
| R8 | 3.70E-09 | 2.49E-04 | 9.00E-05 | 6.27E-05 | 2.53E-05 |
| R9 | 4.02E-09 | 2.71E-04 | 9.77E-05 | 6.81E-05 | 2.75E-05 |
| R10 | 3.55E-09 | 2.39E-04 | 8.63E-05 | 6.02E-05 | 2.43E-05 |
| R11 | 3.37E-09 | 2.27E-04 | 8.20E-05 | 5.72E-05 | 2.31E-05 |
| R12 | 2.48E-09 | 1.67E-04 | 6.02E-05 | 4.19E-05 | 1.69E-05 |
| R13 | 1.99E-09 | 1.34E-04 | 4.83E-05 | 3.37E-05 | 1.36E-05 |
| R14 | 1.84E-09 | 1.24E-04 | 4.47E-05 | 3.12E-05 | 1.26E-05 |
| R15 | 1.30E-09 | 8.76E-05 | 3.16E-05 | 2.20E-05 | 8.90E-06 |
| R16 | 1.70E-09 | 1.15E-04 | 4.13E-05 | 2.88E-05 | 1.16E-05 |
| R17 | 2.21E-09 | 1.49E-04 | 5.37E-05 | 3.74E-05 | 1.51E-05 |
| R18 | 2.53E-09 | 1.71E-04 | 6.16E-05 | 4.29E-05 | 1.73E-05 |
| R19 | 2.61E-09 | 1.76E-04 | 6.35E-05 | 4.43E-05 | 1.79E-05 |
| R20 | 2.42E-09 | 1.63E-04 | 5.89E-05 | 4.11E-05 | 1.66E-05 |
| R21 | 2.71E-09 | 1.83E-04 | 6.60E-05 | 4.60E-05 | 1.86E-05 |
| R22 | 2.28E-09 | 1.54E-04 | 5.54E-05 | 3.86E-05 | 1.56E-05 |
| R23 | 2.72E-09 | 1.84E-04 | 6.63E-05 | 4.62E-05 | 1.86E-05 |
| R24 | 2.08E-09 | 1.40E-04 | 5.07E-05 | 3.53E-05 | 1.43E-05 |
| R25 | 2.33E-09 | 1.57E-04 | 5.66E-05 | 3.94E-05 | 1.59E-05 |
| R26 | 2.03E-09 | 1.37E-04 | 4.93E-05 | 3.44E-05 | 1.39E-05 |
| R27 | 2.37E-09 | 1.60E-04 | 5.76E-05 | 4.02E-05 | 1.62E-05 |
| R28 | 2.13E-09 | 1.44E-04 | 5.19E-05 | 3.61E-05 | 1.46E-05 |
| R29 | 2.04E-09 | 1.38E-04 | 4.97E-05 | 3.46E-05 | 1.40E-05 |
| R30 | 1.75E-09 | 1.18E-04 | 4.27E-05 | 2.97E-05 | 1.20E-05 |
| R31 | 1.87E-09 | 1.26E-04 | 4.54E-05 | 3.16E-05 | 1.28E-05 |
| R32 | 2.17E-09 | 1.46E-04 | 5.28E-05 | 3.68E-05 | 1.48E-05 |
| R33 | 2.53E-09 | 1.70E-04 | 6.15E-05 | 4.29E-05 | 1.73E-05 |

**Notes:** Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Figure 13 Predicted maximum incremental 1-hour benzene impacts – Scenario 2


**Source:** Northstar

### 7.2.5. Assessment of Criteria Exceedances

Presented in Table 31 is a summary of the number of additional exceedances of the short-term $PM_{10}$, $PM_{2.5}$ and $NO_2$ criteria, and those values presented as a probability (*p*) (*p*=0 being impossible, *p*=1 being certain). These values are discussed further in Section 8.2.

**Table 31 Assessment of the number of additional exceedances**

| Receptor | Number of additional exceedances of the criterion | | | Probability that an exceedance is predicted in one year | | |
|---|---|---|---|---|---|---|
| | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ |
| R1 | - | - | - | - | - | - |
| R2 | - | 1 | - | - | 0.0027 | - |
| R3 | - | 1 | - | - | 0.0027 | - |
| R4 | - | - | - | - | - | - |
| R5 | - | - | - | - | - | - |
| R6 | - | - | - | - | - | - |
| R7 | - | - | - | - | - | - |
| R8 | - | 1 | - | - | 0.0027 | - |
| R9 | - | 1 | - | - | 0.0027 | - |
| R10 | - | 2 | - | - | 0.0055 | - |
| R11 | - | 1 | - | - | 0.0027 | - |
| R12 | - | 1 | - | - | 0.0027 | - |
| R13 | - | 1 | - | - | 0.0027 | - |
| R14 | - | - | - | - | - | - |
| R15 | - | - | - | - | - | - |
| R16 | - | - | - | - | - | - |
| R17 | - | - | - | - | - | - |
| R18 | - | - | - | - | - | - |
| R19 | - | - | - | - | - | - |
| R20 | - | - | - | - | - | - |
| R21 | - | - | - | - | - | - |
| R22 | - | - | - | - | - | - |
| R23 | - | - | - | - | - | - |
| R24 | - | - | - | - | - | - |
| R25 | - | - | - | - | - | - |
| R26 | - | - | - | - | - | - |
| R27 | - | - | - | - | - | - |
| R28 | - | 1 | - | - | 0.0027 | - |
| R29 | - | - | - | - | - | - |
| R30 | - | - | - | - | - | - |
| R31 | - | - | - | - | - | - |
| R32 | - | - | - | - | - | - |

| Receptor | Number of additional exceedances of the criterion | | | Probability that an exceedance is predicted in one year | | |
|---|---|---|---|---|---|---|
| | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1- hour $NO_2$ |
| R33 | - | - | - | - | - | - |

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a testing event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the testing of back-up generators for an entire 15-hour period).

## 7.3. Comparison with POEO (Clean Air) Regulation Standards of Concentrations

Section 3.2 outlines the context of the POEO CAR and the emission standards applicable to activities and plants, categorised as scheduled or non-scheduled under the regulation.

As detailed in Section 2.2, the Project is expected to include the following relevant characteristics:

- 97 no. diesel generators;
- A maintenance testing regime totalling 170 hours per year; and
- Maximum fuel storage capacity of less than 2 000 tonnes.

Clause 73, Part 5, Division 6 of the POEO CAR exempts emergency electricity generation using stationary reciprocal internal combustion engines from the air impurities standards for nitrogen dioxide ($NO_2$) and nitric oxide (NO) specified in Schedule 2, Part 2, Division 3, provided the engines operate for no more than 200 hours per year.

Based on the maintenance schedule presented in Section 2.3.2, non-scheduled activities for electricity generation and chemical storage under the POEO Act are to be conducted at the Project site. Notwithstanding, Table 32 below compares the emissions from both of the individual data centre generator options at the Project site against the respective concentration standards.

Table 32 POEO CAR – Standards of concentrations comparison

| Air impurity | Standard of concentration ($mg \cdot m^{-3}$) (A) | Standby generator emissions ($mg \cdot m^{-3}$) (B) | |
|---|---|---|---|
| | | MTU 20V4000G94F | CAT 3516E |
| Solid particles (Total) | 100 | 5.6 | 24.9 |

**Notes:** (A Standard of emissions concentration under dry, 273 K, 101.3 kPa, 7 % $O_2$ conditions

(B) The Project's generator emissions above are based on the $mg \cdot Nm^{-3}$ generator emission data in Appendix F, assumed as dry, 273 K, 101.3 kPa and 5 % $O_2$ content, which were then converted into 7 % $O_2$ content as per the POEO CAR requirements.

Table 32 shows that the respective concentration standards can be met with the use of either of the standby diesel generator options at the Project site.

# 8. DISCUSSION AND CONCLUSION

This AQIA has been prepared by Northstar on behalf of LCI for the proposed development of a data centre, to be located at 2 Glendenning Road, Glendenning NSW.

The assessment evaluates the potential air quality impacts during both construction and operation phases, with a focus on dust soiling and increased ambient $PM_{10}$ (including $PM_{2.5}$) concentrations due to dust arising from construction activities at the Project site, and combustion emissions from standby diesel generator engines during operations.

Data provided by the Proponent and publicly available environmental data were used. The routine testing and emergency use of diesel generators has the potential to lead to the exceedance of air quality criteria at nearby sensitive receptor locations from associated emissions to air. Therefore, operational impacts were evaluated based on a realistic and justified worst case emissions scenarios.

## 8.1. Construction Phase Risk Assessment

As discussed in Section 6, to ensure that the activities that pose the greatest risk are assessed, the stage with the largest dust emission magnitudes was assessed in this risk assessment. Correspondingly, Stage 1 was assessed in detail (refer Table 14).

The construction phase risk assessment for the Project, presented in Section 6 indicates that dust soiling impacts are associated with medium risks of all construction phase activities while human health impacts are associated with low risks of other construction phase activities if no mitigation measures were to be applied to control emissions.

Based upon that assessment, a range of mitigation measures are recommended to ensure that short-term impacts associated with construction phase activities are minimised, as presented in Appendix B.

## 8.2. Operational Phase Impact Assessment

The predicted impacts of operational phase activities under a worst-case scenario (Scenario 1) and realistic operational scenario (Scenario 2) are presented in Section 7.

### 8.2.1. Scenario 1 – Justified Worst-Case

Under the justified worst-case standby generator operational scenario (Scenario 1), a number of additional exceedances of the short-term air quality criteria for $PM_{10}$, $PM_{2.5}$ and $NO_2$ are predicted.

**Note:** care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of back-up generators for an entire 24-hour period).

That scenario assumes that all 97 no. generators would be operational at one time. The predicted incremental concentrations under Scenario 1 show exceedances of particulate matter and $NO_2$ at sensitive receptor locations if a power outage occurred, and all 97 no. emergency generators were operating at 100 % load continuously (refer Section 7.1) to assess emissions under all potential meteorological conditions.

An assessment of the probability (*p*) of an exceedance of the relevant short-term $PM_{10}$, $PM_{2.5}$ and $NO_2$ criteria has been performed and is presented in Section 7.1.4. As a maximum across all receptors, the probability of an exceedance of the $PM_{10}$, $PM_{2.5}$ or $NO_2$ criterion (where $p$=0 is an impossible event, and $p$=1 is a certain event) in any year is as follows:

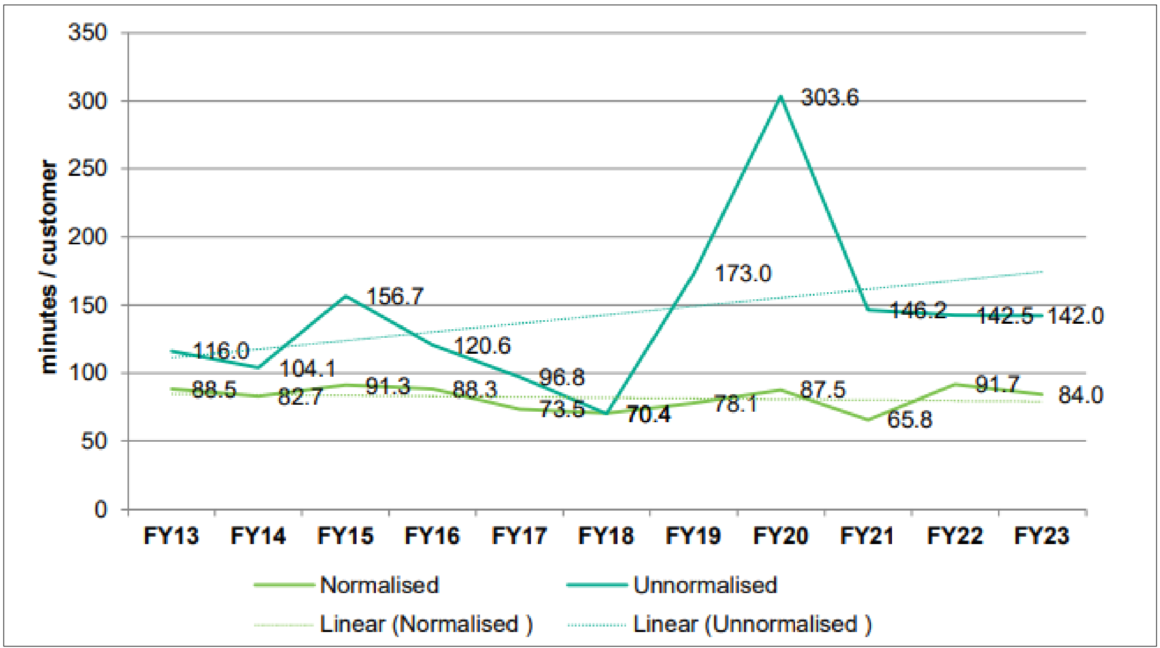
- $PM_{10}$: $p = 0.08$;
- $PM_{2.5}$: $p = 0.21$; and
- $NO_2$: $p = 0.01$.

To predict the likelihood of exceedances under the worst-case scenario (i.e. all 97 no. generators operating continuously at 100 % load), the reliability of the power network was considered against the latest information supplied in the 2023 Distribution Annual Planning Report (DAPR) from Endeavour Energy (Endeavour Energy, 2023).

Based on the DAPR and associated network reliability statistics, the average unplanned outage duration per year per customer from financial-year 2013 to financial-year 2023 equates to approximately 82.0 minutes, although exact duration of power outages requiring standby generators cannot be determined. Correspondingly, the likelihood of power interruptions occurring is approximately 0.016 % of the time per year (82.0 / (8 760 × 60)) or have a probability of $p$=0.00016.

Figure 14 depicts the normalised (i.e. Major Event Days data excluded) system average interruption duration index (SAIDI, in minutes) and unnormalised (i.e. inclusion of all events) SAIDI trends over an eleven financial-year period from 2013 to 2023.

Figure 14 Endeavour Energy SAIDI Performance Information




**Source**: (Endeavour Energy, 2023)

The probability of both the interruption to the power supply, and an exceedance of the relevant air quality criteria occurring can be calculated through the multiplication of the probability of each event occurring. Those values are incredibly small and have been placed into context by calculating the percentage chance that the event could occur in a number of years. Table 33 presents the results of those calculations.

Table 33 Chance of an exceedance during a power outage

| Number of years | Percentage chance of an additional exceedance of the short-term criterion during a power outage (%) | | |
|---|---|---|---|
| | 24-hour $PM_{10}$ | 24-hour $PM_{2.5}$ | 1-hour $NO_2$ |
| 100 | 0.12 | 0.32 | 0.01 |
| 200 | 0.25 | 0.65 | 0.02 |
| 500 | 0.62 | 1.61 | 0.06 |
| 1 000 | 1.23 | 3.20 | 0.12 |
| 1 250 | 1.54 | 3.98 | 0.16 |

The results indicate that the chance of an additional exceedance of the air quality criteria during a power outage is low.

It is noted that the Project would be connected to the 132 kV transmission network, and the anticipated power outage time would be much less than that presented above. These average statistics include all of the network, including those premises on less reliable power lines. Should the 132 kV network experience an outage, the whole of Sydney would experience an outage.

### 8.2.2. Scenario 2 – Realistic Operations

Predicted incremental concentrations for Scenario 2 show that exceedances of the 24-hour criterion for $PM_{2.5}$ are predicted to occur at nine receptors (refer Table 31). However, as previously discussed, the results are conservative for a number of reasons:

1. The generator testing has been assumed to occur for all hours between 7:00 am and 10:00 pm (15 hours). The testing regime outlined in Section 2.3.2 indicates that the longest test would occur for 90 minutes (1.5 hours). Should one test only be performed each day, the results would be conservative by a factor of 10 times ($15/1.5$).

    a. Should only one test be performed each day (1.5 hours), then incremental concentrations would be reduced such that the cumulative criterion would not be exceeded at any surrounding sensitive receptor location.
    b. The results indicate that this test could be performed during either the daytime or evening period.
    c. Further analysis of the results indicates that generator testing could occur over a period of approximately 5 hours in any one day, to ensure that the cumulative concentrations of $PM_{2.5}$ would be below the criterion.

