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Julius Avenue Data Centre (SSD-80018208)

Air Quality Impact Assessment

Addressee(s): ISPT Pty Ltd

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Final Authority

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



Martin Doyle

1 December 2025

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NON-TECHNICAL SUMMARY

Northstar Air Quality Pty Ltd has been engaged by Logic Projects Co on behalf of ISPT Pty Ltd to perform an air quality impact assessment in support of a State Significant Development Application submitted to the NSW Department of Planning, Housing and Infrastructure for the development of the Julius Avenue Data Centre located at 6-8 Julius Avenue, North Ryde, NSW.

This assessment evaluates the potential air quality impacts associated with the construction and operation of the Julius Avenue Data Centre, following NSW Environment Protection Authority guidelines.

The assessment considers emissions from two key scenarios: a justified worst-case scenario involving all emergency standby generators operating at 100 % load during a power supply failure, and a more realistic scenario based on planned, controlled monthly generator testing. It evaluates the associated impacts and provides, where required, recommendations for management and monitoring measures to ensure compliance with relevant air quality standards and to protect nearby sensitive receptors.

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.

Predicted air quality impacts under the worst-case scenario, with all generators operating simultaneously at full (100 %) load, have been assessed in the context of the likelihood of such conditions. This includes consideration of the probability of an electrical supply failure based on historical Ausgrid SAIDI performance data. The analysis demonstrates that, even under a hypothetical exceedance scenario, the combined probability of both a power outage and an air quality exceedance occurring is extremely low.

Predicted cumulative concentrations for a realistic emissions scenario during routine maintenance of the standby generators show that no exceedances are predicted to occur at any surrounding receptors for all assessed pollutants. The predicted cumulative concentrations for all assessed pollutants remain below the relevant criteria under realistic operations, where the standby generators are to be operated under an appropriate testing schedule.

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1. INTRODUCTION

Northstar Air Quality Pty Ltd (Northstar) has been commissioned by Logic Projects Co on behalf of ISPT Pty Ltd (the Applicant) to perform an air quality impact assessment (AQIA) to accompany a State Significant Development Application (SSDA) for the Julius Avenue Data Centre (SSD-80018208, the Proposal) at 6-8 Julius Avenue, North Ryde (the Proposal site).

The AQIA has been prepared to support the SSDA submission to the NSW Department of Planning, Housing and Infrastructure (NSW DPHI). It has been completed 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 Proposal, aligning with the NSW Planning Secretary's Environmental Assessment Requirements (SEARs), and outlines mitigation and monitoring requirements commensurate with those anticipated impacts to ensure that air quality criteria are achieved at sensitive receptor locations.

1.1. Purpose of the AQIA

The purpose of this AQIA is to assess the potential air quality impacts associated with the Proposal and to identify appropriate mitigation measures to ensure that the required environmental outcomes are achieved during both construction and operation.

The specific objectives of this AQIA are to:

- Identify existing air quality conditions and the location, extent and sensitivity of nearby receptors;
- Assess the potential impacts of the Proposal on air quality to support approvals under relevant legislation, policies and guidelines; and
- Provide recommendations to avoid or, where avoidance is not practicable, minimise impacts on identified air quality values.

To enable assessment of the level of risk associated with the Proposal in relation to air quality, the AQIA has been performed in accordance with, and with due reference to the following legislation, policy and guidelines (in no particular order):

- *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 and
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.

Appendix A provides a list of abbreviations, nomenclature, and units used in this AQIA.

1.2. Changes to the AQIA

Design refinements have been made since publication of the submitted AQIA (Northstar, 2025) which affected several parameters relevant to the assessment. Key updates include:

- Reduction in total IT load capacity from 115.2 MW to approximately 76 MW, reducing the number of data halls from 12 to eight (8) and lowering building height from 50.9 m to 40 m (from seven stories plus basement and rooftop plant to five stories plus rooftop plant).
- Removal of the basement and relocation of parking to ground level, with associated changes to building form and volume.
- Reduction in gross floor area (GFA) from 26 076 m² to approximately 17 515 m².
- Reduction in the number of critical IT standby generators on site from 72 to 48, with reconfigured generator flue locations to the south of each gantry. Associated diesel fuel capacity has been reduced on account of the reduction of standby generators, from 1 279 kilolitres (kL) to 955 kL.
- Revision of the Sub-Transmission Switching Station (STSS) configuration, including reduced capacity and relocation to the eastern side of the site.
- Minor layout and landscape adjustments consistent with updated architectural and planning requirements.

These changes have the potential to alter the operational load profile previously considered which in may also impact on emission rates and building-wake effects considered in the AQIA. The assessment has therefore been updated to reflect the revised design inputs.

1.3. NSW Planning Secretary Environmental Assessment Requirements

This AQIA has been prepared in response to the requirements contained within the NSW Planning SEARs for Data Storage Centres, which were issued for the SSDA (SSD-80018208) on 20 February 2025.

Table 1 details the SEARs coverage and indicates where requirements have been addressed within this AQIA.

Table 1 SEARs Compliance - SSD-80018208

Issue	Assessment Requirements	Addressed
Air Quality	Provide an assessment of air quality impacts, prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.	This AQIA
	The assessment must address construction works ...	Section 5.1 Section 6 Section 8.1 Appendix B

Issue	Assessment Requirements	Addressed
	... and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) ...	Section 5.2 Section 7 Section 8.2
	... and a peak emission and air pollutant scenario ...	Section 5.2 Section 7.1 Section 8.2.1
	... and outline the proposed mitigation, management and monitoring measures that would be implemented.	Section 8.2 Appendix B

Section 9 of the Approved Methods 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 - Figure 4
All emissions sources clearly identified	Figure 7 - Figure 9, Section 5.2.3
Plant boundary	Figure 1
Sensitive receptors (e.g. nearest residences)	Section 4.2
Topography	Section 4.5 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 Section 2.3.2
A detailed list of all process inputs and outputs	Section 2.2 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 8.2.5 Section 8.2.6
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 8.2.5 Section 8.2.6
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

Assessment component	Addressed
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 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 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 Appendix D
Tables summarising the ambient monitoring data	Appendix D
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 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

1.4. Test Of Adequacy

As part of the SSDA process, a Test of Adequacy (ToA) was carried out by NSW DPHI to confirm that the draft Environmental Impact Statement (EIS) addressed the SEARs (refer Table 1). On 6 June 2025, NSW DPHI issued comments on this AQIA for SSD-80018208.

Table 3 presents the ToA comments and the clarifications provided to NSW DPHI in response. The AQIA was subsequently updated where relevant (Northstar, 2025), with explanatory clarifications provided where no changes were required.

Table 3 Test of Adequacy commentary – SSD-80018208

NSW DPHI ToA commentary	Clarification / response
The Noise and Vibration Impact Assessment (Appendix 18) has adopted the MTU 20V 4000 G94LF generator for assessment, whereas the Air Quality Impact Assessment has adopted the CAT C175-20 diesel generator set for assessment.	Generally, all consultants have taken the 'worst case' option for plant selection as it relates to their assessment. Northstar have used the worst case emissions criteria whereas Arup have used the worst case noise emissions criteria. Generator selection is not finalised at this stage hence we believe this to be a sensible conservative approach. No change proposed.
Section 2.3.2.1 of the AQIA notes that <i>"The separate 1 MW generator, located on the roof of the FOH building within an acoustically treated enclosure, was not included in the dispersion modelling, as key technical specifications (e.g. discharge height, location, and emissions parameters) were unavailable at the time of assessment"</i> . Please include this element of the project in the dispersion modelling, adopting reasonable benchmarks where key technical specifications are not available.	AQIA has been updated. EIS updated to reference generator testing requirements for all 73 generators. The power supply is dual redundant as correctly stated in the AQIA and the Infrastructure Delivery, Management & Staging Plan has been updated accordingly.
Section 2.3.2.1 of the AQIA references a dual redundant power supply, as per the following quote. This dual redundant power supply is not referenced within the EIS, please clarify. <i>"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 secondary back-up to the primary provision of a dual redundant power supply, and as such their use is designed to be minimal."</i>	
The mitigation measures in Table B10 of Appendix B of the AQIA have not been carried over into Appendix D of the EIS	Mitigation measures updated in EIS

1.5. Response to Submissions

Supplemental to the ToA conducted by NSW DPHI (refer Section 1.3) for SSD-80018208, NSW DPHI coordinated a series of responses to the issues raised during the exhibition period and public submissions. This process is intended to address issues raised in submissions, ensure the community receives feedback from the Applicant, and assist the consenting authority in its evaluation of the Proposal.

To support this process, NSW DPHI requested the preparation of a Submissions Report to formally respond to all public comments, Council and agency submissions. On 26 September 2025, NSW DPHI provided direction on additional matters to be included such as a request for further information with regard to the submitted AQIA (ref. 25.1064.FR1V5, dated 19 June 2025 (Northstar, 2025)).

Table 4 summarises the NSW DPHI comments and the corresponding clarifications.

NSW EPA provided recommended information and assessment requirements in correspondence dated 27 August 2025. These requirements, relating to data centre assessments, have been considered by NSW DPHI and are presented in Table 4.

The AQIA has been updated where relevant, with detailed responses to air quality related matters incorporated into the Submissions Report.

Table 4 Response to submissions commentary – SSD-80018208

Commentary	Clarification / response
NSW DPHI – Julius Avenue Data Centre – Additional Matters for Submissions Report – 26 September 2025	
10. It is noted that the EIS documentation does not include an assessment of potential air pollution or urban heat island effects on nearby sensitive public recreation areas, such as the Great North Walk. These areas may be particularly vulnerable to changes in local air quality and microclimate conditions, especially during prolonged generator testing or other heat- and emission-generating activities. In addition, the proposal involves the clearing of significant vegetation, which may further exacerbate both air quality impacts and localised urban heat effects by reducing natural shading, evapotranspiration, and pollutant filtration. Please provide an assessment of potential air quality and urban heat impacts on these types of receivers, including: • Identification of relevant public recreation areas within the potential impact zone. • Consideration of cumulative heat and emissions from proposed activities (e.g. generator operation from 7 am to 6 pm), in the context of vegetation removal. • Any mitigation measures proposed to minimise impacts on users of these areas. This information is required to ensure that potential impacts on public health, amenity, and the local environment have been adequately assessed.	The amended AQIA includes additional sensitive receptor locations positioned along nearby public recreation areas, including several points on the Great North Walk (Receptor R25 to receptor R32). These receptors represent key public use areas such as the Riverside Walk, Fairylands, Ironbarks, and Carters Creek. Figure 4 and Table 9 have been updated, and both incremental and cumulative pollutant concentrations have been predicted for these locations. Assessment of urban heat and microclimate effects is outside the scope of the AQIA.
16. Further information is required to clarify the anticipated total duration of backup generator usage and testing per year, excluding power outage events. The Department notes discrepancies across the EIS, with quoted totals of 194.4 hours (NVIA), 197.1 hours (AQIA), and 256 hours (GHGA). Please confirm the correct figure and explain the basis for the variation with reference to any manufacturer requirements for efficient operation and avoidance of improper operation.	The discrepancies noted in earlier assessments reflect previous versions of the generator inventory and testing assumptions. With the reduced number of standby generators, the Applicant has recalculated the testing regime, resulting in a revised annual total of 132.3 hours based on a 27-minute test cycle (22 minutes runtime plus 5 minutes cooldown (refer Table 5)). This remains well below the 200 hour exemption threshold under the POEO Act for scheduled electricity generation activities. The updated total is derived from the monthly functional testing program, which allows for up to 25 test events per month.