2. The emissions data adopted in dispersion modelling has assumed the most conservative $PM_{2.5}$ emission rate from the MTU 20V4000 G94F and the CAT 3516E (0.07 $g{\cdot}s^{-1}$, CAT3516E). Installation of a generator with a lower emission rate than the worst-case assumption adopted would ensure that the cumulative criterion would be achieved during the generator testing program.

    a. For information only, installation of the MTU 20V4000 G94F generator (0.016 $g{\cdot}s^{-1}$) (or equivalent performing generator) would be sufficient to ensure that the cumulative $PM_{2.5}$ criterion would be achieved. In that case, testing could occur over every hour of the day and evening (7:00 am to 10:00 pm) without resulting in an exceedance of the 24-hour $PM_{2.5}$ criterion.

3. All emitted PM has been assumed to be TSP, $PM_{10}$ and $PM_{2.5}$. As outlined in (US EPA, 1996) 69 % of total PM in large stationary diesel engines is present as $PM_3$, with 82 % present as $PM_{10}$. Therefore, the predicted incremental impacts would be lower than those presented.

Based on the above, it is considered that any predicted exceedances of the 24-hour $PM_{2.5}$ criterion during generator testing can be easily managed, either through generator selection, or through the limiting of testing hours in any day.

### 8.2.3. POEO (Clean Air) Regulation – Standard of Concentrations

Section 7.3 assesses generator emissions against the applicable POEO CAR concentration standards for non-scheduled activities, demonstrating compliance with the total solid particles standard.

### 8.2.4. Recommended Mitigation Measures

Based on the findings of the dispersion modelling assessment under Scenario 2, it is considered that the operation of the maintenance testing schedule would not result in exceedances being experienced at sensitive receptor locations surrounding the Project site, if the hours of testing are limited to 5 hours or less each day.

Should an increase in the number of hours of generator testing be required (up to 15 hours), then a generator with a lower particulate matter emission rate should be installed.

Operation of the emergency generators should be minimised as practicably possible.

### 8.2.5. Additional Mitigation Measures

A number of additional mitigation measures considered to be Best Available Technology (BAT) have been reviewed and discussed in Appendix F.

For clarity, should the testing program be performed for less than 5 hours each day, the Project is predicted to not result in any exceedances of the relevant air quality criteria under the proposed maintenance testing schedule (refer Section 2.3.2) and correspondingly, the additional controls discussed in Appendix F have been reviewed to solely provide context for how air quality impacts may be further reduced.

## 8.3. Conclusion

During the construction phase, the potential dust soiling and human health risks are assessed as being manageable through appropriate implementation of the recommended mitigation measures. This AQIA provides a comprehensive suite of recommended mitigation measures to control dust emissions and impacts during construction.

During the operational phase (Scenario 2: Realistic Case), based upon the information presented in this AQIA, the operation of the Project is not considered likely to result in additional exceedances of the relevant air quality criteria at any identified receptor location, should appropriate selection of generators, or limiting of generator testing hours be implemented. Scenarios replicating the worst-case and realistic case operations have been considered in the assessment.

The predicted incremental concentrations for all assessed pollutants (with the exception of $PM_{2.5}$) are shown to be significantly below the relevant criteria under realistic operations where the back-up generators are appropriately operated under the testing schedule. In the case of $PM_{2.5}$, a range of conservatisms are present in the assessment, and any minor exceedances can be easily managed through the considered selection of generators, or the testing over limited hours, rather than the full 15 hour working day.

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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 ($1 \times 10^{-5}$) | 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 DPE | New South Wales Department of Planning and Environment |
| NSW DPHI | New South Wales 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

## Construction Phase Dust Risk Assessment

Provided below is a summary of the risk assessment methodology used in this assessment. It is based upon IAQM (2024) *Guidance on the assessment of dust from demolition and construction* (version 2.2) and adapted by Northstar.

### Adaptions to the Published Methodology Made by Northstar

The adaptions made by Northstar from the IAQM published methodology are:

- **$PM_{10}$ criterion**: an amended criterion representing the annual average $PM_{10}$ criterion relevant to Australia rather than the UK;
- **Nomenclature**: a change in nomenclature from 'receptor sensitivity' to 'land use value' to avoid misinterpretation of values attributed to 'receptor sensitivity' and 'sensitivity of the area' which may be assessed as having different values;
- **Construction traffic**: the separation of construction vehicle movements as a discrete risk assessment profile from those associated with the 'on-site' activities of demolition, earthworks and construction. The IAQM methodology considers four risk profiles of: 'demolition', 'earthworks', 'construction' and 'trackout'. The adaption by Northstar introduces a fifth risk assessment profile of 'construction traffic' to the existing four risk profiles; and,
- **Tables**: minor adjustments in the visualisation of some tables.

### Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located:

- Beyond a distance of 250 m from the Project site boundary; and,
- At a distance greater than 50 m from the route(s) used by construction vehicles on public roads, beginning from the Project site entrance and extending past 250 m from the Project site entrance.

This step is noted as having deliberately been chosen to be conservative and would require assessments for most developments.

Table B1 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table B1 Construction phase impact screening criteria distances

| Rec. ID | Location | Land use | Screening distance (m) | | |
|---|---|---|---|---|---|
| | | | Project site boundary (250 m) | Project site entrance(s) (250 m) | Construction route(s) (50m) |
| R1 | Glendenning Road, Glendenning | Industrial | 32 | 71 | 71 |
| R2 | Kilto Crescent, Glendenning | Industrial | 50 | 136 | 136 |
| R3 | Kilto Crescent, Glendenning | Industrial | 31 | 241 | 240 |
| R4 | Kilto Crescent, Glendenning | Industrial | 33 | 367 | 367 |
| R5 | Western Sydney Parklands | Parkland | 22 | 388 | 387 |
| R6 | Glendenning Road, Glendenning | Industrial | 55 | 60 | 55 |
| R7 | Glendenning Road, Glendenning | Industrial | 57 | 54 | 42 |
| R8 | Glendenning Road, Glendenning | Industrial | 39 | 34 | 25 |
| R9 | Glendenning Road, Glendenning | Industrial | 41 | 86 | 26 |
| R10 | Woodstock Avenue, Glendenning | Industrial | 74 | 263 | 216 |
| R11 | Woodstock Avenue, Glendenning | Industrial | 45 | 141 | 26 |
| R12 | Woodstock Avenue, Glendenning | Industrial | 149 | 211 | 59 |
| R13 | Kellogg Road, Rooty Hill | Industrial | 343 | 444 | 330 |
| R14 | Blacktown International Sportspark | Recreational | 765 | 1030 | 950 |
| R15 | Western Sydney Parklands | Parkland | 887 | 1238 | 1201 |
| R16 | Coghlan Crescent, Doonside | Residential | 904 | 1262 | 1248 |
| R17 | Cross Street, Doonside | Residential | 868 | 1222 | 1220 |
| R18 | Knox Road, Doonside | Residential | 847 | 1222 | 1220 |
| R19 | Knox Road, Doonside | Residential | 833 | 1216 | 1215 |
| R20 | Knox Road, Doonside | Residential | 846 | 1229 | 1228 |
| R21 | Knox Road, Doonside | Residential | 878 | 1252 | 1252 |
| R22 | Knox Road, Doonside | Residential | 945 | 1305 | 1305 |
| R23 | Glendenning Road, Glendenning | Industrial | 140 | 165 | 163 |
| R24 | Woodstock Avenue, Rooty Hill | Residential | 411 | 426 | 73 |
| R25 | Station Street, Rooty Hill | Residential | 463 | 510 | 215 |
| R26 | Station Street, Rooty Hill | Residential | 644 | 718 | 493 |
| R27 | Polonia Avenue, Plumpton | Residential | 409 | 400 | 61 |
| R28 | Haleluka Crescent, Plumpton | Residential | 445 | 448 | 40 |
| R29 | Parkwood Street, Plumpton | Residential | 656 | 666 | 64 |
| R30 | Power Street, Plumpton | Residential | 815 | 829 | 53 |
| R31 | Carroll Crescent, Plumpton | Recreational | 811 | 814 | 301 |
| R32 | Darice Place, Plumpton | Recreational | 406 | 405 | 64 |
| R33 | The Colebee Function Venue | Commercial | 563 | 916 | 914 |

With reference to Table B1 sensitive receptors are noted to be within the screening distance thresholds and therefore require further risk assessment as summarised in Table B2.

**Table B2 Application of Step 1 screening**

| Construction impact | Screening criteria | Step 1 screening | Comments |
|---|---|---|---|
| Demolition | 250 m from boundary, 250 m from site entrance(s) | Not screened | Receptors identified within the screening distance |
| Earthworks | 250 m from boundary, 250 m from site entrance(s) | | |
| Construction | 250 m from boundary, 250 m from site entrance(s) | | |
| Trackout | 250 m from site entrance(s) | | |
| Construction Traffic | 50 m from roadside, 250 m from site entrance(s) | | |

### Step 2 – Define the Potential Dust Emission Magnitude

Step 2 of the assessment provides 'dust emissions magnitudes' for each of the dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles) and construction traffic.

The magnitudes are: Small, Medium, or Large with suggested definitions for each category as presented in Table B3.

**Table B3 Dust emission magnitude activities**

| Activity | Small | Medium | Large |
|---|---|---|---|
| **Demolition** | | | |
| Total building volume | < 12 000 $m^3$ | 12 000 $m^3$ to 75 000 $m^3$ | > 75 000 $m^3$ |
| Demolition height | < 6 m AGL | 6 m and 12 m AGL | > 12 m AGL |
| Onsite crushing | no | no | yes |
| Onsite screening | no | no | yes |
| Demolition of materials with high dust potential | no | yes | yes |
| Demolition timing | wet months only | any time of the year | any time of the year |
| **Earthworks** | | | |
| Total area | < 18 000$m^2$ | 18 000 $m^2$ to 110 000 $m^2$ | > 110 000 $m^2$ |
| Soil types | soil type with large grain size (e.g. sand) | moderately dusty soil type (e.g. silt) | potentially dusty soil type (e.g. clay) |
| Heavy earth moving vehicles | < 5 heavy earth moving vehicles active at any one time | 5 to 10 heavy earth moving vehicles active at any one time | > 10 heavy earth moving vehicles active at any time |
| Formation of bunds | < 3 m AGL | 3 m to 6 m AGL | > 6 m AGL |
| **Construction** | | | |
| Total building volume | < 12 000 $m^3$ | 12 000 $m^3$ to 75 000 $m^3$ | > 75 000 $m^3$ |
| Concrete batching | no | yes | yes |
| Sandblasting | no | no | yes |

| Activity | Small | Medium | Large |
|---|---|---|---|
| Materials | metal cladding or timber | concrete | concrete |
| **Trackout** | | | |
| Outward heavy vehicles movements per day | < 20 | 20 to 50 | > 50 |
| Surface materials | low potential | moderate potential | high potential |
| Unpaved road length | < 50 m | 50 m to 100 m | > 100 m |
| **Construction traffic (from construction site entrance to construction vehicle origin)** | | | |
| Demolition traffic - total building volume | < 12 000 $m^3$ | 12 000 $m^3$ to 75 000 $m^3$ | > 75 000 $m^3$ |
| Earthworks traffic total area | < 18 000$m^2$ | 18 000 $m^2$ to 110 000 $m^2$ | > 110 000 $m^2$ |
| Earthworks traffic soil types | soil type with large grain size (e.g. sand) | moderately dusty soil type (e.g. silt) | potentially dusty soil type (e.g. clay) |
| Construction traffic total building volume | < 12 000 $m^3$ | 12 000 $m^3$ to 75 000 $m^3$ | > 75 000 $m^3$ |
| Total traffic outward heavy vehicles Movements per day | < 20 | 20 to 50 | > 50 |

The footprint of the Project site (the area affected) is approximately 104 506 $m^2$ in area. The affected area for earthworks has been assumed to comprise the proposed data centre buildings and internal substation, which are estimated to be approximately 22 575 $m^2$ for both Stage 1 and Stage 3, and 15 025 $m^2$ for Stage 2, corresponding to 'medium' and 'small' dust emission magnitudes respectively.

The proposed buildings to be constructed are also expected to be larger than 75 000 $m^3$ ('large' dust emission magnitude) for all stages.

The Proponent has indicated that the estimated daily truck movements during each stage of the construction would be between 4 and 7 heavy vehicles per day on standard days and up to 30 per day for localised periods during concrete pours. Correspondingly, the risk assessment has been conservatively performed on the assumption that 30 outward bound vehicle movements would be required to service the Project each day for all stages.

As outlined in Section 2.2, demolition works have not been considered within this Project.

A summary of the scope of construction phase activities performed during each stage of the Project is provided below in Table B4.

Table B4 Anticipated scope of construction phase activities

| Stage | Earthworks ($m^2$) | Construction ($m^3$) | Track-out (n.o.) |
|---|---|---|---|
| Stage 1 | 22 575 | >75 000 | 30 |
| Stage 2 | 15 025 | >75 000 | 30 |
| Stage 3 | 22 575 | >75 000 | 30 |

Based upon the discussion provided above and the criteria presented in Table B3, the assessed dust emission magnitudes are as presented in Table B5.

Table B5 Construction phase impact categorisation of dust emission magnitude

| Activity | Dust emission magnitude | | |
|---|---|---|---|
| | Stage 1 | Stage 2 | Stage 3 |
| Demolition | N/A | N/A | N/A |
| Earthworks and enabling works | Medium | Small | Medium |
| Construction | Large | Large | Large |
| Track-out | Medium | Medium | Medium |
| Construction traffic routes | Large | Large | Large |

**Note**: N/A = Not Applicable

### Step 3 – Sensitivity of the Area

Step 3 of the process requires the sensitivity of the area to be defined. The sensitivity of the area considers:

- Specific sensitivities that land use values have to dust deposition and human health impacts;
- The proximity and number of those receptors locations;
- In the case of $PM_{10}$, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

### Land Use Value

Individual receptor locations may be attributed different land use values based on the land use of the land, and may be classified as having low, medium or high values relative to dust deposition and human health impacts (ecological receptors are not addressed using this approach).

Essentially, land use value is a metric of the level of amenity expectations for that land use.

The IAQM methodology provides guidance on the land use value with regard to dust soiling and human health impacts and is shown in Table B6 below. It is noted that user expectations of amenity levels (dust soiling) are dependent on existing deposition levels.

Table B6 IAQM guidance for categorising land use value

| Land use value | Low | Medium | High |
|---|---|---|---|
| Dust soiling | The enjoyment of amenity would not reasonably be expected; or<br>Property would not reasonably be expected to be diminished in appearance, aesthetics, or value by soiling; or<br>There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. | Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or<br>The appearance, aesthetics or value of their property could be diminished by soiling; or<br>The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal land use pattern. | Users can reasonably expect a high level of amenity; or<br>The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. |
| *Examples* | *Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.* | *Parks and places of work.* | *Dwellings, museums, and other culturally important collections, medium- and long-term car parks and car showrooms* |
| Health impacts | Locations where human exposure is transient. | Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for $PM_{10}$ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for 8 hours or more in a day). | Locations where the public are exposed over a time period relevant to the air quality objective for $PM_{10}$ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for 8 hours or more in a day). |
| *Examples* | *Public footpaths, playing fields, parks, and shopping street.* | *Office and shop workers but would generally not include workers occupationally exposed to $PM_{10}$.* | *Residential properties, hospitals, schools, and residential care homes.* |

### Dust Soiling Impacts

To assess dust soiling impacts, the sensitivity of the local area is determined by considering the receptors and their quantity, as detailed in Table B7.

**Table B7 IAQM guidance for categorising the sensitivity of an area to dust soiling impacts**

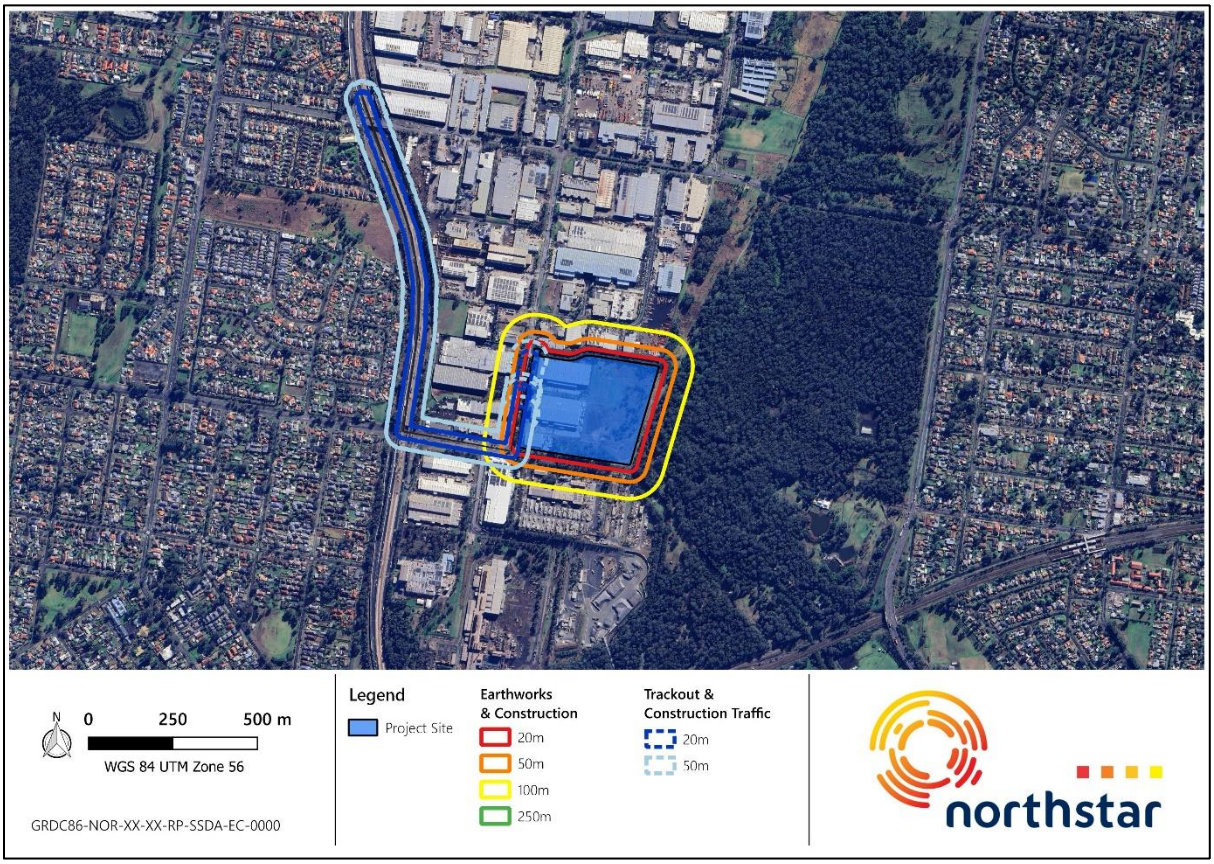
| Land use value | Number of receptors[(a)] | Distance from the source (m)[(b)] | | | |
|---|---|---|---|---|---|
| | | < 20 | < 50 | < 100 | < 250 |
| Low | > 1 | Low | Low | Low | Low |
| Medium | > 1 | Medium | Low | Low | Low |
| High | 1 – 10 | Medium | Low | Low | Low |
| | 10 – 100 | High | Medium | Low | Low |
| | > 100 | High | High | Medium | Low |

**Notes:** (a) Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of less than 20 m and less than 50 m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50 m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Figure B1 illustrates the extent of works considered for this AQIA, delineating the outer envelope boundary of the anticipated construction works, the IAQM distance bands and the positions of receptors. Note that the buffers for trackout and construction traffic have been made for all possible construction routes across all stages due to the varying construction access points for each stage.

**Figure B1 Scope of construction activities, buffer distances and surrounding environment**




**Source:** Northstar

The IAQM guidance does not necessitate precise counting of human receptors. Instead, it advises using professional judgment to estimate the approximate number of buildings within each distance band and that only the highest level of area sensitivity from Table B needs to be considered.

It is estimated that up to 10 receptors are within 50 m of the Project site boundary, and less than 20 receptors within a distance of 250 m from the Project site boundary. Considering both the land use value of receptors and their numbers within specified distances from the footprint, the sensitivity to dust soiling impacts is assessed as 'medium'.

### Human Health Impacts

The assessed land use value (as described in Table B6) is then used to assess the sensitivity of the area surrounding the active construction area, considering the proximity and number of those receptors, and the local background $PM_{10}$ concentration (in the case of potential health impacts) and other site-specific factors.

Additional factors to consider when determining the sensitivity of the area include:

- Any history of dust generating activities in the area;
- The likelihood of concurrent dust generating activity on nearby sites;
- Any pre-existing screening between the source and the receptors;
- Any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant, the season during which the works would take place;
- Any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- Any known specific receptor sensitivities which go beyond the classifications given in (IAQM, 2024).

The IAQM guidance for assessing the sensitivity of an area of human health impacts is shown in Table B8.

The background annual average $PM_{10}$ concentration measured at Prospect AQMS in 2023 is 16.8 µg·m$^{-3}$ (refer Table D2). Together with the calculated land use value, this classifies the sensitivity as 'low' for human health impacts for all stages of the Project.

**Table B8 IAQM guidance for categorising the sensitivity of an area to human health impacts**

| Land use value | Annual mean $PM_{10}$ concentration (µg·m$^{-3}$) | Number of receptors[(a)] | Distance from the source (m)[(b)] | | | |
|---|---|---|---|---|---|---|
| | | | < 20 | < 50 | < 100 | < 250 |
| Low | - | > 1 | Low | Low | Low | Low |
| Medium | ≤ 22 | 1-10 | Low | Low | Low | Low |
| | | > 10 | Low | Low | Low | Low |
| | 22 - 26 | 1-10 | Low | Low | Low | Low |
| | | > 10 | Low | Low | Low | Low |
| | 26 - 30 | 1-10 | Low | Low | Low | Low |
| | | > 10 | Medium | Low | Low | Low |
| | > 30 | 1-10 | Medium | Low | Low | Low |

| Land use value | Annual mean $PM_{10}$ concentration ($\mu g \cdot m^{-3}$) | Number of receptors[a] | Distance from the source (m)[b] | | | |
|---|---|---|---|---|---|---|
| | | | < 20 | < 50 | < 100 | < 250 |
| | | >10 | High | Medium | Low | Low |
| High | ≤ 22 | 1-10 | Low | Low | Low | Low |
| | | 10-100 | Low | Low | Low | Low |
| | | > 100 | Medium | Low | Low | Low |
| | 22 – 26 | 1-10 | Medium | Low | Low | Low |
| | | 10-100 | High | Medium | Low | Low |
| | | > 100 | High | Medium | Low | Low |
| | 26 – 30 | 1-10 | High | Medium | Low | Low |
| | | 10-100 | High | Medium | Low | Low |
| | | > 100 | High | High | Medium | Low |
| | > 30 | 1-10 | High | Medium | Low | Low |
| | | 10-100 | High | High | Medium | Low |
| | | > 100 | High | High | High | Medium |

**Notes**: (a) Estimate the total within the stated distance (e.g. the total within 250 m and not the number between 100 m and 250 m), noting that only the highest level of area sensitivity from the table needs to be considered. In the case of high sensitivity areas with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of less than 20 m and less than 50 m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50 m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

### Step 4 - Risk Assessment (Pre-Mitigation)

The matrices shown in Table B9 for each activity determine the risk category with no mitigation applied.

**Table B9 Pre-mitigated risk of dust impacts from construction related activities**

| Sensitivity of area | Pre-mitigated dust emission magnitude | | |
|---|---|---|---|
| | Small | Medium | Large |
| **Demolition** | | | |
| Low | Negligible risk | Low risk | Medium risk |
| Medium | Low risk | Medium risk | High risk |
| High | Medium risk | Medium risk | High risk |
| **Earthworks, Construction and Trackout** | | | |
| Low | Negligible risk | Low risk | Low risk |
| Medium | Low risk | Medium risk | Medium risk |
| High | Low risk | Medium risk | High risk |
| **Construction traffic (from construction site entrance to origin)** | | | |
| Low | Negligible risk | Low risk | Low risk |
| Medium | Negligible risk | Low risk | Medium risk |
| High | Low Risk | Medium risk | High risk |

Given the sensitivity of the identified receptors is classified as medium for dust soiling and low for human health impacts, and the dust emission magnitudes for the various construction phase activities as shown in Table B5, the resulting risk of air quality impacts (without mitigation) is as presented in Table B10.

**Table B10 Risk of air quality impacts from construction activities – pre-mitigation**

| Sensitivity of area | Dust emission magnitude | | | | | Preliminary risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Demolition | Earthworks | Construction | Track-out | Const. traffic | Demolition | Earthworks | Construction | Track-out | Const. traffic |
| **Stage 1** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Med. | Large | Med. | Large | N/A | Med. | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Med. | Large | Med. | Large | N/A | Low | Low | Low | Low |
| **Stage 2** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Small | Large | Med. | Large | N/A | Low | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Small | Large | Med. | Large | N/A | Neg. | Low | Low | Low |
| **Stage 3** | | | | | | | | | | |
| **Dust soiling** | | | | | | | | | | |
| Medium | N/A | Med. | Large | Med. | Large | N/A | Med. | Med. | Med. | Med. |
| **Human health** | | | | | | | | | | |
| Low | N/A | Med. | Large | Med. | Large | N/A | Low | Low | Low | Low |

**Note**: Med. = Medium, Neg. = Negligible

The risks summarised in Table B10 show that Stage 1 and Stage 3 are assessed as having the highest risks, with dust soiling impacts associated with medium risks for all construction phase activities while human health impacts are associated with low risks for all activities.

### Step 5 – Identify Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high-risk site.

The identified mitigation measures are presented as follows:

N = not required (although they may be implemented voluntarily)

D = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided);

H = highly recommended (to be implemented as part of the CEMP and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

Although it would be possible to apply low and medium risk mitigation measures during Stage 2 of the construction phase of the Project, (refer Table B10), the application of a consistent set of controls across the entire Project site is preferable operationally, as it would ensure the CEMP is more easily adopted and followed by contractors.

Consequently, the mitigation measures presented in Table B11 are commensurate with the risks associated for Stage 1 and Stage 3 of the Project and are recommended to be applied during all construction stages to ensure construction dust will be adequately managed.

**Table B11 Site specific management and mitigation measures**

| Identified mitigation | | Unmitigated risk |
|---|---|---|
| **1** | **Communications** | **Medium** |
| 1.1 | Develop and implement a stakeholder communications plan that includes community engagement before work commences on site. | H |
| 1.2 | Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager. | H |
| 1.3 | Display the head or regional office contact information. | H |
| 1.4 | Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies. | H |
| **2** | **Site Management** | Medium |
| 2.1 | Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. | H |
| 2.2 | Make the complaints log available to the relevant authority when asked. | H |
| 2.3 | Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book. | H |
| 2.4 | Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes. | N |
| **3** | **Monitoring** | **Medium** |
| 3.1 | Perform daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the relevant authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100 m of the site boundary. | D |
| 3.2 | Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and maintain an inspection log available to the relevant authority when asked. | H |

| | Identified mitigation | Unmitigated risk |
|---|---|---|
| 3.3 | Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions. | H |
| 3.4 | Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies, should dust monitoring be required. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences. | H |
| **4** | **Preparing and Maintaining the Site** | **Medium** |
| 4.1 | Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. | H |
| 4.2 | Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site. | H |
| 4.3 | Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period. | H |
| 4.4 | Avoid site runoff of water or mud. | H |
| 4.5 | Keep site fencing, barriers and scaffolding clean using wet methods. | H |
| 4.6 | Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below | H |
| 4.7 | Cover, seed or fence stockpiles to prevent wind erosion | H |
| **5** | **Operating Vehicle/Machinery and Sustainable Travel** | **Medium** |
| 5.1 | Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable | H |
| 5.2 | Ensure all vehicles switch off engines when stationary - no idling vehicles | H |
| 5.3 | Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment, where practicable | H |
| 5.4 | Impose and signpost a maximum-speed-limit of 25 $km \cdot hr^{-1}$ on surfaced and 15 $km \cdot hr^{-1}$ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the relevant authority, where appropriate | D |
| 5.5 | Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials. | N |
| 5.6 | Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing) | D |
| **6** | **Operations** | **Medium** |
| 6.1 | Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems | H |
| 6.2 | Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate | H |
| 6.3 | Use enclosed chutes and conveyors and covered skips | H |

| | Identified mitigation | Unmitigated risk |
|---|---|---|
| 6.4 | Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate | H |
| 6.5 | Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods. | H |
| **7** | **Waste Management** | **Medium** |
| 7.1 | Avoid bonfires and burning of waste materials. | H |
| **8** | **Measures Specific to Earthworks** | **Medium** |
| 8.1 | Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. | D |
| 8.2 | Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. | D |
| 8.3 | Only remove the cover in small areas during work and not all at once | D |
| **9** | **Measures Specific to Construction** | **Medium** |
| 9.1 | Avoid scabbling (roughening of concrete surfaces) if possible | D |
| 9.2 | Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place | H |
| 9.3 | Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery. | D |
| 9.4 | For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust | D |
| **10** | **Measures Specific to Track-Out** | **Medium** |
| 10.1 | Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. | H |
| 10.2 | Avoid dry sweeping of large areas. | H |
| 10.3 | Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport. | H |
| 10.4 | Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. | H |
| 10.5 | Record all inspections of haul routes and any subsequent action in a site log book. | H |
| 10.6 | Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned. | H |
| 10.7 | Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable). | H |
| 10.8 | Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permit. | H |
| 10.9 | Access gates to be located at least 10 m from receptors where possible. | H |

### Step 6 – Risk Assessment (post-mitigation)

Following Step 5, the residual impact is then determined.

The objective of the mitigation is to manage the construction phase risks to an acceptable level, and therefore it is assumed that application of the identified mitigation would result in a low or negligible residual risk (post mitigation).

Given the size of the Project site, the distance to sensitive receptors and the activities to be performed, residual impacts associated with fugitive dust emissions from the Project would be anticipated to be 'negligible', should the implementation of the mitigation measures outlined above be performed appropriately.

# APPENDIX C

## Meteorology

## Meteorological Stations

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

A summary of the relevant monitoring sites is provided in Table C1.