Commentary	Clarification / response
17. The Air Quality Impact Assessment notes there could be up to 37 tests conducted each month. Further information is required to clarify the maximum duration of testing on any given day, noting that the proposed operating hours suggest testing could occur for up to 11 hours continuously from 7am to 6pm. This clarification is necessary to assess potential short-term impacts and cumulative exposure risks, including those related to noise and urban heat.	The testing program includes up to 25 generator tests per month, with each generator completing a 27 minute cycle (22 minutes runtime and 5 minutes cooldown). Testing is carried out in pairs i.e. two at any one time, with one generator on the eastern side and one on the western side operating at the same time. Under this configuration, the maximum possible testing duration on any given day is governed by the sequential scheduling of these paired 27 minute tests. Even if all monthly tests were conducted on a single day, a scenario that is operationally unlikely with the total cumulative testing period would equate to approximately 11 hours [27 minutes x 24.5 generator tests]. In practice, testing would be distributed across several days each month in accordance with operational requirements. Testing is anticipated to be constrained to within daytime hours (7:00 am – 6:00 pm). The short duration of each test, combined with the two unit testing limit, constrains potential short-term and cumulative impacts. These parameters have been incorporated into the AQIA.
18. The Noise and Vibration Impact Assessment has adopted the MTU 20V 4000 GQ4LF generator for assessment, whereas the Air Quality Impact Assessment has adopted the CAT C175-20 diesel generator. Unless otherwise justified, please clarify which generator model is proposed and ensure consistency across technical assessments.	The Applicant confirmed that the CAT C175-20 diesel generator is the nominated model for assessment purposes for the critical IT operational configuration. A separate 1 MW generator, located on the roof of the FOH building within an acoustically treated enclosure (nominally a CAT DE1100 GC), is also included in the AQIA assessment (refer Table 3).

Commentary	Clarification / response
NSW EPA Response to EIS for the Julius Avenue Data Centre (SSD-80018208) – 27 August 2025	
a) Licencing requirements Proposals should clearly identify whether an Environment Protection Licence (EPL) will be required under the Protection of the Environment Operations (POEO) Act 1997. Information should be provided addressing the following thresholds in Schedule 1 of the POEO Act. • Clause 9 - Chemical Storage (diesel storage) – 2,000t, • Clause 9 - Chemical Storage (pressurised gases) – 20t, • Clause 17 - Energy Generation (back-up generators) – 30MW and 200hrs/pa, • Any other activity in Schedule 1 that may be undertaken at the premises.	Section 3.1 of the AQIA considers the relevant thresholds in Schedule 1 of the POEO Act, namely chemical storage (Clause 9) and electricity generation (Clause 17). The Proposal includes capacity to store up to 955 kL of diesel, which is below the 2 000 tonne threshold for chemical storage under Clause 9. While the combined standby generator capacity exceeds the 30 MW threshold under Clause 17, the proposed maintenance testing program totals 132.3 hours per year, which is below the 200 hour limit applicable to emergency standby plant. On this basis, both the diesel storage and the standby generator operation would be classified as non-scheduled activities under Schedule 1 of the POEO Act, and an Environment Protection Licence (EPL) would not be required for these activities.
b) Details of generator testing Proposals should clearly outline the proposed testing regime for back-up generators, and provide detailed information regarding: • All testing types and details (e.g. monthly, annual) of the maintenance schedule and unscheduled works that would require use of back-up diesel generators (e.g. electrical infrastructure works), • Number of tests for each generator per year. • Number of generators to be tested at any one time. • Testing duration for each generator (including start up and cool down). • Load during testing. • Time of the day testing will occur. • Maximum number of tests per day. • Total number of cumulative hours generators will be tested and operated per annum.	Section 2.3.2 outlines the proposed maintenance testing regime for the standby generators, with the considered schedule presented in Table 5. The regime comprises an annual total of 132.3 hours, based on a 27 minute test cycle (22 minutes runtime plus 5 minutes cooldown). Testing is assumed to occur during daytime hours (7:00 am to 6:00 pm) for the purposes of the AQIA. Up to 25 individual tests may occur within a monthly testing period. Monthly functional tests are conducted at 100 % load, consistent with the Applicant's maintenance guidance and industry practice, where a cumulative four hour on-load test is typically required annually. The number of generators operated at any one time and the number of tests per generator per year are set by this monthly schedule and the reduced generator inventory. The total cumulative testing hours per year (132.3 hours) remains well below the 200 hour POEO Act exemption threshold for scheduled electricity generation activities.

Commentary	Clarification / response
c) Assessment of air quality impacts Proposals should prepare an Air Quality Impact Assessment (AQIA). These assessments should be prepared in accordance with: • Approved Methods for Modelling and Assessment of Air Pollutants in NSW 2022. • Protection of the Environment Operations (Clean Air) Regulation 2022. Where a data centre, or future changes to a data centre, exceed the threshold for Energy Generation (back-up generators – 200hr/pa) in the POEO Act and require an EPL, the Proposal will need to comply with emission concentration limits listed in Schedule 2 and Schedule 3 of the Clean Air Regulation (including NO_x). Modelling Assessment reports should include modelling scenarios and inputs that represent reasonable worst-case scenario and address: • Typical operations, • Operational scenarios that include generator testing, • Emergency scenario (loss of power and 100% operation of back-up generators), including details on likelihood of occurrence, • Consideration of cumulative impacts, including quantitative assessment where there are potential testing conflicts with any nearby data centres or industries. Mitigation Assessment reports should include an appropriate level of information as required by the relevant guidelines on proposed mitigation and management measures, including: • Air – Should commit to replacement of generators with best available technology.	This AQIA has been prepared in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants in NSW and relevant requirements of the Protection of the Environment Operations (Clean Air) Regulation 2022. The assessment applies Level 2 refined dispersion modelling, incorporating site-specific meteorology, source characteristics, and representative operational conditions. Predicted incremental concentrations of NO₂, PM₁₀, PM_{2.5}, CO and SO₂ from the assessed operational scenarios have been combined with background levels and compared against the relevant impact assessment criteria. Predicted incremental concentrations of a number of Total Volatile Organic Compounds (VOC) have also been assessed (refer Section 3.3). Section 3.2 outlines the applicable in-stack concentration standards based on whether the Proposal constitutes a scheduled activity under the Protection of the Environment Operations Act 1997. As summarised in Section 2.3.2, the Proposal includes diesel storage of up to 955 kL and a maintenance testing program of 132.3 hours per year. Both are below the thresholds for chemical storage (Clause 9) and emergency electricity generation (Clause 17), and the Proposal is therefore considered a non-scheduled activity. Accordingly, the applicable concentration standards are those for non-scheduled activities under Schedule 2, Part 3 of the Protection of the Environment Operations (Clean Air) Regulation 2022. Two dispersion modelling scenarios have been assessed namely an emergency operation representing full generator operation during a power loss event and routine maintenance testing, representing typical functional testing. Cumulative impacts have been addressed in Section 5.3, Section 8.3 and Appendix F, based on the relative probability of concurrent generator operation at nearby facilities, spatial proximity, and wind frequency patterns that may influence overlapping impacts at common receptors.

Commentary	Clarification / response
Mitigation measures to address cumulative impacts should be considered – including consideration of minimising conflict and coordinating testing times with other nearby data centres or industries and notification protocols for impacts receivers/receptors during emergency / maintenance scenarios.	Mitigation and management measures, including relevant design safeguards and operational controls, are provided in Section 9.

2. THE PROPOSAL

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

2.1. Environmental Setting

The Proposal site is located at 6-8 Julius Avenue, North Ryde, NSW. It is legally described as Lot 89 in Deposited Plan (DP) 1082131 and covers approximately 2.863 hectares (ha). Irregular in shape, the Proposal site occupies a position on the south-eastern side of Julius Avenue, with a primary frontage of approximately 100 meters (m) to Julius Avenue. It also has a partial rear frontage to Richardson Place (cul-de-sac), at its north-eastern corner.

Currently vacant, the north-western part of the Proposal site was excavated and cleared of vegetation in 2009 under a previous development consent.

The Proposal site is zoned E3 Productivity Support pursuant to Ryde Local Environmental Plan 2014 (RLEP2014) and is located within the City of Ryde Local Government Area (LGA) which is approximately 15 km north-west of the Sydney Central Business District (CBD).

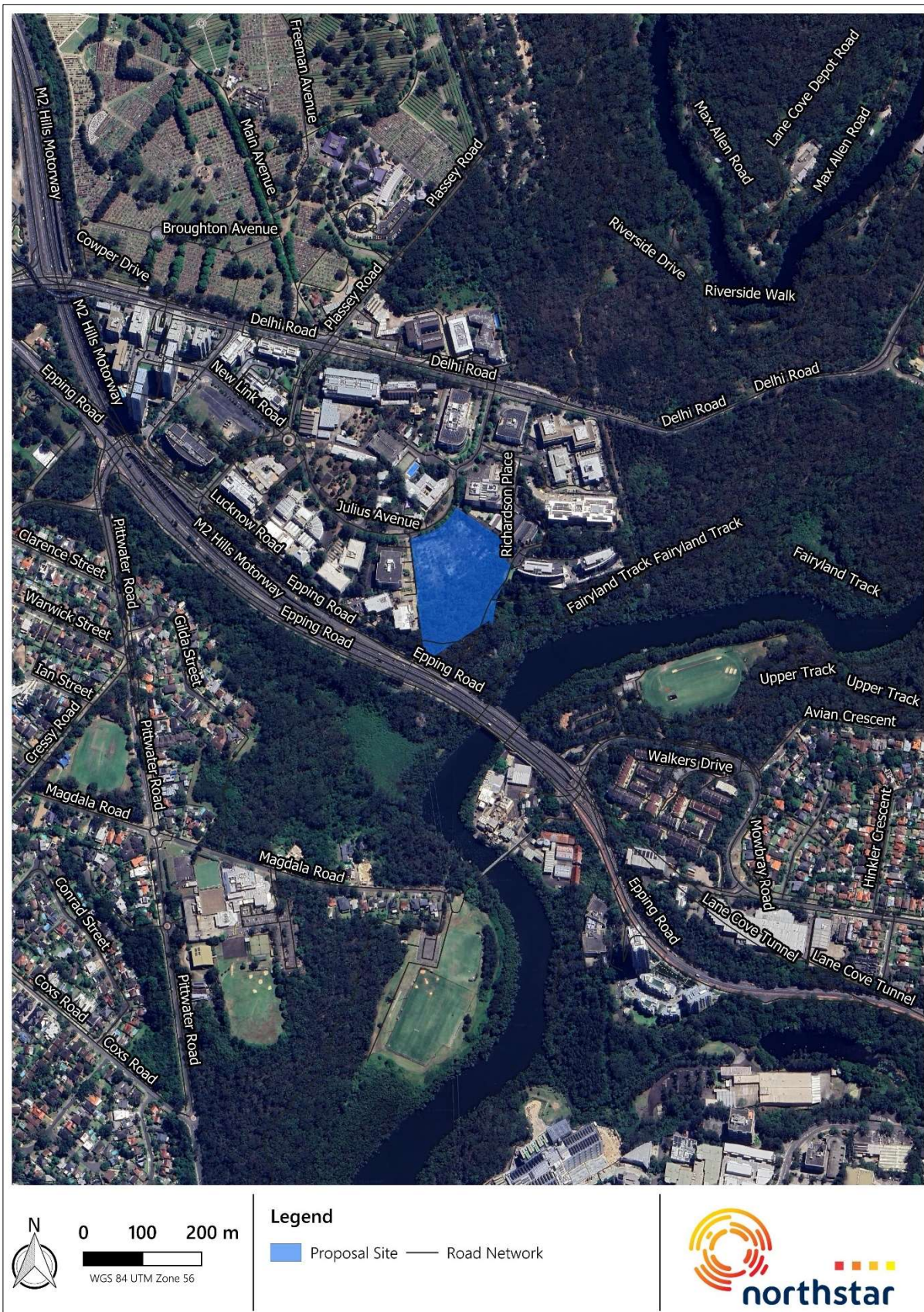
Existing attributes of the Proposal site are noted as follows:

- Direct adjacency to Lane Cove National Park to the east and south-east, which contains The Great North Walk and a fire trail.
- The Lane Cove River located approximately 100 m to the east.
- The Proposal site directly adjoins to the City of Ryde Council Administrative Centre to the east.
- Approximately 500 m to the west of the Proposal site is the North Ryde Metro Station.