**Table C1 BoM meteorological monitoring sites within 20 km of the Project site**

| Site name | Station # | Approximate location | | Approximate distance (km) |
|---|---|---|---|---|
| | | mE | mS | |
| Horsley Park Equestrian Centre AWS | 067119 | 301 708 | 6 252 298 | 9.9 |
| Penrith Lake AWS | 067113 | 284 871 | 6 266 524 | 16.6 |

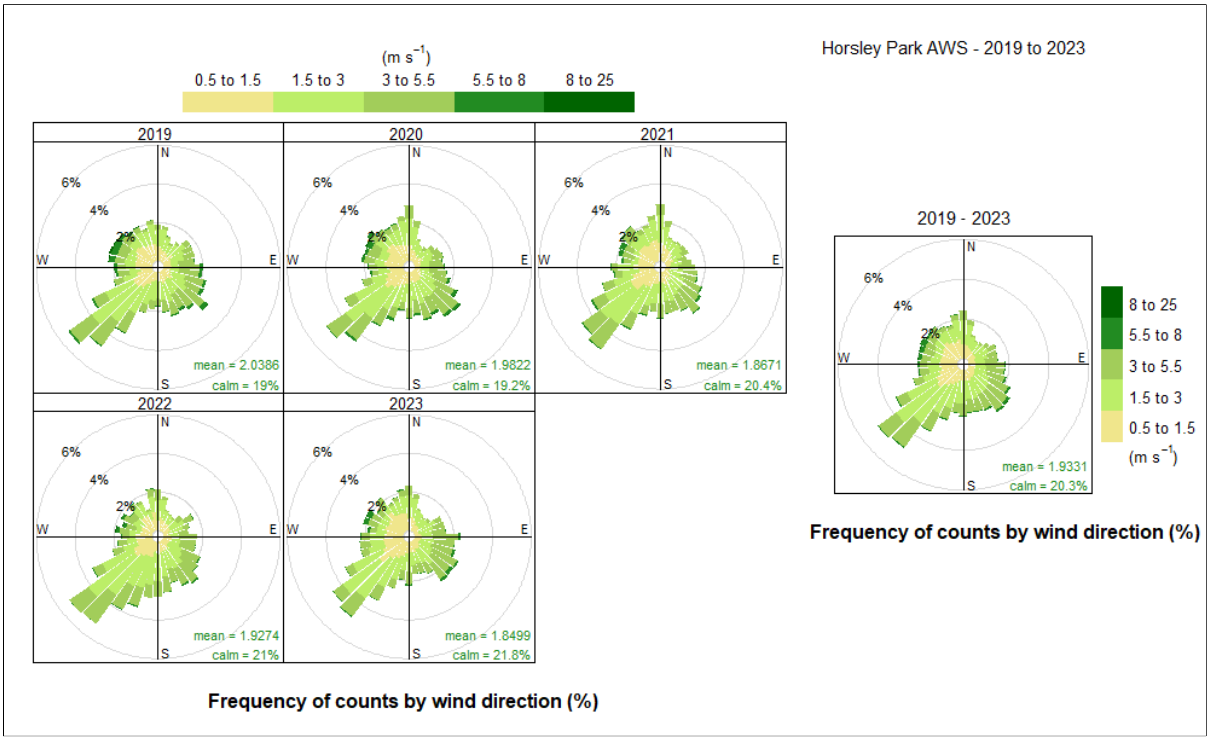
As outlined in Section 4.3, metrological conditions at Horsley Park Equestrian Centre AWS have been examined to be determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2019 to 2023) are presented in Figure C1. The annual wind speed frequency distribution for the five-year period is presented in Figure C2.

The wind roses presented in Appendix C indicate that from 2019 to 2023, winds at Horsley Park Equestrian Centre AWS show similar wind distribution patterns across the years assessed, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at Horsley Park Equestrian Centre AWS between 2019 and 2023 are generally in the range 0.5 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 from mostly north-westerly directions. Winds of this speed are rare and occur during 0.2 % of the observed hours during the years. Calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 20.3 % of hours on average across the years between 2019 and 2023.

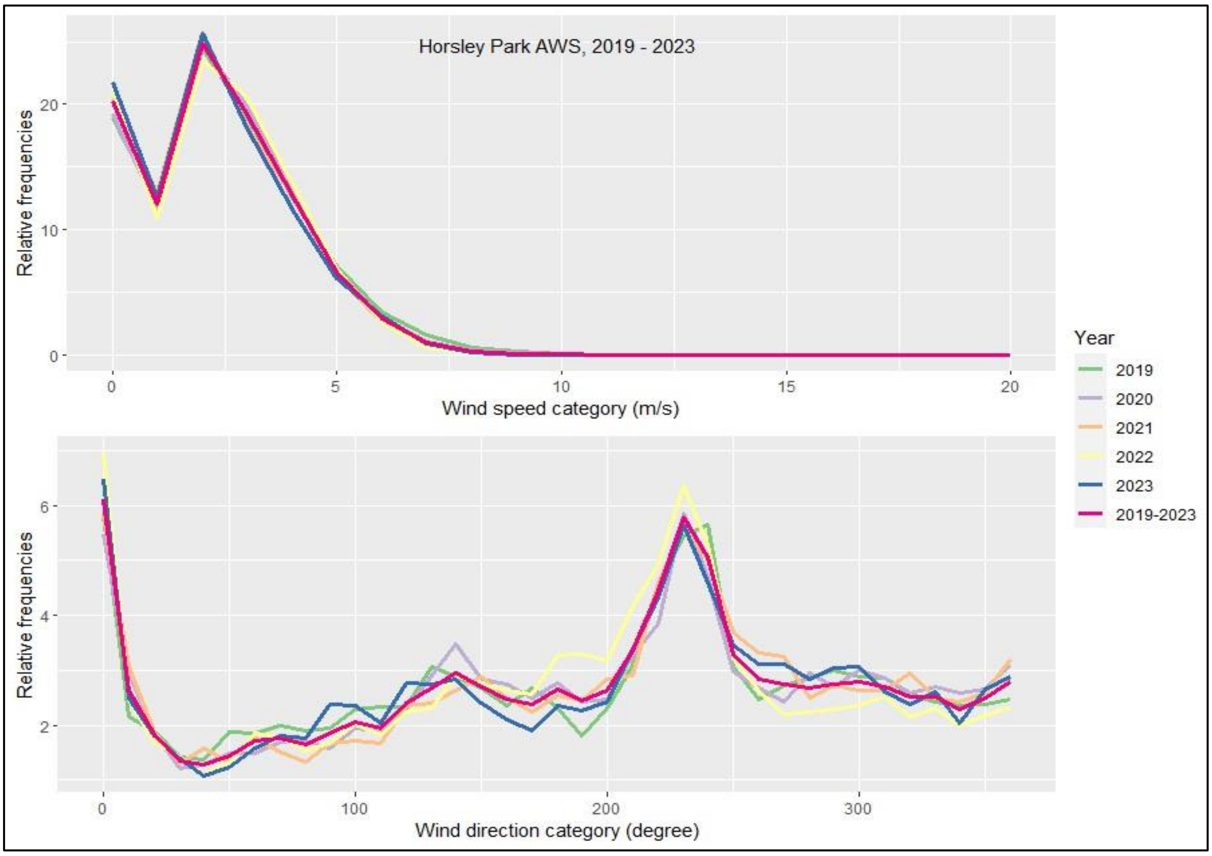
The correlation coefficient between each year and the five-year period for the distribution of wind speed and wind direction are summarised in Table C2. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table C2.

## Figure C1 Annual wind roses – Horsley Park Equestrian Centre AWS (2019 – 2023)




**Source:** Northstar

## Figure C2 Annual wind speed and direction distributions – Horsley Park Equestrian Centre AWS (2019 – 2023)




**Source:** Northstar

Table C2 Correlation coefficient analysis – Horsley Park Equestrian Centre AWS and Prospect AQMS (2019 – 2023)

| Parameter | Wind speed | | Wind direction | | $PM_{10}$ | | $PM_{2.5}$ | | Aggregated rank |
|---|---|---|---|---|---|---|---|---|---|
| | Corr. | Rank | Corr. | Rank | Corr. | Rank | Corr. | Rank | |
| 2019 | 0.9992 | 2 | 0.9667 | 4 | 0.9464 | 4 | 0.9093 | 5 | 4 |
| 2020 | 0.9993 | 1 | 0.9782 | 2 | 0.9935 | 3 | 0.9798 | 3 | =2 |
| 2021 | 0.9990 | 3 | 0.9719 | 3 | 0.9974 | 1 | 0.9879 | 2 | =2 |
| 2022 | 0.9973 | 5 | 0.9653 | 5 | 0.9389 | 5 | 0.9558 | 4 | 5 |
| 2023 | 0.9980 | 4 | 0.9741 | 1 | 0.9959 | 2 | 0.9941 | 1 | 1 |
| **2019-2023** | **1** | - | **1** | - | **1** | - | **1** | - | - |

**Note**: Corr. = Correlation

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

Wind direction observations for each year are well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than of 0.96. The year 2023 is the highest ranked for correlation against the wind direction over the five-year period.

Particulate matter concentrations for each year are also well correlated against particulate matter concentrations over the five-year period. Each year resulted in having a correlation coefficient greater than 0.9. The year 2021 holds the highest rank for $PM_{10}$ and the year 2023 holds the highest rank for $PM_{2.5}$.

The correlation coefficient analysis indicates that 2023 is the most appropriate representative year for meteorological modelling.

### Meteorological Processing

The BoM data adequately covers the issues of data quality assurance; however, it is limited by its location compared to the Project site. 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 this Project was generated using the CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.2.1).

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

For this AQIA, CALMET has been run in no-observations (no-obs) mode using gridded prognostic data generated by The Air Pollution Model (TAPM, v 4.0.5), developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

TAPM is a prognostic model which predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater, 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 the outputs from an initial TAPM modelling run were compared to observed meteorological monitoring data collected at Horsley Park AWS. These data generally compare well and correspondingly, the initial TAPM modelling run is considered sufficient to represent meteorological parameters at the Project site for use in CALMET.

The parameters used in TAPM and CALMET modelling are presented in Table C3.

**Table C3 TAPM meteorological parameters**

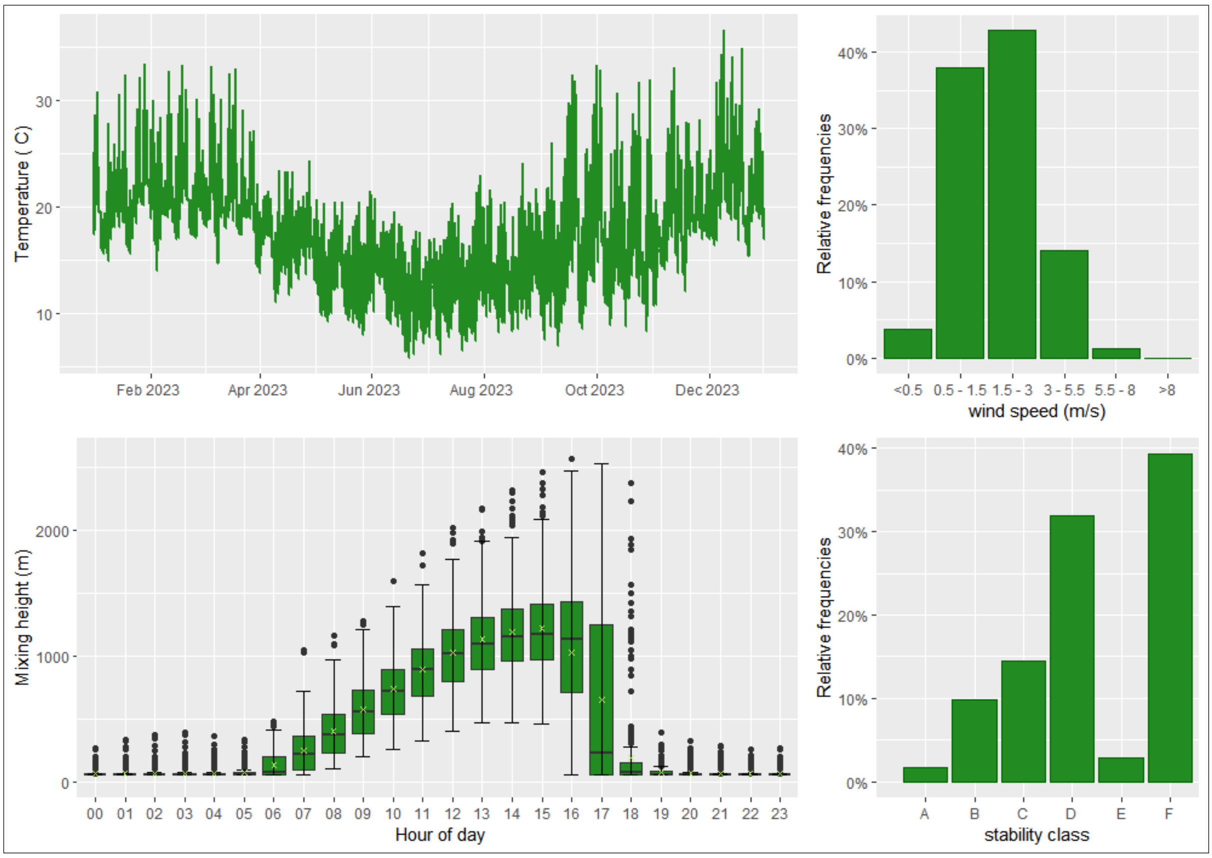
| TAPM v 4.0.5 | |
|---|---|
| Modelling period | 1 January 2023 to 31 December 2023 |
| Centre of analysis | 300 970 mE, 6 257 941 mS (UTM Coordinates) |
| Number of grid points | 35 × 35 × 25 |
| Number of grids (spacing) | 4 (30 km, 10 km, 3 km, 1 km) |
| Terrain | AUSLIG 9 second DEM |
| Data assimilation | None |
| **CALMET** | |
| Modelling period | 1 January 2023 to 31 December 2023 |
| Southwest corner of analysis | 291 000 mE, 6 250 000 mS (UTM Coordinates) |
| Meteorological grid domain (resolution) | 20 km × 20 km (0.2 km)5 km × 5 km (0.2 km) |
| Vertical resolution (cell heights) | 10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1 200 m, 2 000 m, 3 000 m, 4 000 m) |
| Data assimilation | No-obs approach using TAPM – 3D.DAT file |

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

Diurnal variations in maximum and average mixing heights predicted by TAPM at the Project site during 2023 period are illustrated in Figure C4.

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.

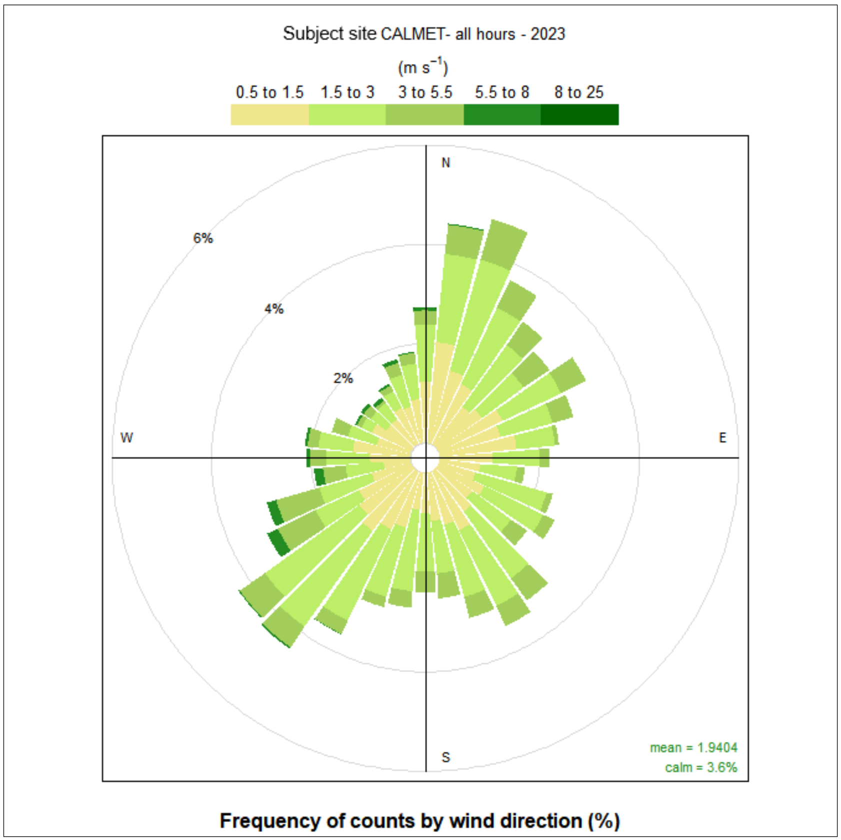
**Figure C4 Predicted mixing height, wind speed and stability class frequency at the Project site (2023)**




**Source:** Northstar

The modelled wind speed and direction at the Project site during 2023 are presented in Figure C5.

Figure C5 Predicted wind characteristics – Project site (2023)




**Source:** Northstar

# APPENDIX D

## Background Air Quality

Air quality is not monitored at the Project site 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 Project site and during a representative year can be complicated by factors which include:

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

Air quality monitoring is performed by the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) at air quality monitoring stations (AQMS) within 10 km of the Project site. Details of the monitoring performed at these AQMS is presented in Table D1.