The Proposal site is generally surrounded by commercial properties to the north east, north west, and south west. The nearest residential development is located approximately 300 m to the south east of the Proposal site on the eastern side of Lane Cove River in Lane Cove North, and 300 m to the south west of the Proposal site on the southern side of Epping Road in North Ryde.

A map showing the location of the Proposal 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 Proposal site location



Source: Northstar

2.2. Proposal Overview

The Proposal involves the construction and operation of a data centre and associated infrastructure and amenities, identified as the Julius Avenue Data Centre (SSD-80018208), comprising the following scope of works:

- Site preparation works, including tree removal;
- Earthworks and additional site retaining;
- Infrastructure comprising civil works and utilities servicing;
- Construction of a data centre including the following:
 - Ground level loading dock, services plantrooms and car parking for 38 cars, including 2 accessible;
 - Eight (8) data halls across four (4) storeys with an IT load of 76 MW and a maximum power consumption of 120 MW, plus rooftop plant;
 - Three (3) storey office / front of house (FOH) building;
 - Five (5) storey enclosed generator gantry to rear of data centre.
- New Ausgrid 132 kilovolt (kV) Sub-Transmission Switching Station (STSS);
- A new pedestrian through-site link from Julius Avenue to Richardson Place; and
- Complementary landscaping and offset planting.

Figure 2 and Figure 3 depict the Proposal site layout, indicating the size, massing, and height of the respective buildings.





2.3. Identification of Emissions to Atmosphere

The Proposal is likely to generate air emissions, as outlined below:

2.3.1. Construction Phase

The Proposal includes new buildings for data halls, a loading dock, unpacking areas, offices, staff amenities, plant and storage rooms, switch and battery rooms, and generator platforms. It also involves site preparation, earthworks, parking, infrastructure, access points, and landscaping.

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

- Excavators, front-end loaders (FEL) and 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.

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. Additionally, there is the potential for minor fugitive emissions from the storage of diesel at the Proposal site.

2.3.2.1. Emissions from Standby Generator Use

The Proposal includes the installation of 48 x 3 MW standby generators to support the critical IT load within the data halls, and one (1) x 1 MW generator to support the office / front-of-house (FOH) and associated safety services, providing a maximum power demand capacity of 120 MW.

The 48 IT load generators will be housed within a five-storey building located at the rear of the Proposal site. A CAT C175-20 diesel generator set, with a capacity of 3 120 kWe, has been identified for use and forms the basis of this AQIA, which is focused on the critical IT operational configuration.

A separate 1 MW generator, located on the roof of the FOH building within an acoustically treated enclosure, (nominally a CAT DE1100 GC) has also been included in the dispersion modelling. This unit is expected to

operate only during mains power failures and undergo periodic testing. Whilst it is considered to have a limited influence on overall air quality impacts, it has been included within the AQIA.

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 secondary back-up to the primary provision of a dual redundant power supply, and as such their use is designed to be minimal.

Data centres are designed with redundancy to ensure continuous operation and minimise downtime during power failures by duplicating critical components. Redundancy is typically classified under the Uptime Institute's four-tier system, with N+1 being the most common, providing one backup unit for each set of components. However, simultaneous failures of multiple components can still result in downtime. Alternative configurations, such as distributed redundancy, offer additional resilience by spreading the operational load across multiple components. In this setup, several generators share the load, allowing the system to maintain functionality if one fails, though not necessarily if multiple units fail simultaneously.

The Applicant has indicated a distributed 6M5 configuration, where six generators are installed, however only five are required to meet the full operational load. This means the system can tolerate a single generator failure without any loss of power to the IT load.

During periods when the standby generators may be required to provide power during mains power outage events, short-term emissions of combustion related pollutants will 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 (SO₂);
- Polycyclic aromatic hydrocarbons (PAHs);
- Volatile organic compounds (VOCs), as benzene (C₆H₆), toluene (C₇H₈) and xylene (C₈H₁₀); and
- Formaldehyde (CH₂O).

In addition to the potential operation as a secondary back-up during a power outage event that also affects the dual redundant power supply, the generators will be required to be run during short-term routine maintenance testing.

The Applicant has provided a maintenance testing schedule for the 48 standby generators that support the critical IT load and the one 1 MW 'front of house' generator. This schedule indicates that two generators will

be operated simultaneously during periodic testing. Table 5 reflects this schedule and includes both the critical IT load and 'house' generator.

Table 5 Proposed standby generator maintenance schedule

Parameter	Detail
Total number of generators to be tested	49 (48 × IT, 1 × 'house')
Testing frequency	Monthly (12 testing periods)
Operational testing hours	Daytime hours (7:00 am to 6:00 pm (Monday to Sunday))
Generators tested simultaneously	Two (one in eastern side, one in western side)
Testing events per period	Up to 25 (24.5)
Duration per test	27 minutes total (22 minutes runtime, 5 mins cooldown)
Total testing time per period	661.5 minutes
Total testing time per year	7 938 minutes
Total testing hours per year	132.3 hours

This assumes that each generator will be tested for a duration of 27 minutes. Additional information provided by the Applicant indicates that testing will take place during daylight hours which are assumed to be between 7:00 am and 6:00 pm.

Section 5.2.2 provides discussion around the two generators which have been selected for quantitative assessment purposes. For the purposes of the dispersion modelling assessment, it has been assumed that two 3 MW generators will undergo maintenance testing simultaneously on any given day. On days when the 1 MW 'house' generator is routinely tested, the emission loads would be lower than during the routine testing of two 3 MW IT generators. In practice, total annual generator testing is expected to be limited to no more than 200 hours, making this a conservative basis for assessing operational phase impacts.

The generator testing schedule is anticipated 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 Section 3.1), in addition to Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation 2022 (refer Section 3.2).

It is noted that should SSDA approval be granted, a condition is likely to require periodic emissions testing of the standby generators.

2.3.2.2. Emissions from Fuel Storage

The Proposal will be provided with a new dedicated and appropriately sized on-site fuel storage system, 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 total diesel storage capacity at the Proposal site is 955 kL (955 000 L).

To service the data halls, the design includes twelve 75 kL underground bulk diesel tanks and each of the 48 critical IT standby generators will have a 1 000 L day tank. Although the bulk tanks are sized for 24-hour capacity, the initial configuration will store 12 hours of fuel to meet Uptime Institute Tier III requirements. A separate 6 kL bulk tank will supply the office / FOH generator, which also has a 1 000 L day tank.

Fuel distribution will be concurrently maintainable, with duty / standby pumps located near each tank in prefabricated enclosures. Dedicated fill points will be positioned at the adjacent loading dock, accessible from either Julius Avenue or Richardson Place. Fuel tank levels will be displayed at each fill point (12 total) and integrated into the on-site Engineering Control and Monitoring System (ECMS) for monitoring.

The storage tank configuration at the Proposal site will include adequate containment (in the form of double-walled tanks and tertiary bunding containment) and automated leak detection measures, in compliance with relevant Australian and New Zealand Standards (AS / NZS), including AS / NZS 1940:2017 (Storage and Handling of Flammable and Combustible Liquids) and AS / NZS 1692:2006 (Steel Tanks for Flammable and Combustible Liquids).

The standby generators are anticipated to use low-sulphur diesel fuel during operations. Spill containment measures are also expected around tank fill connections, pumps, and filters where necessary. Given the low potential for fugitive emissions from fuel storage and the minimal risk of off-site impacts, no further quantification of these emissions has been included 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 odorous emissions, with the exception of the periodic operation of the diesel fuelled generators for testing and tertiary 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, diesel generators remain the most reliable and practical solution for large-scale data centre standby operations due to their proven reliability, rapid startup, and robust power delivery under high-load conditions.

While renewable energy is central to clean energy transitions, it alone cannot meet data centre baseload and peak demands. Challenges include renewable intermittency and the limited scalability of energy storage and backup systems. Consequently, most data centres will currently continue relying on fossil fuels in some form. Although many operators have committed to 100 % renewable energy by 2030¹, such commitments often rely on purchasing renewable energy credits or power purchase agreements rather than direct renewable generation.

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.

Alternative technologies such as large-scale Battery Energy Storage Systems (BESS), hydrogen fuel cells (HFC), and renewable fuels like Hydrotreated Vegetable Oil (HVO) may offer alternative solutions.

BESS offers rapid response and zero onsite emissions but requires significant initial investment and depends on grid electricity, which may not always be renewable. Hydrogen (H₂) fuel cells provide clean and efficient power, but face challenges related to H₂ supply infrastructure and currently high costs. HVO offers an immediate pathway to emissions reduction when used as a renewable substitute in existing diesel generator sets, requiring minimal retrofit. Emission assessments indicate up to a 90 % lifecycle CO₂ reduction with HVO compared to fossil diesel. Both BESS and HFCs provide near-zero local emissions, consistent with long-term sustainability goals. Initial cost analyses show BESS incurs higher upfront capital costs but benefits from low operating expenses, whereas HVO provides a cost-effective mid-term option balancing emissions reductions with operational practicality.

Given current technological and financial constraints, diesel generators remain essential for standby power at data centre developments.

¹ <https://www.pv-magazine-australia.com/2025/10/15/dealing-with-demands-of-power-hungry-data-centres/>

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 Proposal site.

3.1. Protection of the Environment Operations Act

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 Proposal, 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 Proposal.

3.1.1. Chemical Storage

Clause 9 of Schedule 1, Part 1 of the POEO Act states:

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

<i>Column 1</i>	<i>Column 2</i>
<i>Activity</i>	<i>Criteria</i>
<i>...</i>	
<i>petroleum products storage</i>	<i>capacity to store more than 200 tonnes (liquefied gases) or 2,000 tonnes (chemicals in any other form)</i>

The Proposal may be deemed to be a scheduled activity due to the quantity of diesel fuel stored at the Proposal site. Should the Proposal have the capacity to store more than 2 000 tonnes (t) of diesel fuel (equivalent to 2 350 kL assuming a fuel density of $850.8 \text{ kg}\cdot\text{m}^{-3}$), then the Proposal 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 Proposal is to include capacity to store up to 955 kL of diesel fuel. Given the chemical storage threshold discussion specified in the POEO Act, the Proposal would therefore be considered to be a non-scheduled activity and correspondingly, an Environment Protection Licence (EPL) would not be required, on this basis.

3.1.2. Electricity Generation

Clause 17 of Schedule 1, Part 1 of the POEO Act states:

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.

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 Proposal 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.

3.1.3. Equipment Maintenance

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.

As previously discussed in Section 3.1, if the Proposal is deemed to be a scheduled activity under the POEO Act, the general standards of concentration for scheduled activities as outlined in the POEO CAR would apply. In any event, the generators would be required to achieve the Schedule 2, Part 3 standard of concentration for non-scheduled activities.

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 Proposal.

The standards of concentration, and whether they are applicable to the Proposal, are summarised in Table 6.

Although the operations may be exempt from the relevant NO_x standards of concentration limits (i.e. in-stack emission concentrations), the Applicant would not be exempt from ensuring the emissions do not exceed ambient air quality criteria for NO₂, which are discussed in Section 3.3.

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.

Table 6 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. Proposal is not 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. Proposal is not a scheduled activity and would operate for less than 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. Proposal is not 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. Proposal is not a scheduled activity and would operate for less than 200 hrs·year ⁻¹ .
Volatile organic compounds (VOCs), as <i>n</i> -propane	A stationary reciprocating internal combustion engine using a liquid fuel	1 140 mg·Nm ⁻³ (A) VOCs <i>or</i> 5 880 mg·Nm ⁻³ (A) CO	No. Proposal is not a scheduled activity.
Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	20 % opacity	No. Proposal is not 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 % O₂
 (B): POEO CAR Sch 2, Pt 2, Div 2: dry, 273 K, 101.3 kPa, 7 % O₂

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

3.3. NSW EPA Approved Methods

State air quality guidelines are prescribed by the NSW EPA in the Approved Methods which has been consulted during the preparation of this AQIA (refer 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 7.

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 $0.029 \text{ mg}\cdot\text{m}^{-3}$ ($29 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) as outlined in table 12 of the Approved Methods 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 7) 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 $0.36 \text{ mg}\cdot\text{m}^{-3}$ ($360 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) and xylene (C_8H_{10}) of $0.19 \text{ mg}\cdot\text{m}^{-3}$ ($190 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) to address the potential for odour impacts. Table 8 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 7 NSW EPA impact assessment criteria

Pollutant	Averaging period	Criterion ($\mu\text{g}\cdot\text{m}^{-3}$) ^(a)	Notes
Sulphur dioxide (SO_2)	1 hour	215	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 $\text{PM}_{2.5}$)	24 hours	25	
	1 year	8	
Particulates (as TSP)	1 year	90	
Pollutant	Averaging period	Criterion ($\text{mg}\cdot\text{m}^{-3}$) ^(c)	Notes
Carbon monoxide (CO)	15 minutes	100	Numerically equivalent to the AAQ NEPM ^(b) standards and goals
	1 hour	30	
	8 hours	10	

Notes: (a): micrograms per cubic metre of air
 (b): National Environment Protection (Ambient Air Quality) Measure
 (c): milligrams per cubic metre of air

Table 8 NSW EPA impact assessment criteria for principal and individual toxic pollutants

Pollutant	Averaging period	Criterion		Notes
		$\text{mg}\cdot\text{m}^{-3}$ ^(a)	$\mu\text{g}\cdot\text{m}^{-3}$ ^(b)	
Polycyclic Aromatic Hydrocarbons (PAH) as benzo(a)pyrene	1 hour	0.0004	0.4	
Benzene (C_6H_6)	1 hour	0.029	29	
Toluene (C_7H_8)	1 hour	0.36	360	Odour
Xylene (C_8H_{10})	1 hour	0.19	190	Odour
Formaldehyde (CH_2O)	1 hour	0.02	20	

Notes: (a): milligrams per cubic metre of air
 (b): micrograms per cubic metre of air

As required under section 7.2.2 of the Approved Methods, the criteria for PAH, benzene (C_6H_6) and formaldehyde (CH_2O) identified in Table 8 are required to be assessed at any location at or beyond the Proposal site boundary.

3.4. Ryde Local Environmental Plan 2014

The Ryde Local Environmental Plan 2014 (RLEP2014) provides the legislative framework for developments and land use within the Ryde LGA. Specifically, the aims of the RLEP2014 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 encourage a range of development, including housing, employment and recreation, that will accommodate the needs of the existing and future residents of Ryde,*
- (b) to provide opportunities for a range of housing types that are consistent with adjoining development and the existing environmental character of the locality,*
- (c) to foster the environmental, economic, social and physical development of Ryde so that it develops as an integrated, balanced and sustainable city,*
- (d) to identify, conserve and promote Ryde's natural and cultural heritage as the framework for its identity, prosperity, liveability and social development,*
- (e) to improve access to the city, minimise vehicle kilometres travelled, facilitate the maximum use of public transport and encourage walking and cycling,*
- (f) to protect and enhance the natural environment, including areas of remnant bushland in Ryde, by incorporating principles of ecologically sustainable development into land use controls,*
- (g) to preserve and improve the existing character, amenity and environmental quality of the land to which this Plan applies,*
- (h) in relation to economic activities, to provide a hierarchy of retail, commercial and industrial activities that enable employment capacity targets to be met, provide employment diversity and are compatible with local amenity.*

Under the RLEP2014 the Proposal would be considered a data centre which is defined as follows:

data centre means a building or place the principal purpose of which is to collect, distribute, process or store electronic data using information technology.

Note—

Data centres are a type of high technology industry—see the definition of that term in this Dictionary.

It is noted that the RLEP2014 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.

3.5. 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 Proposal 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 Proposal 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 Proposal.

4.1. Surrounding Land Sensitivity

The Proposal site is situated within an E3 Productivity Support zone pursuant to the RLEP2014.

The land use immediately surrounding the Proposal site includes additional E3 Productivity Support, Infrastructure and C1 National Parks and Nature Reserves. Other land uses proximate to the Proposal site include E2 Commercial Centre, MU1 Mixed Use and RE1 Public Recreation to the south-east encompassing the Chatswood Rotary War Memorial Athletics Field.

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 (SO₂) (refer Table 7) 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 does not aim to cover all sensitive receptors within the study area. Rather, the selected locations are intended to be representative of their broader surroundings and can reasonably be assumed to reflect conditions in the immediate vicinity. In cases where multiple sensitive receptors exist in close proximity (such as a school adjacent to a medical centre) the receptor closest to the emission source is typically chosen to assess potential risks to other sensitive land uses in the area.

With regard to the response to submissions (refer Table 4), additional receptors have been incorporated into the dispersion model to account for public recreational use along the Great North Walk, including the North Ryde Fairyland Circuit and adjoining areas of Lane Cove National Park. These locations have been added to ensure the AQIA captures potential exposure at key recreational points within the surrounding National Park.

Beyond the identified discrete receptors, the entire modelling area has been overlaid with a grid of uniform receptor points to map predicted impacts in a comprehensive manner. As such, the accidental omission of a particular sensitive location does not invalidate the AQIA or render it incapable of assessing 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 9 and illustrated in Figure 4. Table 9 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 2024 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2025).

Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities (refer Figure 4).

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.

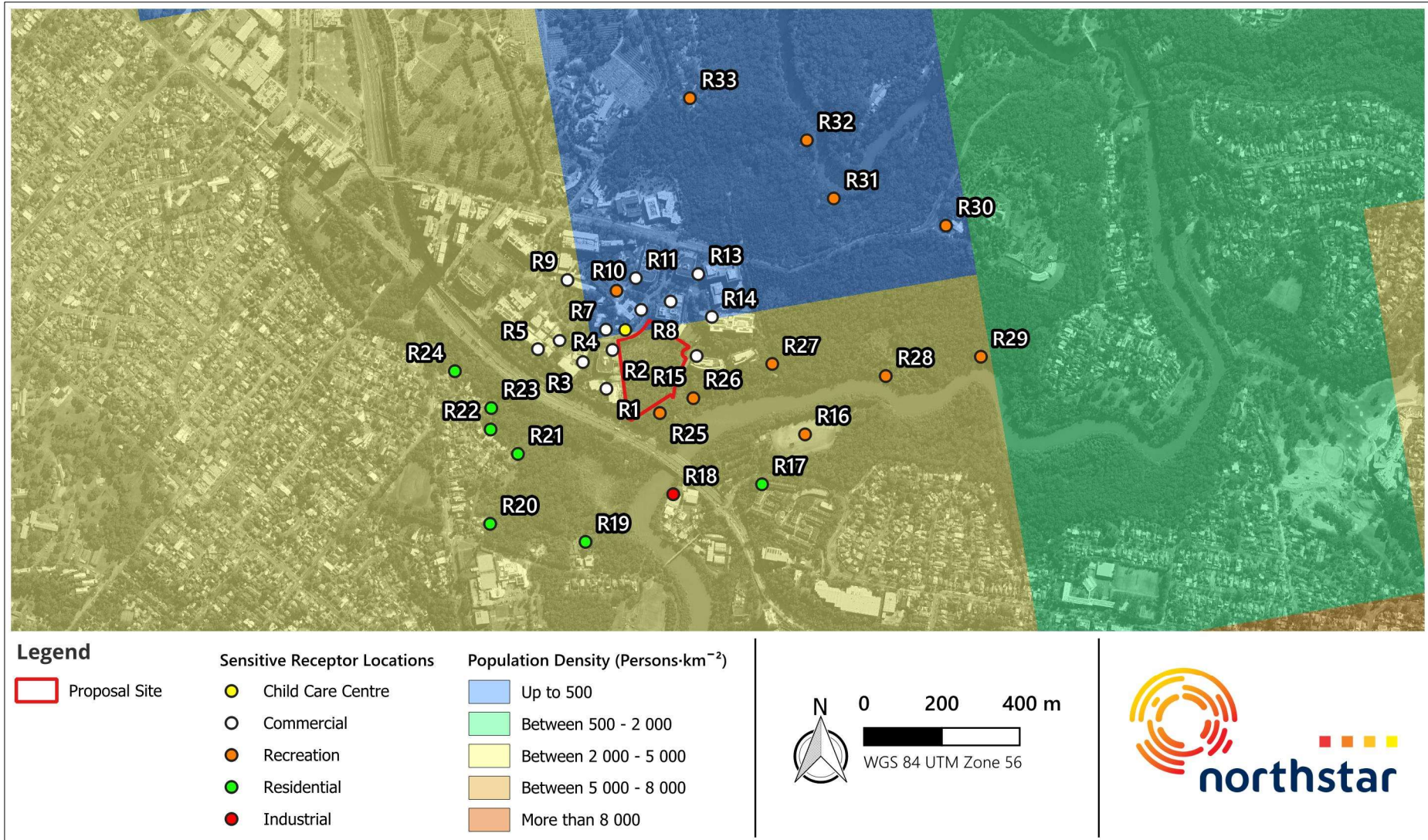
Using the ABS data in a GIS, the population density around the Proposal site and its immediate vicinity is categorised as low (i.e. between 500 and 2 000 persons- km^{-2}), indicating a predominantly commercialised and industrial area. To the west, the population density increases to a medium range of between 2 000 and 5 000 persons- km^{-2} , reflecting a transition to the suburbs of Ryde, where residential and recreational land is prevalent.

Table 9 Discrete sensitive receptor locations

Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
R1	Julius Avenue, North Ryde	Commercial	328 001	6 258 568
R2	Julius Avenue, North Ryde	Commercial	328 017	6 258 668
R3	Julius Avenue, North Ryde	Commercial	327 941	6 258 637
R4	Julius Avenue, North Ryde	Commercial	327 881	6 258 693
R5	Julius Avenue, North Ryde	Commercial	327 825	6 258 670
R6	Julius Avenue, North Ryde	Child Care Centre	328 050	6 258 722
R7	Julius Avenue, North Ryde	Commercial	328 000	6 258 722
R8	Julius Avenue, North Ryde	Commercial	328 091	6 258 773
R9	Julius Avenue, North Ryde	Commercial	327 901	6 258 849
R10	Julius Avenue, North Ryde	Recreation	328 027	6 258 822
R11	Julius Avenue, North Ryde	Commercial	328 077	6 258 854
R12	Julius Avenue, North Ryde	Commercial	328 166	6 258 794
R13	Delhi Road, North Ryde	Commercial	328 237	6 258 864
R14	Richardson Place, North Ryde	Commercial	328 272	6 258 755
R15	Richardson Place, North Ryde	Commercial	328 233	6 258 653
R16	Rotary Athletics Field	Recreation	328 512	6 258 452
R17	Walkers Drive, Lane Cove North	Residential	328 401	6 258 324
R18	Epping Road, Lane Cove North	Industrial	328 173	6 258 299
R19	Magdala Road, North Ryde	Residential	327 948	6 258 177
R20	Magdala Road, North Ryde	Residential	327 703	6 258 223
R21	Gilda Road, North Ryde	Residential	327 774	6 258 402
R22	Gilda Road, North Ryde	Residential	327 704	6 258 464
R23	Gilda Road, North Ryde	Residential	327 706	6 258 519
R24	Gilda Road, North Ryde	Residential	327 612	6 258 614
R25	Fairyland Track, Great North Walk	Recreation	328 139	6 258 506
R26	Fairyland Track, Great North Walk	Recreation	328 225	6 258 544
R27	Fairyland Track, Great North Walk	Recreation	328 427	6 258 632
R28	Fairyland Track, Great North Walk	Recreation	328 719	6 258 601
R29	Fullers Bridge, Great North Walk	Recreation	328 964	6 258 651
R30	Northern Suburbs Memorial Gardens	Recreation	328 874	6 258 988
R31	Ironbarks, Great North Walk	Recreation	328 586	6 259 058
R32	Carters Creek, Great North Walk	Recreation	328 516	6 259 207
R33	Lane Cove River Tourist Park	Recreation	328 216	6 259 315

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 4 Sensitive receptors surrounding the Proposal site and population density



Source: Northstar

4.3. Meteorology

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

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

To characterise local conditions, meteorological data from the Macquarie Park Air Quality Monitoring Station (AQMS), operated by the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW), was analysed. This station, located approximately 4.4 km north west of the Proposal site, provided data from 2020 to 2024 (the most recent five years of complete records), as presented in Appendix C.