**Table D1 NSW DCEEW AQMS within 10 km of the Project site**

| AQMS | Distance to Project site (km) | 2023 data | Measurements | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | $PM_{10}$ | $PM_{2.5}$ | TSP | $NO_2$ | CO | $SO_2$ |
| Prospect | 6.6 | ✓ | ✓ | ✓ | × | ✓ | ✓ | ✓ |
| St Marys | 8.7 | ✓ | ✓ | ✓ | × | ✓ | × | × |

Given the availability of data and its proximity to the Project site, data from Prospect AQMS is considered to be the most representative air quality dataset and has correspondingly been adopted for use in this assessment. Particulate matter data for the period 2019 to 2023 has been analysed.

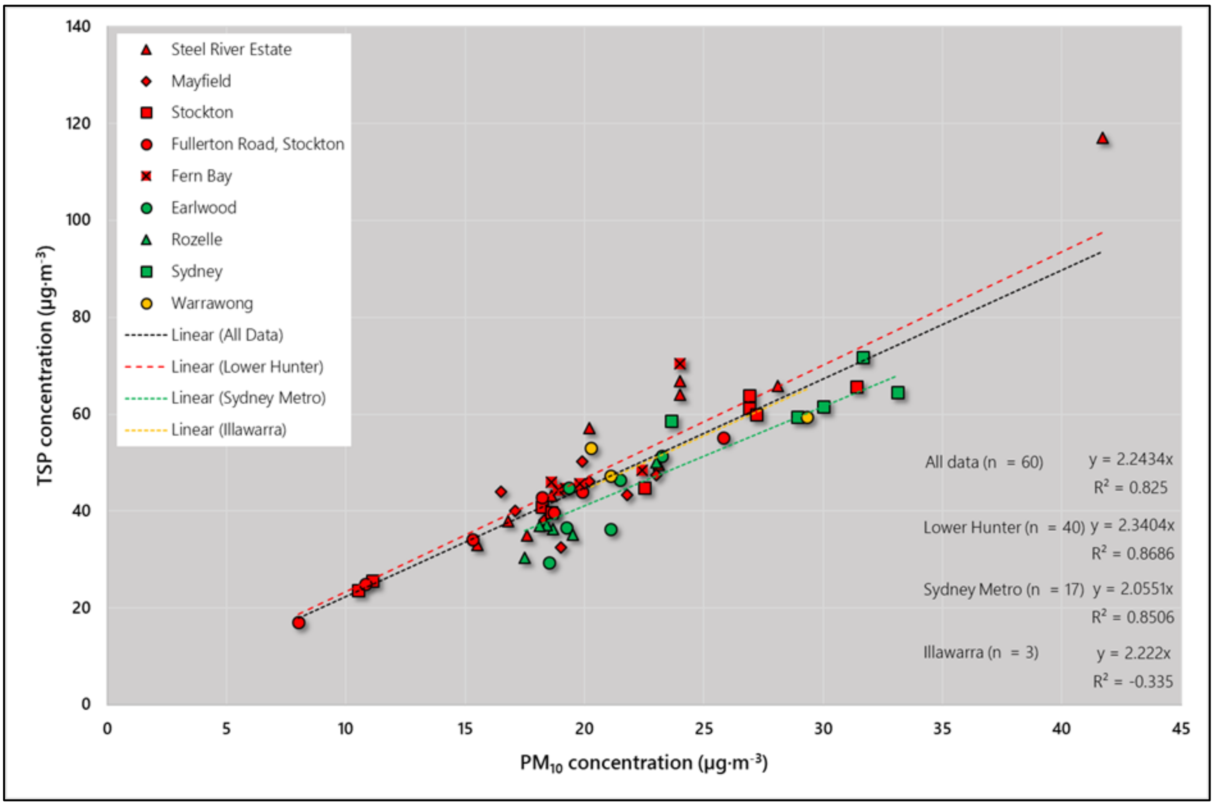
The results of the correlation coefficient analysis provided in Appendix C indicates that data measured in 2023 is the most appropriate dataset for use within this AQIA.

Concentrations of TSP are not measured at any AQMS surrounding the Project site. 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 D1.

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 ~49% of TSP) from the Sydney Metropolitan location 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 34.5 $\mu g{\cdot}m^{-3}$ being adopted.

Summary statistics for the selected data are presented in Table D2.

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




Graphs presenting the daily varying $PM_{10}$, $PM_{2.5}$, and $NO_2$ data recorded at Prospect AQMS in 2023 are presented in Figure D2, Figure D3 and Figure D4 respectively.

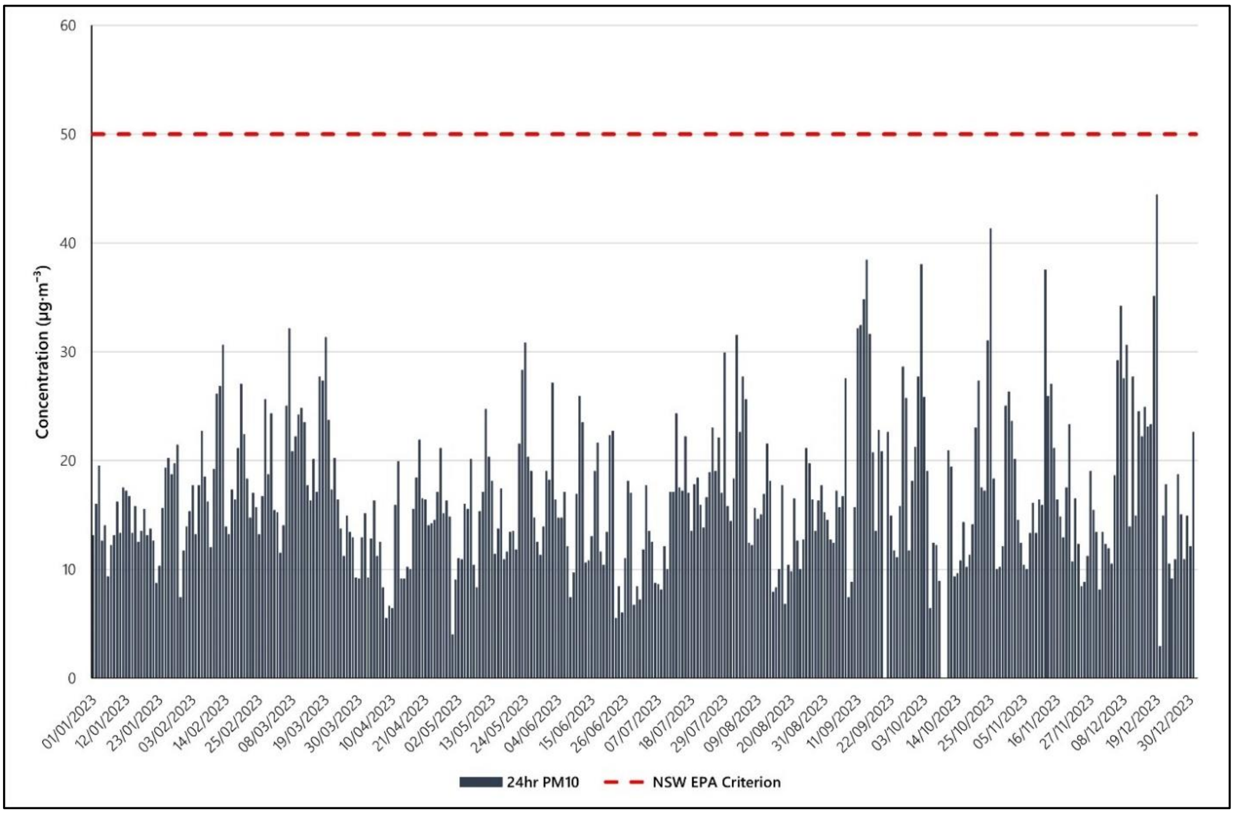
Table D2 Background air quality statistics – Prospect AQMS (2023)

| Pollutant | TSP | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | $SO_2$ | $NO_2$ | CO | CO | CO |
|---|---|---|---|---|---|---|---|---|---|
| Averaging period | Annual | 24-hour | 24-hour | 24-hour | 1-hour | 1-hour | 15-minute | 1-hour | 8-hour (rolling) |
| Units | $\mu g{\cdot}m^{-3}$ | $\mu g{\cdot}m^{-3}$ | $\mu g{\cdot}m^{-3}$ | $\mu g{\cdot}m^{-3}$ | $\mu g{\cdot}m^{-3}$ | $\mu g{\cdot}m^{-3}$ | $mg{\cdot}m^{-3}$ | $mg{\cdot}m^{-3}$ | $mg{\cdot}m^{-3}$ |
| **Statistics** | | | | | | | | | |
| Data Points | 362 | 362 | 355 | 350 | 8118 | 8072 | 7665 | 7665 | 7978 |
| Mean | 34.5 | 16.8 | 7.4 | 1.3 | 1.4 | 14.9 | 0.1 | 0.1 | 0.1 |
| Standard deviation | - | 6.7 | 4.1 | 1.9 | 3.2 | 14.7 | 0.2 | 0.2 | 0.1 |
| *Skew*[1] | - | 1.0 | 1.9 | 1.7 | 5.2 | 1.2 | 2.4 | 2.4 | 1.9 |
| *Kurtosis*[2] | - | 1.3 | 6.1 | 3.3 | 46.7 | 1.2 | 9.3 | 9.3 | 5.9 |
| Minimum | - | 2.9 | 0.7 | 0.0 | -2.6 | -5.6 | -0.3 | -0.2 | -0.2 |
| **Percentiles** | | | | | | | | | |
| $25^{th}$ | - | 12.2 | 4.5 | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 |
| $50^{th}$ | - | 15.8 | 6.7 | 0.0 | 0.0 | 11.3 | 0.0 | 0.0 | 0.0 |
| $75^{th}$ | - | 20.1 | 9.1 | 2.6 | 2.6 | 22.6 | 0.2 | 0.1 | 0.1 |
| $90^{th}$ | - | 25.9 | 11.9 | 2.6 | 2.6 | 35.7 | 0.3 | 0.2 | 0.2 |
| $95^{th}$ | - | 29.9 | 14.4 | 5.2 | 5.2 | 45.1 | 0.5 | 0.3 | 0.3 |
| $97^{th}$ | - | 31.7 | 16.0 | 5.2 | 7.9 | 48.9 | 0.6 | 0.5 | 0.3 |
| $98^{th}$ | - | 33.8 | 20.7 | 7.9 | 10.5 | 52.6 | 0.8 | 0.6 | 0.5 |
| $99^{th}$ | - | 37.7 | 22.6 | 7.9 | 15.7 | 60.2 | 0.9 | 0.7 | 0.6 |
| **Maximum** | **-** | **44.4** | **29.6** | **10.5** | **62.9** | **92.1** | **2.1** | **1.6** | **1.2** |
| **Data Capture (%)** | **98.9** | **98.9** | **97.0** | **95.6** | **92.4** | **91.9** | **87.3** | **87.3** | **90.8** |

**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.

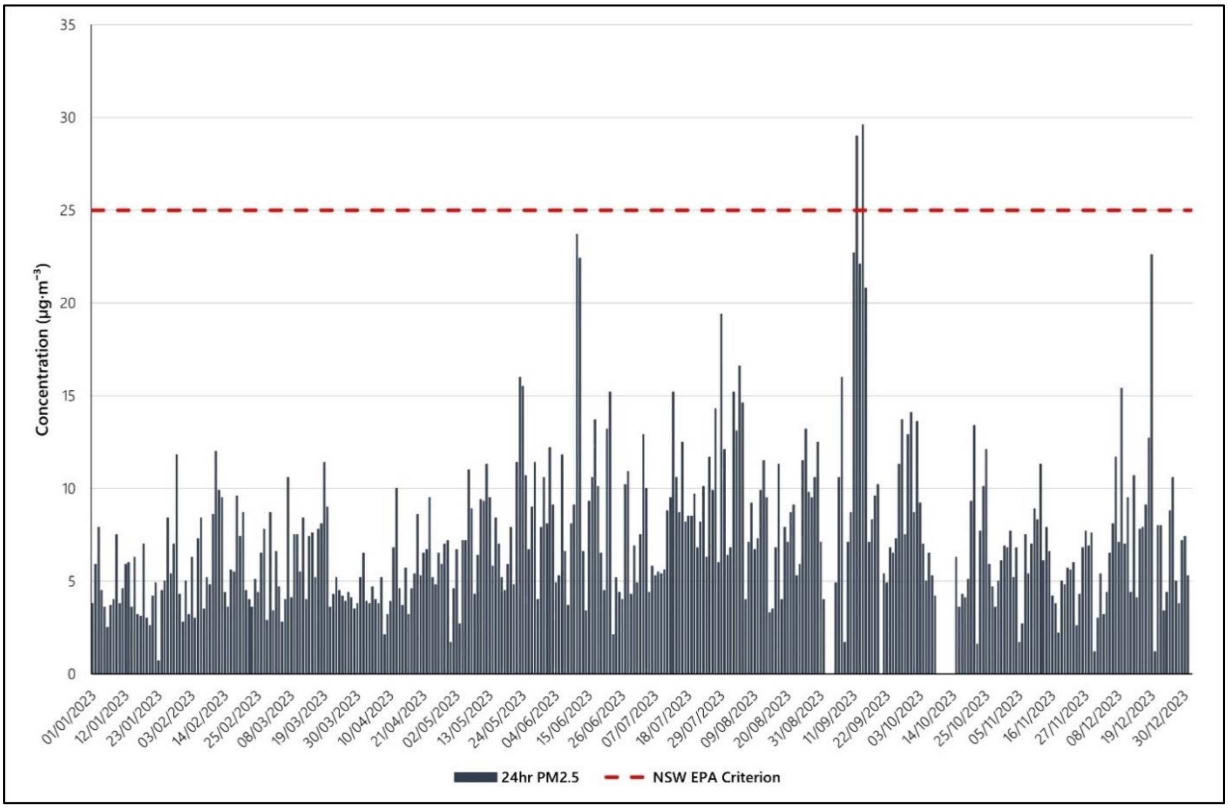
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive kurtosis represents a more peaked distribution, and negative kurtosis represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure D2 24-hour $PM_{10}$ measurements – Prospect AQMS (2023)



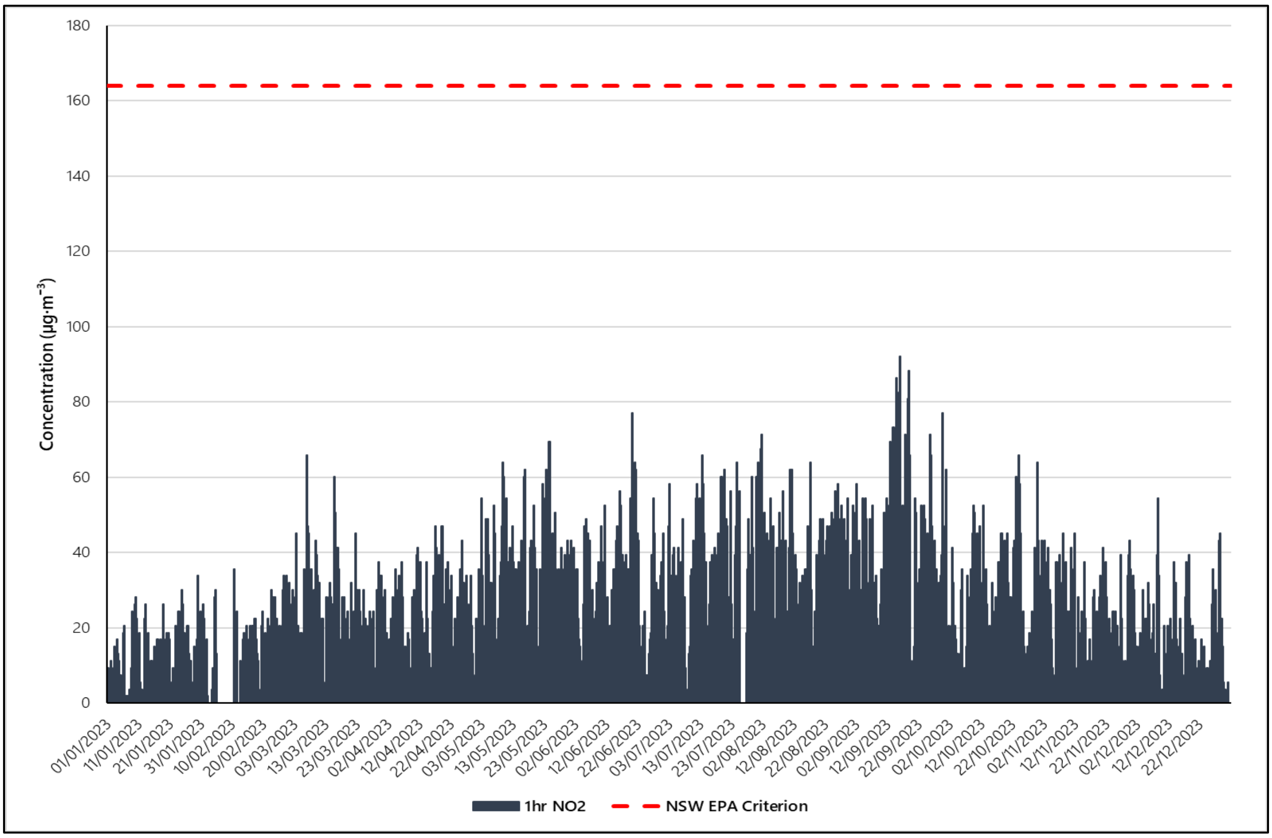

**Source**: Northstar

Figure D3 24-hour $PM_{2.5}$ measurements – Prospect AQMS (2023)




**Source**: Northstar

## Figure D4 1-hour $NO_2$ measurements – Prospect AQMS (2023)




Source: Northstar

# APPENDIX E

## Generator Technical Specifications

# Cat® 3516E
## Diesel Generator Sets


Image shown may not reflect actual configuration

| | |
|---|---|
| Bore – mm (in) | 170 (6.69) |
| Stroke – mm (in) | 215 (8.46) |
| Displacement – L (in³) | 78.1 (4766) |
| Compression Ratio | 14.7:1 |
| Aspiration | ATAAC |
| Fuel System | EUI |
| Governor Type | ADEM™ A5 |

| Standby / Mission Critical 50 Hz kVA (ekW) | Emissions Performance |
|---|---|
| 3500 (2800) | Tier 2 (U.S. EPA Stationary Emergency) |

## Package Performance

| Performance | Standby | | Mission Critical | |
|---|---|---|---|---|
| Engine Speed | 1800 rpm | | 1800 rpm | |
| Frequency | 50 Hz | | 50 Hz | |
| Gen set power rating with fan | 2800 ekW | | 2800 ekW | |
| Gen set power rating with fan @ 0.8 power factor | 3500 kVA | | 3500 kVA | |
| Emissions | Tier 2 (EPA ESE) | | Tier 2 (EPA ESE) | |
| Performance number | EM7054-05 | | EM7058-02 | |
| **Fuel Consumption** | | | | |
| 100% load with fan – L/hr (gal/hr) | 750.9 | (198.4) | 750.9 | (198.4) |
| 75% load with fan – L/hr (gal/hr) | 566.3 | (149.6) | 566.3 | (149.6) |
| 50% load with fan – L/hr (gal/hr) | 413.1 | (109.1) | 413.1 | (109.1) |
| 25% load with fan – L/hr (gal/hr) | 241.1 | (63.7) | 241.1 | (63.7) |
| **Cooling System** | | | | |
| Radiator air flow restriction (system) – kPa (in. water) | 0.12 | (0.48) | 0.12 | (0.48) |
| Radiator air flow – m³/min (cfm) | 2922 | (103189) | 2922 | (103189) |
| Engine coolant capacity – L (gal) | 233.2 | (61.6) | 233.2 | (61.6) |
| Radiator coolant capacity – L (gal) | 202.0 | (53.4) | 202.0 | (53.4) |
| Total coolant capacity – L (gal) | 435.2 | (115.0) | 435.2 | (115.0) |
| **Inlet Air** | | | | |
| Combustion air inlet flow rate – m³/min (cfm) | 239.5 | (8455.3) | 239.5 | (8455.3) |
| **Exhaust System** | | | | |
| Exhaust stack gas temperature – °C (°F) | 490.6 | (915.1) | 490.6 | (915.1) |
| Exhaust gas flow rate – m³/min (cfm) | 639.6 | (22584.9) | 639.6 | (22584.9) |
| Exhaust system backpressure (maximum allowable) – kPa (in. water) | 6.7 | (27.0) | 6.7 | (27.0) |
| **Heat Rejection** | | | | |
| Heat rejection to jacket water – kW (Btu/min) | 926 | (52636) | 926 | (52636) |
| Heat rejection to exhaust (total) – kW (Btu/min) | 3102 | (176400) | 3102 | (176400) |
| Heat rejection to aftercooler – kW (Btu/min) | 982 | (55872) | 982 | (55872) |
| Heat rejection to atmosphere from engine – kW (Btu/min) | 171 | (9736) | 171 | (9736) |
| Heat rejection from alternator – kW (Btu/min) | 111 | (6307) | 111 | (6307) |
| **Emissions* (Nominal) - Full Load** | | | | |
| NOx mg/Nm³ (g/hp-h) | 2203.9 | (4.71) | 2203.9 | (4.71) |
| CO mg/Nm³ (g/hp-h) | 472.2 | (1.02) | 472.2 | (1.02) |
| HC mg/Nm³ (g/hp-h) | 30.1 | (0.07) | 30.1 | (0.07) |
| PM mg/Nm³ (g/hp-h) | 28.5 | (0.07) | 28.5 | (0.07) |
| **Emissions* (Potential Site Variation) - Full Load** | | | | |
| NOx mg/Nm³ (g/hp-h) | 2644.7 | (5.65) | 2644.7 | (5.65) |
| CO mg/Nm³ (g/hp-h) | 661.1 | (1.42) | 661.1 | (1.42) |
| HC mg/Nm³ (g/hp-h) | 40.0 | (0.10) | 40.0 | (0.10) |
| PM mg/Nm³ (g/hp-h) | 39.8 | (0.10) | 39.8 | (0.10) |

**mg/Nm³ levels are corrected to 5% $O_2$. Contact your local Cat dealer for further information.*

# MTU 20V4000G94F

## Application data [1)]

### Engine

| | |
|---|---|
| Manufacturer | *mtu* |
| Model | 20V4000G94F |
| Type | 4-cycle |
| Arrangement | 20V |
| Displacement: l | 95.4 |
| Bore: mm | 170 |
| Stroke: mm | 210 |
| Compression ratio | 16.4 |
| Rated speed: rpm | 1500 |
| Engine governor | ECU 9 |
| Max power: kWm | 3088 |
| Air cleaner | dry |

### Fuel system

| | |
|---|---|
| Fuel specification | EN 590, Grade No.1-D/2-D (ASTM D975-00), EN 15940 (e.g. HVO) |
| Maximum fuel lift: m | 5 |
| Total fuel flow: l/min | 27 |

### Fuel consumption [2)]

| | l/hr | g/kwh |
|---|---|---|
| At 100% of power rating: | 756 | 203 |
| At 75% of power rating: | 578 | 207 |
| At 50% of power rating: | 402 | 216 |

### Liquid capacity (lubrication)

| | |
|---|---|
| Total oil system capacity: l | 390 |
| Engine jacket water capacity: l | 260 |
| Intercooler coolant capacity: l | 50 |

### Combustion air requirements

| | |
|---|---|
| Combustion air volume: m³/s | 4.5 |
| Max. air intake restriction: mbar | 30 |

### Cooling/radiator system

| | |
|---|---|
| Coolant flow rate (HT circuit): m3/hr | 80 |
| Coolant flow rate (LT circuit): m3/hr | 44 |
| Heat rejection to coolant: kW | 1140 |
| Heat radiated to charge air cooling: kW | 890 |
| Heat radiated to ambient: kW | 105 |
| Fan power for electr. radiator (40°C): kW | 105 |

### Exhaust system

| | |
|---|---|
| Exhaust gas temp. (after engine, max.): °C | 550 |
| Exhaust gas temp. (before turbocharger): °C | 642 |
| Exhaust gas volume: m3/s | 11.1 |
| Maximum allowable back pressure: mbar | 50 |
| Minimum allowable back pressure: mbar | - |

| | Genset | Marine | O & G | Rail | C & I |
|---|---|---|---|---|---|
| Application | X | | | | |
| Engine model | 20V4000G94F | | | | |
| Rated power [kW] | 3088 | | | | |
| Rated speed [rpm] | 1500 | | | | |
| Application Group | 3D | | | | |
| Legislative body | NEA Singapore for ORDE | | | | |
| Test cycle | D2 | | | | |
| Data Set No. | XZ54954100066 | | | | |
| Data Set Basis | NEA Singapore for ORDE | | | | |
| Fuel sulphur content [ppm] | 7 | | | | |

**Engine raw emissions***

| Cycle point | [ - ] | n1 | n2 | n3 | n4 | n5 |
|---|---|---|---|---|---|---|
| Power | kW | 3090 | 2317 | 1545 | 772 | 309 |
| Power relative | [ - ] | 1 | 0.75 | 0.5 | 0.25 | 0.1 |
| Engine speed | 1/min | 1501 | 1501 | 1501 | 1501 | 1500 |
| Engine speed relative | [ - ] | 1 | 1 | 1 | 1 | 1 |
| Filter smoke number | Bosch | 0.18 | 0.2 | 0.7 | 0.89 | 0.04 |
| Exhaust temperature after ETC | grdC | 453 | 420.8 | 421 | 378.5 | 259 |
| Exhaust back pressure after ETC (static) | mbar | 34 | 23 | 11 | 5 | 2 |
| Exhaust back pressure after ETC (total) | mbar | 52 | 35 | 16 | 5 | 0 |
| Exhaust mass flow wet | kg/h | 18499.9 | 15818.7 | 11326.3 | 7149.8 | 5283.9 |
| NOX-Emissions specific | g/kWh | 6.46 | 5.32 | 4.78 | 4.56 | 9.18 |
| SO2-Emissions specific | g/kWh | 0.003 | 0.003 | 0.003 | 0.003 | 0.004 |
| CO-Emissions specific | g/kWh | 0.23 | 0.29 | 1.1 | 1.36 | 3.2 |
| HC1-Emissions specific | g/kWh | 0.07 | 0.08 | 0.1 | 0.18 | 0.84 |
| NMHC-Emissions specific | g/kWh | 0.07 | 0.08 | 0.1 | 0.18 | 0.82 |

# APPENDIX F

## Additional Mitigation Measures

As outlined in Section 8.2.5, a number of additional mitigation measures considered to be Best Available Technology (BAT) have been reviewed and discussed below. For clarity, should the Project perform testing for <5 hours per day, the Project is predicted to not result in any exceedances of the relevant air quality criteria under the proposed maintenance testing schedule and correspondingly, the following additional controls have been outlined to solely provide context for how air quality impacts may be further reduced.

To prevent or minimise emissions during operation, BAT ensures through proper design, operation, and maintenance, that emission control techniques are utilised at their optimal capacity and availability.

**Source – Pathway – Receptor Model**

The source-pathway-receptor (SPR) model is useful for understanding the hypothetical relationships between contributing factors to create exposure linkages and also how controls may be applied to manage the risk of exposure from those linkages. Each component of the SPR model is defined below, as relates to the context of this study:

- **Source** – the origin of air emissions, which in this case is the discharge points from the back-up generators.
- **Pathway** – the route through which pollutants disperse from source to receptor. In this case the pathway assessed in through atmospheric dispersion which can be influenced by various parameters such as meteorological conditions, terrain, and characteristics of the emission source(s).
- **Receptor** – The presence of receptors that could be adversely affected by a contaminant. In this case receptors are assessed as the receptor locations identified in Section 4.2.

For air emissions to have an impact on the receiving environment, there needs to be a connection through the SPR model. This means that the source of pollution, the way it travels (pathway), and the affected area (receptor) must all be linked for there to be a potential risk.

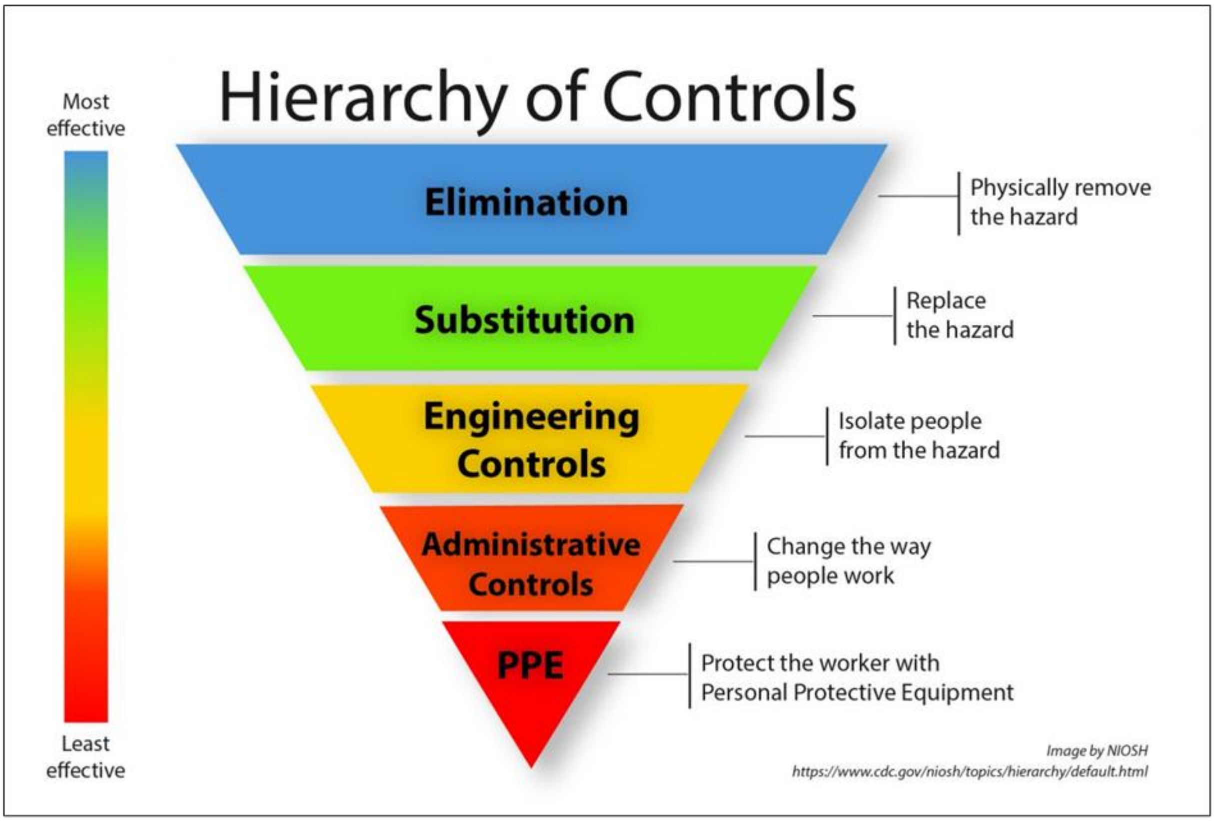
Identification of the SPR model allows for targeted management interventions to manage the environmental risks and prevent pollution from reaching sensitive areas.

**Hierarchy of Controls**

The hierarchy of controls are a well-documented and utilised tool for evaluating the efficacy and reliability for the control of hazards. An example of the hierarchy is presented in Figure F1.

The hierarchy of controls shows 'elimination' of the hazard as the most desirable control, through 'substitution', 'engineering' and 'administrative controls' to 'PPE' (i.e. protection from the hazard at the point of exposure) being the least effective.