Annual wind roses indicate a consistent wind distribution pattern across these years, with predominant north-westerly winds. The majority of wind speeds range between $0.5 \text{ m}\cdot\text{s}^{-1}$ and $5.5 \text{ m}\cdot\text{s}^{-1}$, with higher speeds (more than $5.5 \text{ m}\cdot\text{s}^{-1}$) primarily from the north west, occurring in only 0.3 % of recorded hours. Calm conditions (less than $0.5 \text{ m}\cdot\text{s}^{-1}$) are more frequent, averaging 12.7 % of recorded hours.

Although the Macquarie Park AQMS is nearby, on-site meteorological analysis is needed to establish baseline conditions for the Proposal. In the absence of on-site data, site-representative conditions were generated using the CALMET model for use in CALPUFF (refer Section 5.2.1.2).

To ensure representativeness, correlation analysis of observed wind direction and speeds at Macquarie Park AQMS was conducted (Appendix C). Based on this analysis, 2021 was selected as the most representative year for meteorological modelling.

For this AQIA, CALMET was 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), to determine surface and wind characteristics at the Proposal site. 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.

The most representative AQMS relative to the Proposal site, with data available for the year 2021 (consistent with the selected representative year for meteorological modelling [refer Appendix C]) is situated at Macquarie Park AQMS (co-located with the monitoring station adopted for observed meteorological data).

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 10. It is noted that although impacts of ozone (O_3) have not been considered in this assessment, O_3 data collected at Macquarie Park AQMS 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).

Appendix D provides further analysis of the background air quality monitoring data used in this AQIA.

Table 10 Summary of background air quality data used in the AQIA

Pollutant	Averaging period	Units	Measured value	Notes
Particles (as TSP)	Annual	$\mu g \cdot m^{-3}$	27.1	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 for PM ₁₀ in 2021 was 125.2 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	13.2	
Particles (as PM _{2.5})	24-hour	$\mu g \cdot m^{-3}$	Daily varying	The 24-hour maximum for PM _{2.5} in 2021 was 213.1 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	7.3	
Nitrogen dioxide (NO ₂)	1-hour	$\mu g \cdot m^{-3}$	149.7	Hourly maximum 1-hr average in 2021
	Annual	$\mu g \cdot m^{-3}$	7.2	Annual average in 2021
Carbon monoxide (CO)	15-minutes	$mg \cdot m^{-3}$	16.5	Calculated from 1-hour data (Section 5.2.7)
	1-hour	$mg \cdot m^{-3}$	12.5	Hourly maximum 1-hr average in 2021
	8-hour	$mg \cdot m^{-3}$	6.4	Maximum 8-hr rolling average in 2021
Sulphur dioxide (SO ₂)	1-hour	$\mu g \cdot m^{-3}$	97.2	Hourly maximum 1-hr average in 2021
	24-hour	$\mu g \cdot m^{-3}$	15.7	The 24-hour maximum for SO ₂ in 2021

As the Macquarie Park AQMS does not measure TSP concentrations, alternative data sources have been used to represent TSP levels in the area surrounding the proposal site. 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:

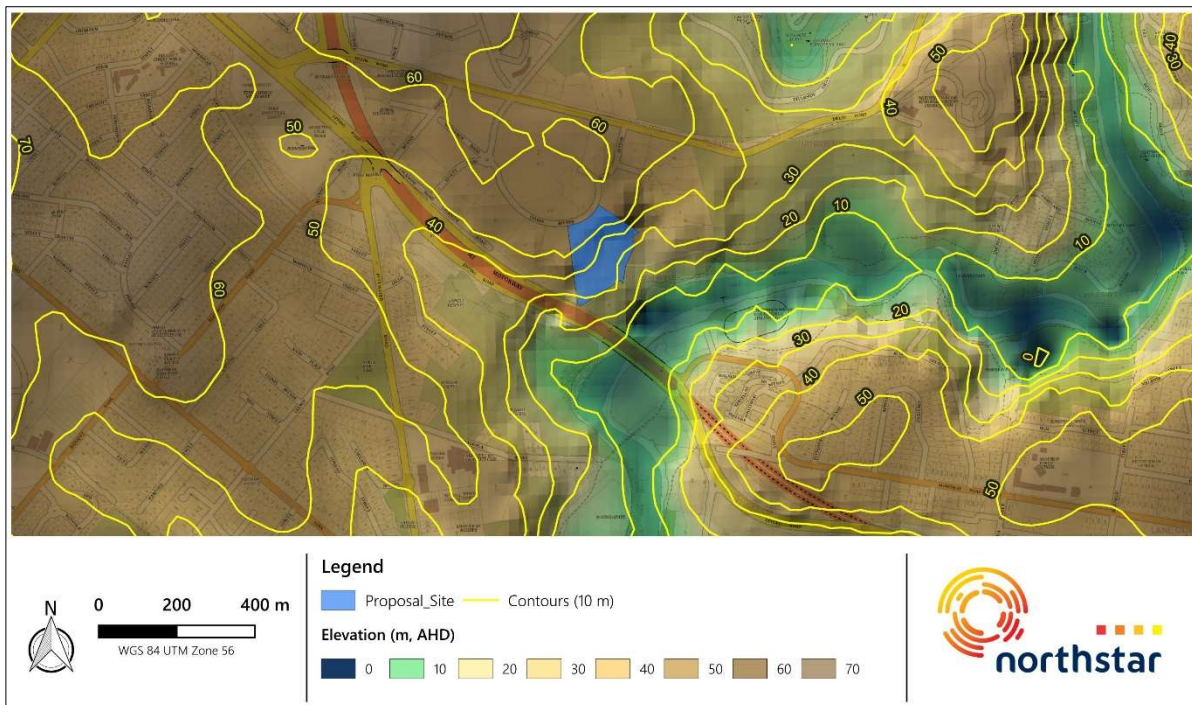
- Polycyclic aromatic hydrocarbons (PAHs);
- Benzene (C₆H₆);
- Toluene (C₇H₈);
- Xylene (C₈H₁₀); and
- Formaldehyde (CH₂O).

For the purposes of this AQIA, it has been assumed that background concentrations of the abovementioned pollutants are negligible. In any case, section 7 of the Approved Methods only requires the assessment of the 99.9th percentile incremental impacts for the pollutants outlined above.

4.5. Topography

The elevation of the Proposal site ranges between approximately 30 m and 50 m Australian Height Datum (AHD) (refer Figure 5). The topography between the Proposal 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.

Figure 5 Local topography



Source: Northstar

4.6. Potential for Cumulative Impacts

The background air quality dataset described in Section 4.4 likely captures the impact of regional sources of air pollutants (such as regional particulate matter), along with local sources near the AQMS (including the surrounding road network and commercial/industrial activities). However, due to the distance between the AQMS and the Proposal site, this data may not fully reflect the impacts of nearby sources, such as existing developments, approved but not yet operational developments, and those developments currently seeking approval, which could contribute to cumulative impacts at sensitive receptor locations in conjunction with the Proposal.

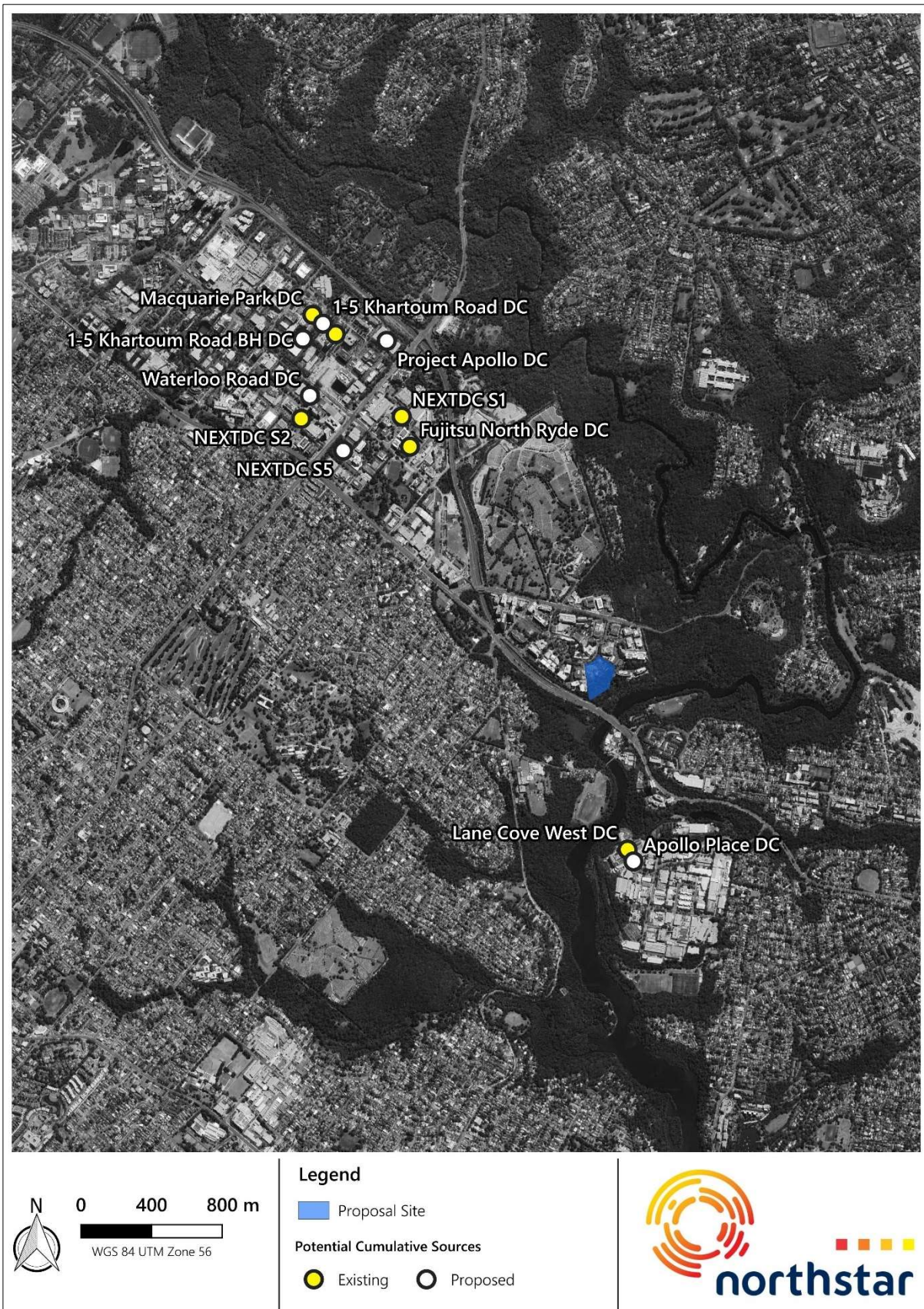
To address this, a desktop survey was conducted to identify data centres in the area around the Proposal site with a similar emissions profile (i.e. those that may emit pollutants comparable to the Proposal) and assess their potential for cumulative impacts at nearby sensitive receptors. The survey included a review of publicly available sources such as the National Pollutant Inventory (NPI) register, the NSW POEO Environment Protection Licence (EPL) register, the NSW Government Major Projects Register, and the City of Ryde Council DA tracker.

The Proposal site is in close proximity to several identified data centres, which are considered potential sources of air emissions. These sources are outlined in Table 11 and illustrated in Figure 6. Further discussion of the potential for cumulative impacts is provided in Section 5.2.8 and Section 8.3, with the full cumulative impact assessment available in Appendix F.