Figure F1 Hierarchy of controls




**Source**: Centres for Disease Control and Prevention (CDC) / National Institute for Occupational Safety & Health (NIOSH)

For each identified potential control that is subsequently evaluated below, each control has been given a unique identifier that is **[S*x*]**, **[P*x*]** or **[R*x*]** relating to how they fit into the SPR model and ***x*** being a sequential number (e.g. **[S1]**, **[S2]**, **[S3]**... for identified controls at source).

It is noted that these references may occur in multiple places in the following sections.

**Controls at Source**

Air pollution controls at the source may involve the installation of emission control devices and adoption of efficient power generation techniques to minimise pollutant releases from the Project site.

**Selection of Generators**

The capacity, number and configuration of the back-up generators at the Project site will have been dependant on the requirements sought by the Proponent during the detailed design phase of the development.

Key factors which may have influenced the selection of generators at the Project site include (in no order) fuel efficiency, reliability, capabilities to retrofit air pollution control (APC) techniques, start-up times and compliance with appropriate emissions limit values as specified in legislative and regulatory requirements.

The UK Environment Agency's working draft guide on the approach to the permitting and regulatory aspects for Data Centres (UK Environment Agency, 2018) notes that:

> *"It is generally accepted that the BAT for data centre back-up generation is presently a set of diesel generators – this allows for an on-site store of fuel for reliability and a scalable provision of MWelec."*

Other technologies identified for standby power generation purposes include the Diesel Rotary Uninterruptible Power Supply engine (DRUPS) and natural gas-fuelled back-up generators utilising either combined-cycle or open-cycle gas turbine technologies or employing spark ignition.

In terms of generator selection for the Project site:

- Diesel engines can offer a faster response speed relative to the demanded load; making them a crucial component for data centre operations which require fast response times. Rapid start-up of back-up generators is essential where a near instantaneous supply of electricity is imperative in the event of a power outage.
- Diesel engines typically have lower maintenance cost compared to gas-fired generators; and,
- Ensuring a reliable fuel supply, particularly diesel, is essential for maintaining dependability. Use of a natural gas generator for example would necessitate reliance on an off-site supply network.

In terms of pollutants, $NO_X$ is a predominant byproduct obtained from the combustion process. The adoption of low $NO_X$ engine technology would aide in reducing emissions at source. It is acknowledged that gas engines are known to emit lower amounts of $NO_X$, SOX, and particulate matter (PM) in comparison to diesel fired engines.

As each generator has a unique specification for operating conditions (such as fuel consumption rate, operating temperature, and resultant emission specifications), the selection of generators to account for the different emission specification is a consideration for control **[S1]**.

In Chapter 3 of the BAT Reference Document (BREF) for Large Combustion Plants (LCP BREF) (Lecomte, et al., 2017) low $NO_x$ burners are described as employing a combination of air staging, fuel staging and internal flue-gas recirculation techniques to achieve low $NO_X$ emission from combustion. The control efficiency can vary depending on the specific design of the burner, the combustion technology applied and fuel type, with low $NO_x$ burners generally achieving between 20 % and 70 % of a reduction of $NO_x$ emissions (Lecomte, et al., 2017) **[S2]**.

**Emissions Standards**

In NSW, standby generators are not required to comply with emissions standards, as long as their operation does not exceed a specific annual hour limit or if maintenance and testing activities are conducted for less than a designated number of hours per year (refer Section 2.2).

Schedule 2, Part 3 of the POEO CAR sets out emission limits relevant to standby electricity generators as a non-scheduled activity. Table G1 outlines the standards of concentration for non-scheduled premises. It is important to note that no reference to other pollutants such as $NO_X$ is within Schedule 2.

**Table F1 POEO CAR – Schedule 2, Part 3 – general standards of concentrations for non-scheduled premises**

| Air impurity | Activity or plant | Group | Concentration |
|---|---|---|---|
| Solid particles | Any activity or plant (except as listed below) | Group A | 400 $mg{\cdot}m^{-3}$ |
| | | Group B | 250 $mg{\cdot}m^{-3}$ |
| | | Group C | 100 $mg{\cdot}m^{-3}$ |
| Smoke | Any activity or plant in connection with which liquid or gaseous fuel is burnt | Group A, B, C | Ringelmann 1 or 20 % opacity |

Standby generators 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.

The US non-road emissions standards are categorized by engine horsepower and model year, regulated by the US EPA. Tier 1 standards were phased in from 1996 to 2000, followed by more stringent Tier 2 from 2001 to 2006, and Tier 3 from 2006 to 2008 (applicable to engines from 37 kW to 560 kW).

Current Tier 4 standards, implemented from 2008 to 2015, require around a 90 % reduction in $NO_x$ and PM emissions, achieved through exhaust gas aftertreatment technologies like SCR catalysts. The California Air Resources Board (CARB) is developing Tier 5 standards to be in place between 2028 and 2030, aiming to further reduce $NO_x$ and PM emissions by between 50 %-90 %, which currently under consideration by the US EPA for adoption into their respective non-road engine regulations.

An air information report published by NSW EPA on the reduction of emissions from non-road diesel engines (NSW EPA, 2014) notes that:

> *Tier 4 emission standards make provision for the following reductions compared to Tier 1 emission standards:*
>
> - *95 % reduction in NOx for engines less than 560 kW and 60% reduction for larger engines*
> - *85 % reduction in HC for engines less than 560 kW and 70% reduction for larger engines, and*
> - *50–60% reduction in PM during first phase (2008), and 80–95% reduction in second phase (2013–2015).*

Table F2 provides details of the corresponding US EPA Tier 1 to Tier 3 emissions standards for engines rated above 560 kW and Table F3 outlines the respective requirements under US EPA Tier 4 emissions standards.

**Table F2 US EPA Tier 1 to Tier 3 emissions standards – engines above 560 kW**

| Rated power | Tier | Model year | Emissions standards | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Units | CO | HC | NMHC + $NO_X$ | $NO_X$ | PM |
| ≥ 560 kW (≥ 750 hp) | Tier 1 | 2000 | $g{\cdot}kWh^{-1}$ | 11.4 | 1.3 | - | 9.2 | 0.54 |
| | | | $g{\cdot}bhp\text{-}hr^{-1}$ | 8.5 | 1.0 | - | 6.9 | 0.4 |
| | Tier 2 | 2006 | $g{\cdot}kWh^{-1}$ | 3.5 | - | 6.4 | - | 0.2 |
| | | | $g{\cdot}bhp\text{-}hr^{-1}$ | 2.6 | - | 4.8 | - | 0.15 |

**Note**: NMHC – non-methane hydrocarbon

**Table F3 US EPA Tier 4 emissions standards – engines above 560 kW**

| Model year | Category | Emissions standards | | | | |
|---|---|---|---|---|---|---|
| | | Units | CO | NMHC | $NO_X$ | PM |
| 2011 - 2014 | Generator sets > 900 kW | $g{\cdot}kWh^{-1}$ | 3.5 | 0.40 | 0.67 | 0.10 |
| | | $g{\cdot}bhp\text{-}hr^{-1}$ | 2.6 | 0.30 | 0.50 | 0.075 |
| | All engines except gensets > 900 kw | $g{\cdot}kWh^{-1}$ | 3.5 | 0.40 | 3.5 | 0.10 |
| | | $g{\cdot}bhp\text{-}hr^{-1}$ | 2.6 | 0.30 | 2.6 | 0.075 |
| 2015 | Generator sets | $g{\cdot}kWh^{-1}$ | 3.5 | 0.19 | 0.67 | 0.03 |
| | | $g{\cdot}bhp\text{-}hr^{-1}$ | 2.6 | 0.14 | 0.5 | 0.022 |
| | All engines except gensets | $g{\cdot}kWh^{-1}$ | 3.5 | 0.19 | 3.5 | 0.04 |
| | | $g{\cdot}bhp\text{-}hr^{-1}$ | 2.6 | 0.14 | 2.6 | 0.03 |

**Note**: NMHC – non-methane hydrocarbon

European emissions standards follow a tiered approach, akin to the US, driven by EU parliamentary directives. EU Directive 2015/2193 on Medium Combustion Plant (MCPD) establishes requirements for stationary combustion plants with a thermal rating of equal to or more than 1 MW and less than 50 MW with limits for $SO_2$, $NO_X$, and PM.

According to MCPD Article 6, emergency plants operating less than 500 hours per year, as a five-year rolling average, are exempt from emission limit values. Each generator with its own discharge stack, under MCPD provisions, can operate for testing or emergencies for up to 500 hours per calendar year without emission limit values under the MCPD. If generators share a common discharge stack, the set can be tested and maintained without emissions limit values for up to 500 hours per year.

Other non-road engine emissions in Europe adhere to EU Directive 2016/1628, known as the NRMM Regulation. This regulation sets emission limits for various power ranges and applications, outlining procedures for engine manufacturers to obtain type-approval. European Stage V standards, derived from Directive 2016/1628, mandates stringent limits on PM emissions, necessitating diesel particulate filters (DPFs) for non-road engines rated between 19 kW and 560 kW. Stage V emissions limits are also established for engines above 560 kW.

Table F4 provides the EU Stage V emissions limits for generators set engines rated above 560 kW.

**Table F4 EU Stage V emissions limits by engine category**

| Engine category | Ignition type | Net power (kW) | Date | Emission limit ($g{\cdot}kWh^{-1}$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | CO | HC | $NO_X$ | PM |
| NRG-v-1<br>NRG-c-1 | All | P > 560 | 2019 | 3.5 | 0.19 | 0.67 | 0.035 |

While the standby generators for the Project have already been determined, ensuring that the selected generators are compliant with the abovementioned emissions standards has been considered in this review **[S1]**.

**Selection of Fuel**

The Project site utilises diesel for the purposes of standby power generation. Diesel is typically the fuel used for emergency generators, and reciprocating engines fuelled by low-sulphur diesel are the most common choice for other developments of this nature.

Diesel fuel in Australia is subject to specified parameters governing environmental factors like sulphur and hydrocarbons (HC), as well as operational considerations such as carbon residue and sediments, which can impact engine performance.

Part 9 of the POEO CAR specifies limits on sulphur content within liquid fuel, whereby clause 159(2) states:

> *"A person must not operate fuel burning equipment powered by a reciprocating internal combustion engine using diesel, if the fuel has a sulfur content of more than the sulfur content specified for diesel—*
>
> *(a) in a fuel standard determined under the Fuel Quality Standards Act 2000 of the Commonwealth, section 21, or*
>
> *(b) in an approval granted under the Fuel Quality Standards Act 2000 of the Commonwealth, section 13."*

The Fuel Standard (Automotive Diesel) Determination 2001, as authorised by the Fuel Quality Standard Act 2000 denotes that diesel fuels must not contain more than 10 $mg{\cdot}kg^{-1}$ (ppm) from 1 January 2009.

In the US, non-road engine emission regulations allowed higher sulphur content (up to 0.5 %) at Tier 1 to Tier 3 stages. However, to accommodate sulphur-sensitive control technologies in Tier 4 engines, like catalytic particulate filters, the US EPA mandated a reduction in sulphur content to 15 ppm for non-road diesel fuels.

Alternative fuel types identified through the desktop review include natural gas, propane, gasoline, liquefied natural gas (LNG). These fuels may provide gas engines with higher thermal efficiencies when compared to use over diesel generators. However, it is important to note that gas engines may come with relatively higher levels of investment, operating and maintenance costs. Additionally, whilst the use of gas engines may have the potential for lower $NO_x$ emissions compared to diesel engines, there would be a reliance on the national gas grid for an uninterruptable supply, which may not provide the Proponent with fuel security **[S3]**.

**Discharge Design**

According to (UK Environment Agency, 2018), data centres can have short, below roof level emissions stacks, which can impact on the efficiency of dispersion of emissions. With reference to BAT, the following techniques are noted for the adequate dispersion of exhaust emissions:

1. Increased stack height
2. Vertical ports
3. Increased distances from buildings to be above roof line
4. 'Common windshield' combining several individual flues.

**Stack Height**

By raising the stack height, this can facilitate a higher level of dispersion of exhaust gases as they mix with the surrounding air beyond the stack plume. Although this does not decrease the pollutant concentration at source, this does aide in reducing pollutant concentrations at ground level. Elevating the stack height serves to mitigate the impact of building wake and the entrainment of emissions in the locality of the emission source.

When wind interacts with buildings or structures, turbulent eddies form on the downwind side, potentially forcing a stack plume down to the ground if it's located within approximately five times the height of the nearby structure. This turbulence, known as building downwash, can lead to increased ground-level pollutant concentrations downstream of the building or structure.

Elevating the stack height above the highest point of the building in which it is located (or nearby buildings) will help mitigate building downwash effects and reduce air quality impacts beyond the Project site, where feasible **[S4]**.

**Discharge Velocity**

Decreases in ground-level pollutant concentrations can be accomplished through improved mixing with the surrounding air once the exhaust gas plume terminates from the stack. A higher emission velocity generates increased momentum, increasing the height of the plume in the atmosphere beyond the stack exit point. This increased vertical mixing contributes to lower pollutant concentrations at surrounding receptors.

Any increase in discharge velocity should be considered alongside any improvements to the stack height to optimise plume dispersion conditions.

Increasing discharge velocities associated with the standby generators may be achieved by:

- increasing the air extraction rate from the discharge point; and / or
- decreasing the physical dimensions of the discharge point; and / or
- the addition of dilution air into the exhaust stream prior to discharge.

Exhaust stack restriction devices can regulate the corresponding exhaust flow through adjustment of the cross-sectional area of the stack at point of discharge **[S5]**

Enhanced discharge velocity may also be gained through the use of dilution fans (for example[5]). They operate by drawing in additional air below the point of discharge to increase volumetric flow and increasing discharge velocity. The effect of this is to significantly increase vertical momentum, which can increase the effective discharge height to conditions that are less affected by turbulent air flows over buildings and enhance dispersion.

They can be configured by multiple inlet manifold and variable speed drive fans to serve multiple discharge points, and as such may offer a practical solution for data centres that are designed with nested discharge points and have highly variable discharge flows.

Such devices have been used on other developments in the Greater Sydney region to good effect **[S6]**.

**Discharge Temperature**

High stack exhaust temperatures can increase both buoyancy and plume rise dispersion conditions. Plumes tend to rise more rapidly when the associated gases are warmer compared to the atmospheric temperature, which in turn contributes to a higher plume rise which can affect the dispersion pattern.

Combustion modification such as changes to the flame temperature and $O_2$ content of the air-fuel (stoichiometric) mixture aim to reduce $NO_x$ pollution by ensuring that the fuel is burned completely, or reducing the amount of nitrogen from the air that is burnt in the combustion process. Such approaches include lean burn, water injection, exhaust gas recirculation or low-$NO_x$ boiler designs that reduce the flame temperature.

Secondary abatement technologies such as SCR operated within a narrow temperature range. Operating at lighter loads typically results in emissions at lower temperature, resulting in poorer performance of SCR aftertreatment **[S7]**.

[5] https://www.criticalairflow.com/site/assets/files/1080/critical_airflow_tristactech.pdf

### Multi-Stack Configuration

By physically bringing together the exhaust streams for multiple engines, it is possible to improve the mixing of flue gases with the surrounding air. This plume aggregation does not decrease the absolute quantities of pollutants being emitted however it can lead to enhanced plume dispersion which results in lower concentration at ground level.

A multi-flue stack configuration pertains to a chimney or exhaust system that contains several flues, where each generator can discharge independently through its own flue but is constrained within that stack. Multi-flue stacks are common in facilities with multiple combustion processes. Each flue may lead to a specific emission control system or stack gas treatment unit.

A combined flue stack configuration involves the use of a single exhaust stack system for the collective discharge of combustion byproducts from various power generation sources. This serves as the termination point with each flue feeding into the shared exhaust system **[S8]**.

### Air Pollution Control

Air pollution control (APC) encompasses a range of technologies and strategies aimed at eliminating or minimising the release of pollutants into the atmosphere. With regard to standby power generation from diesel combustion, the application of exhaust aftertreatment technologies is common.

Known air pollution control technologies that are available to reduce diesel combustion pollutant emissions include:

- **Diesel Oxidisation Catalyst (DOC) –** use of a catalyst to promote the oxidation of CO and hydrocarbons (HC) contained in the diesel exhaust gas to produce $CO_2$ and water as byproducts.
- **Diesel Particulate Filters (DPF) –** filters particulate matter (PM) from the exhaust gas and is 'burned off' through either active of passive filter regeneration.
- **Selective Catalytic Reduction (SCR) –** emissions control method that reduces $NO_x$ emissions within exhaust gases by injecting a reducing agent which initiates a chemical reaction that converts $NO_X$ into $N_2$, water, and small amounts of $CO_2$.
- **Non-selective Catalytic Reduction (NSCR) –** use of a catalyst reaction to simultaneously reduce $NO_X$, CO, and hydrocarbon (HC) to water, $CO_2$, and $N_2$.

A diesel oxidisation catalyst (DOC) is an aftertreatment component that is designed specifically for modern diesel engines to convert CO and HC and are commonly used alongside other emission control devices such as DPF and SCR systems. DOCs can achieve a higher level of performance with the use of low sulphur diesel. General information provided by the US Environmental Protection Agency[6] (US EPA) indicates that DOCs are

[6] https://www.epa.gov/sites/default/files/2016-03/documents/420f10031.pdf

typically effective at reducing emissions of particulate matter (PM) between 20 % to 40 %, HC emissions can be reduced between 40 % and 75 % and CO emissions between 10 % and 60 % **[S9]**.

A Diesel Particulate Filter (DPF) serves as an APC device aimed at minimising particulate matter (PM) emissions linked to diesel engine exhaust. Positioned downstream of the engine, the DPF employs a filtration medium, typically a porous ceramic filter, to capture PM. Subsequently, the accumulated PM undergoes combustion at elevated temperatures to ensure effective removal. This technology can be combined with other emissions controls including SCR and DOC as DPF has a limited effect on other pollutants such as $NO_X$.

Passive regeneration takes place when the exhaust gas temperatures reach a level that initiates the combustion of collected PM within the DPF without the need for additional fuel, heat, or driver intervention. Conversely, Active regeneration may necessitate external sources of fuel or heat to elevate the DPF temperature to a point where the accumulated PM can be effectively combusted.

The associated control efficiencies for DPF technology, as verified by US EPA[7] ranges between 85 % and 90 % for PM emissions **[S10]**.

Selective catalytic reduction (SCR) control devices are considered to be one of the most effective abatement techniques for $NO_X$ releases. SCRs induce a chemical reduction via a reducing agent and catalyst to convert $NO_X$ to molecular nitrogen ($N_2$) and water in the presence of a catalyst. In mobile source applications, an aqueous urea solution is typically preferred as the reductant. The LCP BREF (Lecomte, et al., 2017) notes that, *"A higher $NO_X$ reduction is achieved with the use of several layers of catalyst. The technique design can be modular; a special catalyst and / or preheating can be used to cope with low loads or with a wide flue-gas temperature window."*

Conversion of $NO_X$ occurs on the catalyst surface with an ideal temperature range of between 300 °C and 450 °C, and less effectively over a wider temperature range of 170 °C and 510 °C depending on the catalyst type and/or configuration employed.

SCR can typically reduce $NO_X$ emissions between 75 % and 90 %, HC emissions by up to 80 %, and PM emissions between 20 % and 30 %[8]. SCR requires the engine and exhaust system to reach operating temperature to be effective, requiring special pre-heaters for $NO_X$ reduction in standby generators, which may reflect a higher cost for implementation **[S11]**.

Selective Non-Catalytic Reduction (SNCR) involves reducing $NO_x$ to $N_2$ through the reaction with ammonia ($NH_3$) or urea ($CH_4N_2O$) at a temperature between 800 °C and 1 100 °C for optimal reaction. The LCP BREF (Lecomte, et al., 2017) provides a technical description for SNCR, whereby, "*Using ammonia as a reagent, the following chemical reactions take place more or less at the same time. At the lower temperature, both*

7 https://www.epa.gov/sites/default/files/2016-03/documents/420f10029.pdf

8 https://archive.epa.gov/international/air/web/pdf/default-file_dieselfact_0106.pdf

*reactions are too slow; at the higher temperature, the unwanted by-reaction dominates with an increase in $NO_X$ emissions."*

In contrast to SCR technology, a catalyst is not required, which lowers investment and maintenance costs, and less space is required to house the SNCR technology at the generator location. The LCP BREF (Lecomte, et al., 2017) notes that SNCR cannot be applied to gas engines or turbines due to the residence time and temperature window required for operation. SNCR processes can typically achieve a $NO_X$ reduction level of between 30 % and 50 % (Lecomte, et al., 2017).

In NSCR technology, the engine exhaust flows through a catalyst bed where $NO_x$ is converted to $N_2$. Simultaneously, VOCs and CO undergo oxidation, resulting in the formation of water and $CO_2$ under optimal conditions.

A technical progress report on reciprocating engine emissions control (Chapman, 2004) notes that, "*For an NSCR system to operate optimally (i.e., to minimize $NO_x$ emissions), the inlet exhaust stream must have very low oxygen content, as well as proper concentrations of $NO_x$, hydrocarbons, and carbon monoxide. This requires initial engine adjustments, followed by careful monitoring of oxygen content in the exhaust.*"

The catalyst demands exhaust with less than 0.5 % $O_2$ content. Although employing a fuel-rich mixture increases engine fuel consumption due to back pressure, it enables effective $NO_X$ control, typically achieving levels between 90 % and 98 %[9] **[S12]**.

Various standby generator manufacturers have developed retrofit emission control device (RECD) systems[10] based on electrostatic precipitation (ESP) fundamentals for use with diesel generator sets. The RECD is installed after the standby generator exhaust and no modifications to the exhaust are required. However, the RECD would have additional spacing requirements which may be constrained at the Project site **[S13]**.

Each air pollution control device identified in this section requires retrofitting to each standby generator (or each discharge point in the event of co-vented discharges), incurring associated costs. Retrofitting involves integrating or adding these devices to existing plant to enhance their emission control capabilities. The costs associated with this process include expenses for purchasing the control devices, installation, and potentially ongoing maintenance **[S10-13]**.

**Controls in the Pathway**

Enhancing the dilution and dispersion of a pollutant plume during its journey from the source to the receptor will lower the concentration at the receptor, subsequently minimising exposure. For instance, extending the

[9] https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf

[10] http://www.jnmachineries.com/cummins_retrofit_emission_control_device.php

pathway, such as by emitting emissions from a tall stack, will generally, under constant conditions, increase both dilution and dispersion conditions.

**Green Infrastructure**

The integration of Green Infrastructure (GI) in the environment has the potential to reduce the effectiveness of the pathway from the emission source to the receptor. Introducing natural elements, like vegetation or green spaces, as contiguous barriers can disrupt the usual flow of pollutants, creating obstacles that impede the direct transmission of emissions. This interference promotes dispersion, dilution, and absorption of pollutants by greenery, which can aide in lowering the concentration of pollutants reaching the receptor.

Strategically placed Vegetative Environment Buffers (VEB) along the perimeter of industrial areas, abutting sensitive areas such as residential, child-care and educational facilities can aide in mitigation human exposure to air pollution.

According to recent research (Barwise & Kumar, 2020), the optimal configuration and plant composition of GI are unclear. Furthermore, the effectiveness of GI depends on factors such as the condition of the built environment, as well as the type, location, and configuration of GI (Kumar, et al., 2019) **[P1]**.

**Structural Barriers**

Structural barriers such as sound walls or shelterbelts can influence the exposure pathway by obstructing the pollutant plume. These barriers can induce turbulence in the airflow, leading to enhanced dispersion and are used in industrial settings to reduce direct exposure to emissions at receptors. These methods may be more feasible in comparison to GI which would also require additional considerations with regard to establishment and maintenance activities.

The Project site is located within a predominately industrial zone with residential land uses located to the south and east.

While the discharges are released at a height, the implementation of structural barriers may be limited to the immediate vicinity of the Project site due to the distance to sensitive land uses and the magnitude of the discharge and structural constraints due to the increased loads of such structures **[P2]**.

**Stack Height Optimisation**

Increasing the stack height can influence the dispersion pattern of pollutants emitted from a stack. A taller stack emits the discharge at greater height and into atmospheric conditions which can enhance more effective dispersion.

Stack heights may be increased through retrofitting, noting that the increased height may have an effect of duct pressure which may affect performance of APC devices.

Often, planning restrictions may also impose limitations on stack heights to limit other environmental effects such as visual impact and design aesthetics **[S4, P3]**.

## Controls at Receptors

### Air Filtration Systems

Air filtration systems reduce indoor pollutant levels in buildings by extracting contaminants from airflow and commonly feature filters like activated carbon and high efficiency particulate attenuator (HEPA) filters, which capture airborne pollutants, particularly particulates, effectively.

Research conducted by the Public Health Research & Practice[11] assessed the effectiveness of air filtration, particularly those utilising HEPA filtration, in residential settings, focusing on their potential to increase infiltration rates. The research focused on the quantification of HEPA filters in residential settings during smoke events and notes that:

> *"The percentage reduction of $PM_{2.5}$ attributable to using the HEPA cleaner, which ranged between 30 % and 75 %. Other international studies suggest that HEPA cleaners can provide approximately 52 % – 67% reductions in PM…"*

The effectiveness of HEPA cleaners depends on several factors, including outdoor smoke concentrations, room size, housing characteristics and building ventilation"

Commercial and industrial buildings in the surrounding environment likely incorporate air handling units (AHU) within their respective building design whilst residential dwellings may also have some uses.

This control is by definition, only of value inside engineered airtight buildings and of limited value in non-airtight buildings (such as residential properties), and of no value in outdoor locations **[R1]**.

### Alerts and Alarms

Implementation of air quality monitoring networks and early warning systems can assist in safeguarding sensitive receptors in proximity to the Project site. These systems can detect pollutant levels in real-time and can issue timely alerts, which can alert the local community to any potential pollution episodes. Alarm and alert systems that could be potentially implemented include:

- Real-time air quality monitoring stations that detect elevated levels of pollutants.
- Automated warning systems that send alerts via SMS, email, or mobile apps to the local community when pollution levels exceed any impact assessment criterion or predetermined thresholds.
- Integration with weather forecasting data to anticipate changes in air quality due to meteorological conditions.
- Online platforms or dashboards providing up-to-date information on air quality advisories for the community.

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[11] https://www.phrp.com.au/issues/online-early/residential-indoor-air-quality-and-hepa-cleaner-use/

Increased community engagement, through mediums such as public forums, community advisory boards and meetings can help educate the local community to understand the Project site's procedures for standby power generation and the potential implications on air quality. The associated costs of implementing real time air quality monitoring and automated warning systems may not be viable given the likelihood of the Project site suffering a catastrophic power outage.

If implemented, each standby generator will feature operational alarms to alert in case of faults and will adhere to maintenance schedules and compliance monitoring programs to ensure emission control equipment functions correctly and complies with regulations. Regular testing and monitoring of the standby generators would incur costs **[R2]**.

**Summary**

The feasibility of implementing the identified control options in the SPR model have been evaluated by considering the following factors:

- Implementations cost;
- Regulatory requirements;
- Environmental impacts;
- Safety implications; and
- Compatibility with current processes.

This summary assesses the measures that may constrain the implementation of the control measures outlined above. Each measure is provided a risk rating (**low**, **medium**, or **high**) which identifies the constraints which may result in the implementation of the measure not being practical at the Project site. Where any of the measures of practicability are rated as high, these measures are not considered further.

It is noted that for the assessment of implementation costs, this review has adopted a relative and qualitative approach as follows:

- Low = $
- Medium = $$
- High = $$$

Table F5 provides a summary of the additional controls that could be employed at the Project site to minimise and reduce air pollution impacts from the standby generator operations.

Table F5 Practicality of implementing control measures at the Project site

| Control measure | Potential Constraints | | | | | Conclusion of evaluation |
|---|---|---|---|---|---|---|
| | Implementation costs | Regulatory requirements | Environmental impacts | Safety implications | System compatibility | |
| **Source** | | | | | | |
| S1 generator specification | $$$ | Low | Low | Low | High | • Selecting alternative generator sets may be a high cost option and could be very difficult to implement once the facility is operating. |
| S2 low $NO_x$ burners | $$$ | Low | Low | Medium | Low | • Change in designed operational conditions (combustion stability, heat exchange) represents some safety issues that would require due consideration.<br>• May offer additional air pollution control, however, would require extensive retrofitting to each standby generator. |
| S3 alternative fuels | $$ | Low | Low | High | High | • Compatibility, storage and handling capabilities and combustion characteristics. Standby generators utilise diesel fuel and would require significant modification, and/or re-specification. |
| S4 stack height | $ | Low | Low | Medium | Low | • Compatibility with clearance requirements to negate building downwash effects, stability, and structural integrity considerations.<br>• May be considered feasible for implementation. |
| S5 increased stack velocities | $ | Low | Low | Medium | Low | • Change in designed operational conditions which may then require structural integrity considerations to stack configuration.<br>• May be feasible for implementation. |
| S6 dilution fans | $$ | Low | Low | Low | Medium | • Higher capital cost but reduced operating costs due to inlet manifolds serving multiple discharges and variable drives. Retrofitting may require load considerations.<br>• May be considered a feasible for implementation. |

| Control measure | Potential Constraints | | | | | Conclusion of evaluation |
|---|---|---|---|---|---|---|
| | Implementation costs | Regulatory requirements | Environmental impacts | Safety implications | System compatibility | |
| S7 stack temperature | $$ | Low | Low | Low | Low | • May be considered feasible for implementation. |
| S8 multi-stack configuration | $$ | Low | Low | Medium | Medium | • Structural and maintenance considerations are required from design perspective.<br>• Additional works required to combine flues into a multi-stack configuration.<br>• Separating exhaust into multiple stacks may aide in optimizing airflow, reducing backpressure, and enhancing generator performance. |
| S9 diesel oxidisation catalyst | $$ | Low | Low | Medium | Low | • Require additional design considerations.<br>• May offer additional air pollution control, require retrofitting each standby generator. |
| S10 diesel particulate filters | $$ | Low | Low | Medium | Low | • Require additional design considerations.<br>• May offer additional air pollution control, require retrofitting each standby generator. |
| S11 selective catalytic reduction | $$ | Low | Low | Medium | Medium | • Require additional design considerations.<br>• May offer additional air pollution control, require retrofitting each standby generator. |
| S12 non-selective catalytic reduction | $$ | Low | Low | Medium | Medium | • Require additional design considerations.<br>• May offer additional air pollution control, would require retrofitting to each standby generator. |
| S13 electrostatic precipitation | $$ | Low | Low | Medium | Medium | • Require additional design considerations.<br>• May offer additional air pollution control, would require retrofitting each standby generator. |

| Control measure | Potential Constraints | | | | | Conclusion of evaluation |
|---|---|---|---|---|---|---|
| | Implementation costs | Regulatory requirements | Environmental impacts | Safety implications | System compatibility | |
| **Pathway** | | | | | | |
| P1 green infrastructure | $ | Low | Low | Low | Low | • May be feasible for implementation |
| P2 structural barriers | $$ | Medium | Low | Medium | Low | • Require compliance with building codes, planning policies.<br>• Choice, design, and stability capabilities for type of barrier used.<br>• Strategic use of barriers may provide airflow restrictions from source to receptor. |
| P3 optimised stack height | $$ | Low | Low | Medium | Low | • Compatibility with clearance requirements to negate building downwash effects, stability, and structural integrity considerations. |
| **Receptor** | | | | | | |
| R1 air filtration systems | $$ | Low | Low | Low | Low | • May be feasible for implementation |
| R2 alerts and alarms | $ | Low | Low | Low | Low | • May be feasible for implementation |

**air quality | environment | sustainability**

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


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