Table 11 Potential sources of air emissions proximity to the Proposal site

Development	Address	Approx. distance to Proposal site (km)	Operational status
NEXTDC S1	4 Eden Park Drive, Macquarie Pk	1.8	Existing
NEXTDC S2	6/8 Giffnock Avenue, Macquarie Park	2.1	Existing
Macquarie Park DC	11-17 Khartoum Road, Macquarie Pk	2.5	Existing
Talavera Road DC Campus	17-23 Talavera Road, North Ryde	2.3	Existing
Fujitsu North Ryde DC	23 Waterloo Road, North Ryde	1.6	Existing
Lane Cove West DC	1 Sirius Road, Lane Cove West	0.8	Existing
Apollo Place DC	1 & 1A Apollo Place, Lane Cove West	0.9	Proposed
Waterloo Road DC	44-50 Waterloo Road, Macquarie Pk	2.2	Proposed
NEXTDC S5	269 Lane Cove Road, Macquarie Pk	1.8	Proposed
1-5 Khartoum Road DC	1-5 Khartoum Road, Macquarie Pk	2.4	Proposed
1-5 Khartoum Road BH DC	1-5 Khartoum Road, Macquarie Pk	2.4	Proposed
Project Apollo DC	4-10 Talavera Road, Macquarie Pk	2.1	Proposed

Figure 6 Potential cumulative sources



Source: Northstar

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) (refer Section 5.1) and a quantitative assessment aligned with (NSW EPA, 2022) for evaluating operational phase air quality impacts (refer Section 5.2).

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 are 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 Proposal 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 published guidance contained in (IAQM, 2024). 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.

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 operational air emissions assessment has been conducted using quantitative dispersion modelling. This section outlines the approach adopted in the AQIA.

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 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 pollutant concentrations over the averaging period.

Table 12 provides the model input configuration to assess the impact of generator emissions from the Proposal, 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 12 General model parameters for CALPUFF dispersion modelling

Model parameter	Input
Model mode	CALPUFF Refined Mode CALMET No-Observations (No-Obs) Mode
Meteorological data	Prognostic Data (TAPM) (.apl)
Terrain topography	SRTM1
Model / Grid domain size	10 km x 10 km x 4 km
Grid resolution / spacing	0.1 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 4 km, with a minimum of 0.1 km. Terrain data with a 1 arc-second resolution (approximately 30 m) were used, in consideration of (Barclay & Scire, 2011). The dispersion model was run over a 10 km × 10 km grid at ground level, encompassing the nearest sensitive receptors (refer 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.

Appendix C contains details on the meteorological model configuration and input parameters.

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 1 second resolution (approximately 30 m) derived from the Shuttle Radar Topography Mission (SRTM) data was processed using CALPUFF's terrain pre-processing tools to prepare it for use in the dispersion modelling.

5.2.1.4. Building Wake Effects

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 can influence pollutant dispersion and premature plume grounding ('building downwash'). The ratio of stack height to

building height also impacts this effect; if the stack is significantly taller than the surrounding buildings, 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.

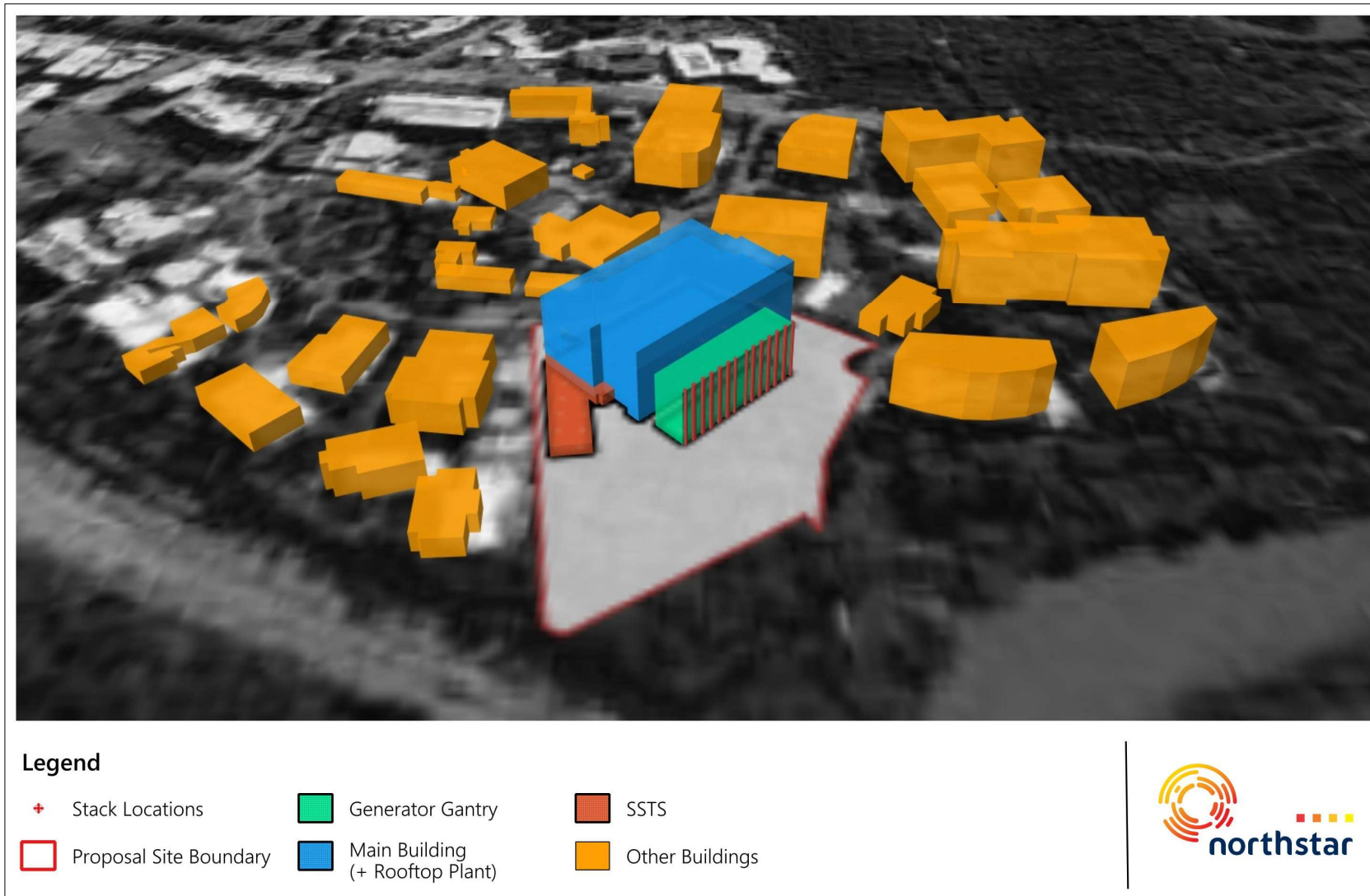
Therefore, to analyse downwash effects from point sources mimicking air emissions, the buildings surrounding the Proposal site were incorporated into the CALPUFF model.

With reference to the requirements outlined in the Approved Methods, Figure 8, Figure 9 and Figure 10 illustrate 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 (Figure 8 and Figure 9 for Scenario 1, and Figure 10 for Scenario 2) (refer Section 5.2.2).

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).

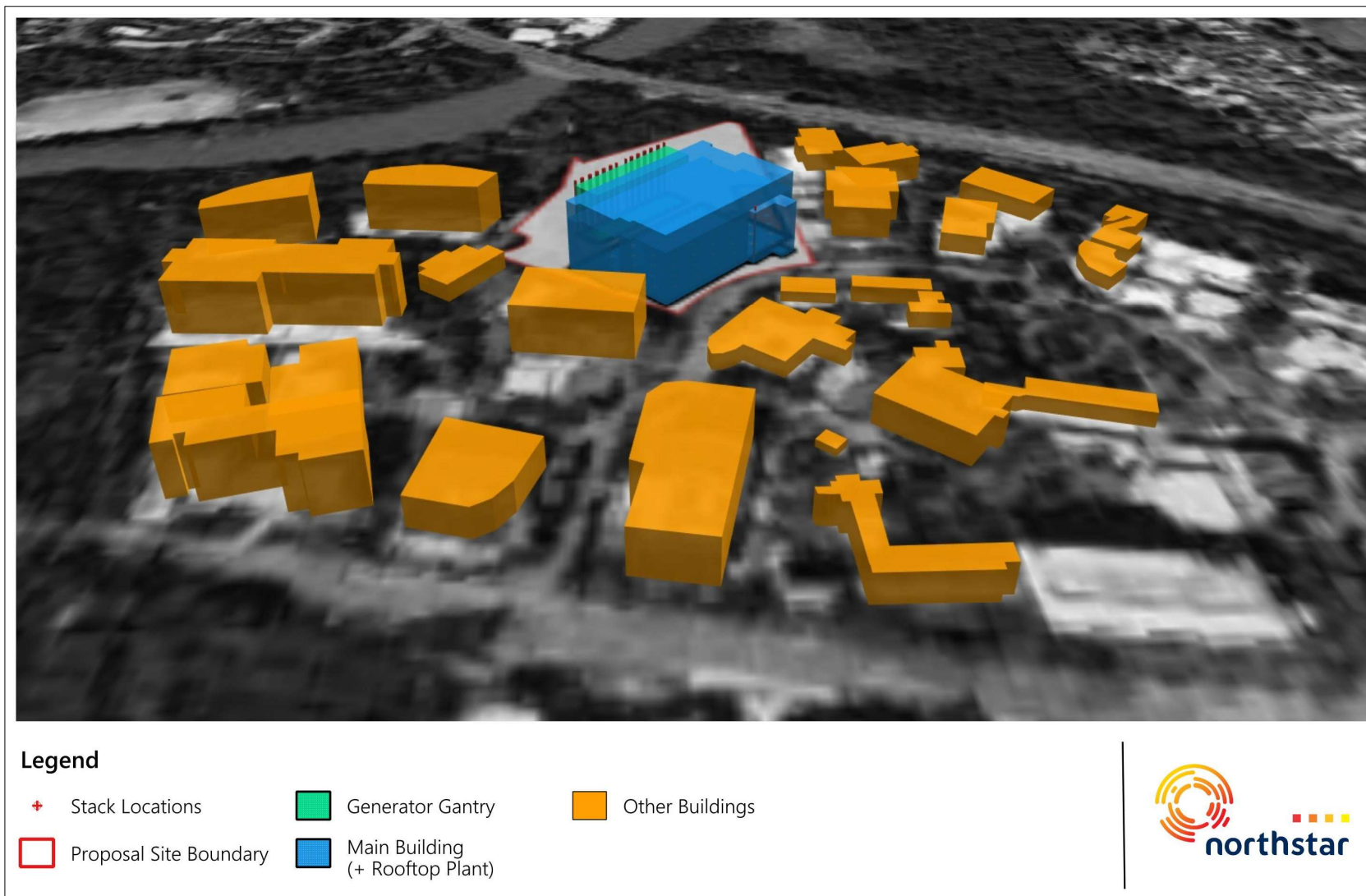
The BPIP-PRIME algorithm has been shown in some studies to result in the overprediction of concentrations by a factor two to eight for certain building types, whilst result in underpredictions for certain building and terrain configurations (Petersen, 2017). In conclusion, the use of the BPIP-PRIME algorithm is required by the NSW 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 7 Buildings and discharge points for Scenario 1 – Viewpoint A



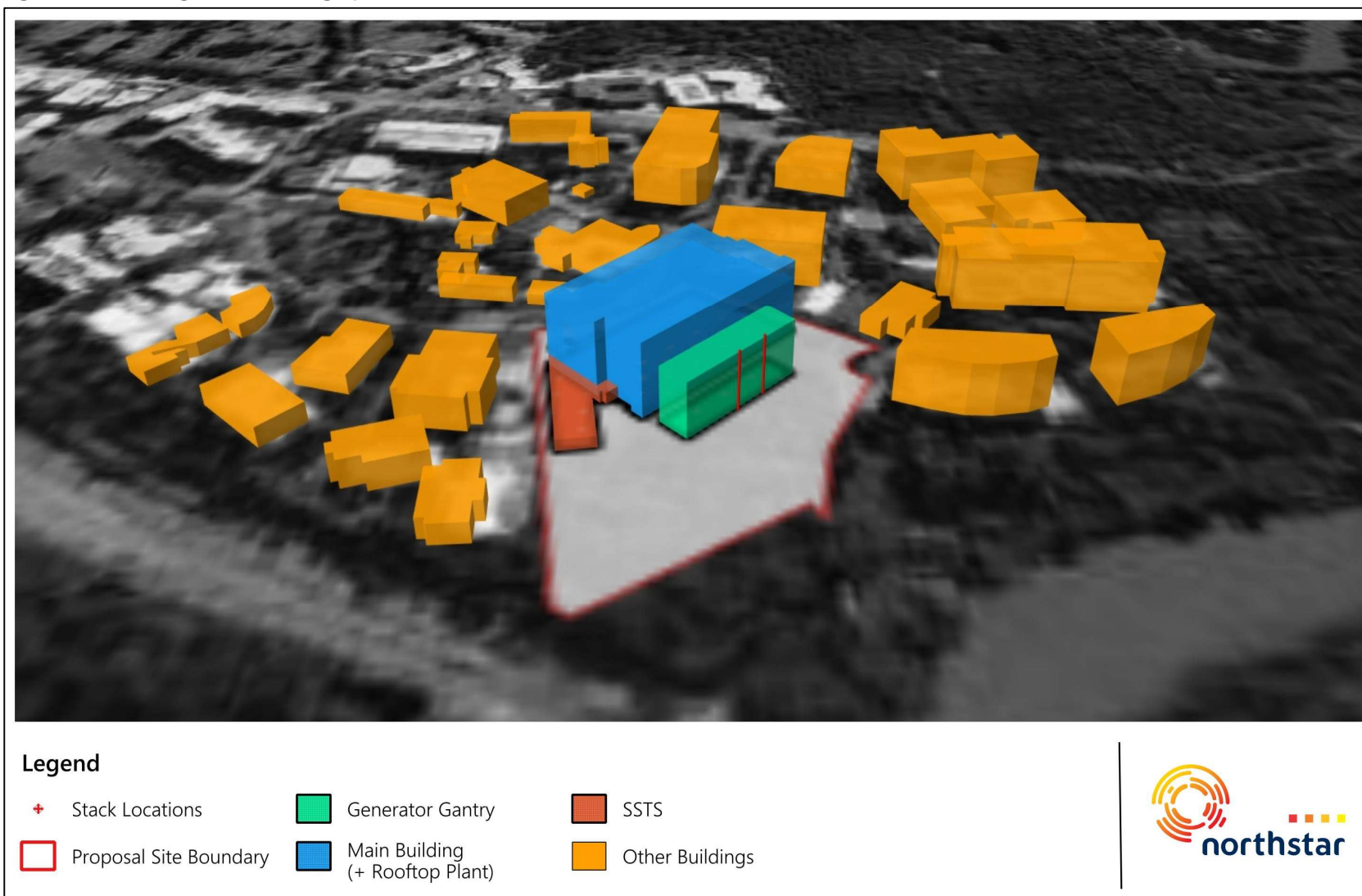
Source: Northstar

Figure 8 Buildings and discharge points for Scenario 1 – Viewpoint B



Source: Northstar

Figure 9 Buildings and discharge points for 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 standby generators.

- **Scenario 1 – justified worst case scenario (emergency operations)** – Operation of 49 generators (48 × 3 MW generators and one (1) × 1 MW generator) at 100 % load.
 - The Proposal includes a total of 49 standby generators; 48 x 3 MW units supporting the critical IT load, and one (1) × 1 MW unit serving the office / FOH and associated safety services.
 - The modelling assumes all units operate concurrently at full capacity, with no redundancy applied to provide a precautionary estimate. In practice, the system incorporates a 6M5 distributed redundancy configuration, whereby five of six generators per gantry block (or 40 of the 48 generators) meet the critical IT load.
 - Each of the generators were modelled as operating continuously for all 8 760 hours of the year. In reality, any outage-driven operation is expected to last for a duration of 10 to 15 minutes, making this scenario highly conservative in nature
 - As the standby generators intended for short-duration use, only assessment against the short-term impact assessment criteria have been performed. Annual average concentrations are not presented, as results would be essentially meaningless.
 - The AQIA contextualises the likelihood of any exceedance of air quality criteria, considering the improbability of full-capacity operation through catastrophic failure.
 - The potential for cumulative impacts to occur during an emergency power outage has been considered and is discussed in Section 5.3.

Considering the above and the NSW DPHI and NSW EPA requirements (refer Section 1.3 and Section 1.5), this scenario reflects the potential for a worst case event involving a site-wide power failure, with all generators operating simultaneously at full load.

- **Scenario 2 – realistic (maintenance testing) scenario** – This scenario reflects the routine testing schedule, where two (2) x 3 MW generators, one in the eastern gantry block and one in the western gantry block operate simultaneously at full load within the specific daytime testing hours (7:00 am to 6:00 pm).
 - Testing is expected to occur periodically, as outlined in Table 5, with any pair of generators potentially tested concurrently within the 11 hour daytime window. The generators considered in this scenario are shown in Figure 9.
 - Given that up to 48 generators may be tested in different pairings over the course of a year, a one-hour NO_x sensitivity analysis has been completed to identify which combinations produce the highest incremental and cumulative impacts at each receptor. The results presented in this AQIA reflect those maximum potential impacts. The FOH generator was

excluded from the sensitivity testing, as it would be tested individually; however, it is included in the emergency operations scenario.

- Although the testing duration is specified as 27 minutes, the AQIA adopts a full hour for modelling purposes in order to maintain a conservative prediction of incremental impacts.
- Impacts are compared against both short- and long-term criteria, with testing conservatively modelled as occurring in every hour between 7:00 am and 6:00 pm on every day of the year (4 015 hours). In practice, testing is anticipated to total 132.3 hours per year (within the allowable 200 hours). This approach ensures all possible combinations of emissions, meteorology, and background levels are captured. Annual average incremental predictions could therefore be weighted by actual operating hours (132.3 / 4 015) over those modelled to account for annual average emission loads. In this instance, that scaling has not been performed, and the results associated with annual average impacts are therefore conservative.

As required by the SEARs, the AQIA includes justification for the selected maintenance testing scenario to demonstrate that the assessed combination of generator flue locations represents a potential worst-case impact at surrounding receptors. A structured combinatorial optimisation framework was applied to identify the flue pairings that produce the maximum incremental impacts during operations.

The following provides a summary of the approach adopted:

- Operational information provided by the Applicant indicates that only two (2) x 3 MW generators can be tested concurrently with one in the eastern gantry block and one in the western gantry block due to site-specific operational and spatial constraints. The FOH generator was excluded from sensitivity testing because it would be tested independently; however, it is included within the emergency operation scenario. Based on the constraint of one generator per gantry block operating simultaneously, 576 possible testing combinations (24 x 24) were required to be assessed.
- Incremental 1-hour NO_x impacts were modelled for each combination by evaluating all 24 flue locations in the eastern gantry block against all 24 in the western gantry block. Impacts were assessed on an incremental NO_x basis (i.e. prior to NO₂ conversion), with the spatial relationship between emission points and receptors for all 48 stacks accounted for in the sensitivity analysis.
- For each receptor, the maximum incremental 1-hour NO_x impact arising from the full set of combinations was identified, along with the specific flue pairing responsible. This process establishes the worst-case flue locations for maintenance-testing activities and confirms that the scenario adopted in the AQIA reflects the upper-bound operational impact.

5.2.3. Generator Emission Rates and Source Characteristics

As noted in Section 2.3.2.1, the Proposal includes 48 x 3 MW standby generators to support the critical IT load, along with one (1) x 1 MW generator servicing the office / FOH and essential safety systems.

A CAT C175-20 diesel generator set (rated at 3 120 kWe) has been identified as the representative critical IT unit and forms the basis of the emission rates and source characteristics adopted in this AQIA. A CAT DE1100 GC unit (rated at 1 100 kWe) has also been included in the dispersion modelling as representative of the FOH generator.

Both the CAT C175-20 and CAT DE1100 generator specifications report emissions and performance data across a range of load conditions (25 %, 50 %, 75 %, and 100 %).

A summary of the standby generator stack design components used to model each scenario is provided in Table 13. Details of the technical specifications for the standby generator is provided in Appendix E.

Table 14 provides a summary of the standby generator discharge point locations

Table 13 Standby 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	00:00	07:00
Hour end	Hr	24:00	24:00	18:00
% load	%	100	100	100
Standby generator model		CAT C175-20	DE1100 GC	CAT C175-20
Number of generators active	no.	48	1	2
Power	kW	3 120	1 100	3 120
Stack height ^(f)	m AGL	32.1	32.5	32.1
Stack diameter	mm ID	600	600	600
Actual discharge rate	Am ³ s ⁻¹	11.7	3.1	11.7
Exit temperature	°C	460.7	508.7	460.7
Exit velocity	m·s ⁻¹	41.5	10.8	41.5
Generator emission specification				
NO _x	g·bhp·hr ⁻¹	4.99	5.84	4.99
CO	g·bhp·hr ⁻¹	0.54	1.14	0.54
TVOC	g·bhp·hr ⁻¹	0.11	7.5	0.11
PM	g·bhp·hr ⁻¹	0.01	0.07	0.01
Pollutant emission rates				
NO _x ^(a)	g·s ⁻¹	5.80E+00	2.39E+00	5.80E+00
CO ^(a)	g·s ⁻¹	6.28E-01	2.50E-01	6.28E-01
TVOC ^(a)	g·s ⁻¹	1.28E-01	4.10E-03	1.28E-01
PM (PM ₁₀ and PM _{2.5}) ^{(a)(d)}	g·s ⁻¹	1.16E-02	1.23E-02	1.16E-02
SO ₂ ^(c)	g·s ⁻¹	3.79E-06	1.07E-06	3.79E-06
Benzene ^(b)	g·s ⁻¹	1.24E-03	3.97E-05	1.24E-03
Toluene ^(b)	g·s ⁻¹	4.47E-04	1.43E-05	4.47E-04
Xylene ^(b)	g·s ⁻¹	3.12E-04	1.00E-05	3.12E-04
PAH ^(b)	g·s ⁻¹	1.84E-08	5.90E-10	1.84E-08
Formaldehyde ^(b)	g·s ⁻¹	1.26E-04	4.04E-06	1.26E-04

- Notes:**
- (a): Emission rates based on values contained in technical specification (refer Appendix E).
 - (b): Emission rates based on emission factors from Table 43 of (NPI, 2008). Refer Section 5.2.4.
 - (c): Based on permissible level of sulphur content in non-road diesel fuel (10 ppm).
 - (d): 100 % of PM is emitted as PM_{2.5}, and PM_{2.5} = PM₁₀.
 - (e): Both scenarios assume that each standby generator considered is operating at 100 % load, consistent with the emission data within the technical specifications presented in Appendix E.
 - (f): Determined from associated SSDA submission architectural drawing set.

Table 14 Standby generator discharge point locations

Location	Level	Generator number	Discharge type	Coordinates (m, UTM56S)		Height (m, AGL)
				X	Y	
Western Gantry	1	1	Vertical	328 114.29	6 258 599.04	32.1
Western Gantry	2	2	Vertical	328 113.85	6 258 599.51	32.1
Western Gantry	3	3	Vertical	328 117.79	6 258 602.43	32.1
Western Gantry	4	4	Vertical	328 117.34	6 258 602.91	32.1
Western Gantry	4	5	Vertical	328 118.02	6 258 603.54	32.1
Western Gantry	3	6	Vertical	328 118.47	6 258 603.07	32.1
Western Gantry	2	7	Vertical	328 121.76	6 258 607.19	32.1
Western Gantry	1	8	Vertical	328 122.20	6 258 606.71	32.1
Western Gantry	1	9	Vertical	328 122.87	6 258 607.36	32.1
Western Gantry	2	10	Vertical	328 122.43	6 258 607.84	32.1
Western Gantry	3	11	Vertical	328 126.18	6 258 610.59	32.1
Western Gantry	4	12	Vertical	328 125.73	6 258 611.06	32.1
Western Gantry	4	13	Vertical	328 126.44	6 258 611.76	32.1
Western Gantry	3	14	Vertical	328 126.89	6 258 611.28	32.1
Western Gantry	2	15	Vertical	328 129.77	6 258 614.97	32.1
Western Gantry	1	16	Vertical	328 130.22	6 258 614.50	32.1
Western Gantry	1	17	Vertical	328 130.91	6 258 615.17	32.1
Western Gantry	2	18	Vertical	328 130.46	6 258 615.64	32.1
Western Gantry	3	19	Vertical	328 134.24	6 258 618.43	32.1
Western Gantry	4	20	Vertical	328 133.79	6 258 618.90	32.1
Western Gantry	4	21	Vertical	328 134.46	6 258 619.55	32.1
Western Gantry	3	22	Vertical	328 134.91	6 258 619.08	32.1
Western Gantry	2	23	Vertical	328 137.57	6 258 622.56	32.1
Western Gantry	1	24	Vertical	328 138.02	6 258 622.08	32.1
Eastern Gantry	1	25	Vertical	328 143.61	6 258 627.53	32.1
Eastern Gantry	2	26	Vertical	328 143.16	6 258 628.01	32.1
Eastern Gantry	3	27	Vertical	328 146.72	6 258 630.57	32.1
Eastern Gantry	4	28	Vertical	328 146.28	6 258 631.04	32.1
Eastern Gantry	4	29	Vertical	328 146.93	6 258 631.68	32.1
Eastern Gantry	3	30	Vertical	328 147.38	6 258 631.21	32.1
Eastern Gantry	2	31	Vertical	328 150.27	6 258 634.92	32.1
Eastern Gantry	1	32	Vertical	328 150.72	6 258 634.45	32.1
Eastern Gantry	1	33	Vertical	328 151.40	6 258 635.11	32.1
Eastern Gantry	2	34	Vertical	328 150.95	6 258 635.58	32.1
Eastern Gantry	3	35	Vertical	328 154.74	6 258 638.38	32.1
Eastern Gantry	4	36	Vertical	328 154.30	6 258 638.86	32.1
Eastern Gantry	4	37	Vertical	328 154.97	6 258 639.52	32.1
Eastern Gantry	3	38	Vertical	328 155.42	6 258 639.04	32.1
Eastern Gantry	2	39	Vertical	328 158.31	6 258 642.74	32.1

Location	Level	Generator number	Discharge type	Coordinates (m, UTM56S)		Height (m, AGL)
				X	Y	
Eastern Gantry	1	40	Vertical	328 158.76	6 258 642.27	32.1
Eastern Gantry	1	41	Vertical	328 159.44	6 258 642.93	32.1
Eastern Gantry	2	42	Vertical	328 158.99	6 258 643.41	32.1
Eastern Gantry	3	43	Vertical	328 163.18	6 258 646.57	32.1
Eastern Gantry	4	44	Vertical	328 162.73	6 258 647.04	32.1
Eastern Gantry	4	45	Vertical	328 63.40	6 258 647.69	32.1
Eastern Gantry	3	46	Vertical	328 163.85	6 258 647.22	32.1
Eastern Gantry	2	47	Vertical	328 166.88	6 258 651.08	32.1
Eastern Gantry	1	48	Vertical	328 167.33	6 258 650.61	32.1
Main Building	Roof	49	Vertical	328 065.39	6 258 688.03	32.5

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 (C_6H_6), toluene (C_7H_8) and xylene (C_8H_{10}), 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.

The emission factors for TVOC and the respective speciated VOCs have been factored to calculate the mass fractions of those species within TVOC. Table 15 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.

Table 15 Speciated VOC fractions

Species	Emission rate ($kg \cdot m^3_{(fuel)}$) Table 43 of (NPI, 2008)	Emission rate relative to HC
TVOC (as HC)	1.32E+00	1.00E+00
Benzene (C_6H_6)	1.28E-02	9.70E-03
Toluene (C_7H_8)	4.62E-03	3.50E-03
Xylene (C_8H_{10})	3.22E-03	2.44E-03
PAH	1.90E-07	1.44E-07
Formaldehyde (CH_2O)	1.30E-03	9.58E-04

5.2.5. Particle Size Fractions

In regard to particulates from diesel, virtually 100 % of diesel particles are less than 1 μm in diameter (i.e. PM_{10}) and consequently particulates from diesel combustion are assessed as $PM_{2.5}$. In this AQIA, the emission rate of $PM_{2.5}$ will be the same as PM_{10} , as all of the PM_{10} particles are assessed as being $\leq 2.5 \mu m$ in diameter ($PM_{2.5}$).

5.2.6. NO_x to NO₂ Conversions

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 NO₂ and nitric oxide (NO), conversion of NO_x predictions to NO₂ concentrations is necessary to appropriately assess potential NO₂ impacts.

NO_x from a combustion process will be emitted as NO and NO₂. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions with atmospheric ozone (O₃) to form NO₂, 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 NO₂ to enable a comparison against the air quality criteria for NO₂. The Approved Methods outlines various methods of assessment, which range from the simple to the more detailed. 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 NO₂, and that further reactions do not occur.
- **Method 2** – Ozone limiting method (OLM): this method uses contemporaneous ozone (O₃) data to estimate that rate at which NO is oxidised to NO₂ hour-on-hour using an established relationship.
- **Method 3** – NO to NO₂ conversion using empirical relationship: an empirical relationship between NO and NO₂ 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 outlines the approach to NO₂ 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 carried out and / or additional management practices or emission controls applied.

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 NO₂ 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 NO₂, in accordance with the empirical equation described in the Approved Methods:

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

Where:

x = distance from the source (km)

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

At each receptor, the hourly varying NO_2/NO_x relationship has been calculated, based on the season, hourly varying O_3 concentration, and wind speed. Results are presented in Section 7.1.2 and Section 7.2.2 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 are required to be adjusted to allow provision of data on those timescales. The following Power Law adjustment has been applied:

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

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)

5.3. Assessment of Cumulative Impacts

At locations where emissions from multiple sources may simultaneously impact a receptor, the Approved Methods requires the AQIA to assess cumulative impacts. The most robust method for evaluating the potential cumulative impact is to perform a dispersion modelling exercise that includes all potentially contributing sources but in reality, the potential for this is limited by various factors including:

- The availability of data from multiple sources, often operated by different organisations;
- The timing of the assessment for different facilities / developments; and/or
- The complexity of assessing multiple sources at different facilities / developments.

These factors are even more limiting for facilities that have discontinuous and sporadic emission profiles, such as data centres that may only be a source of air emissions for a short period in any year. To provide a robust assessment of cumulative impacts without iteratively remodelling multiple developments, this AQIA has adopted an assessment of the factors outlined in Table 16.

Table 16 Factors affecting the potential for cumulative impacts

Assessment scenario	Factor	Description
Emergency scenario The operation of standby generators in the event of a power outage	Probability	The potential of simultaneous failure of multiple feeders
	Proximity	The distance between the sources of air emissions
	Wind frequency	The potential for cumulative impacts from both data centres at a common receptor location under specific meteorological conditions
Realistic scenario The routine testing of standby generators	Probability	The potential for simultaneous testing at multiple facilities
	Proximity	The distance between the sources of air emissions
	Wind frequency	The potential for cumulative impacts from both data centres at a common receptor location under specific meteorological conditions

5.3.1.1. Proximity to Receptor

Significant cumulative impacts may be anticipated where contributing sources are close to the common receptor and emissions may be transported from both sources over the relevant averaging period.

The key considerations are:

- *Identification:* information from publicly announced projects and regulatory databases, (e.g. NSW Major Project register, the NSW EPA Environment Protection Licensing (EPL) register, and the National Pollutant Inventory (NPI)) to identify developments with comparable emissions profiles, including data centres.
- *Screening:* application of published recommended screening distances to identify where any level of assessment is required.
- *Incremental screening:* review of predicted incremental impacts from the relevant AQIA to determine whether the aggregation of increments plus background would lead to an exceedance.

5.3.1.2. Probability

The probability of simultaneous emissions from multiple sources may be estimated as outlined below.

Emergency Operations

The potential for power supply outage affecting multiple feeders simultaneously may be estimated as a product function of the relevant system average interruption duration index (SAIDI) (mins) for each feeder.

$$P_{A,B} = \left(\frac{SAIDI_A}{8760 \times 60} \right) \times \left(\frac{SAIDI_B}{8760 \times 60} \right)$$

Where:

A = Facility A

B = Facility B
 P = probability
 $SAIDI$ = system average interruption duration index

For example, if two facilities each have a SAIDI of 70 mins, the probability of a simultaneous power outage event would be $([70/525600] \times [70/525600])$ $P = 1.77e-08$. In the case where both data centres are connected to a common feeder then the probability would be the common SAIDI.

Realistic Operations

The probability of the routine testing of multiple facilities may be estimated as a product function of the testing plans for those facilities:

$$P_{A,B} = P_A \left(\frac{n_A}{h_A} \right) \times P_B \left(\frac{n_B}{h_B} \right)$$

Where:

A = Facility A
 B = Facility B
 P = Probability
 n = Number of hours testing in a year
 h = Number of available testing hours in a year. For example, if 24/7 testing is proposed $h = 8760$, if testing is proposed during 7:00 am to 7:00 pm $h = 4380$

For example, if two facilities each have a 200-hour testing schedule each year to be performed during a 7:00 am to 7:00 pm window, the probability of a simultaneous testing hour would be $([200/4380] \times [200/4380])$ $P = 0.002$.

In the case where more continuous emissions are emitted from a potentially cumulative source steady-state emissions from that source can be assumed to be a factor of 1.

5.3.1.3. Wind Direction and Frequency

If a potential cumulative impact has (i) been identified, (ii) is not screened as being outside of the published separation distance thresholds, and (iii) incremental impacts are sufficient to potentially give rise to a significant cumulative impact, the next step is to assess the potential for a common pathway and the potential cumulative impact on that wind vector.

Given the low duration of operation of data centres, a 1-hour average would be the most relevant, and therefore the frequency of 1-hour average wind vectors that link both contributing sources to the receptor should be established. Receptors that are situated outside of the common 1-hour average wind vectors physically cannot be simultaneously impacted from both contributing sources and can be screened from the cumulative assessment.

The frequency of the required wind vector to give rise to a cumulative impact may be multiplied by the probabilities for the relevant scenarios to estimate the potential for both sources being operational due to a simultaneous power outage event and the wind conditions being capable of transporting emissions from both sources to the common receptor location.

Cumulative impacts may be estimated by adding increments at receptors along a common wind vector and incorporating relevant background assumptions. Section 8.3 provides a summary, further considering cumulative impacts based on the identified sources in Section 4.6, while the full assessment is detailed in Appendix F.

6. CONSTRUCTION PHASE ASSESSMENT

Northstar has 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.

Table 17 below presents the dust risk assessment for the construction phase of the Proposal, outlining the potential risk of dust impacts occurring prior to the implementation of any mitigation measures.

Appendix B provides the methodology, structure and corresponding risk score descriptors used for the construction phase risk assessment.

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 17.

Table 17 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
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, N/A = Not Applicable, Neg. = Negligible

Table 17 summarises that dust soiling impacts are classified as a medium risk for earthworks, construction, trackout, and construction-traffic activities. Human health impacts from these activities are considered a low risk. Consequently, effective dust mitigation and management measures are necessary to reduce emissions and minimise nuisance and health-related dust impacts.

As a result, the mitigation measures outlined in Appendix B are aligned with the Proposal's risks and should be implemented throughout the construction phase to effectively manage construction dust.

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 Proposal site, the distance to sensitive receptors, and the nature of activities involved, residual impacts related to fugitive dust emissions from the Proposal are expected to be 'negligible' if the mitigation measures outlined in Appendix B are implemented appropriately.

7. OPERATIONAL PHASE 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 Proposal in isolation.
- **Cumulative impact** – relates to the incremental concentrations predicted as a result of the operation of the Proposal 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
------------------	--	--

Details of each scenario under each modelled scenario are provided in Section 5.2.2.

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 73 stand-by generators operating at 100 % load and consideration of the background pollutant concentrations (refer Section 4.4), where appropriate.

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

Note: Care should be taken when interpreting 24-hour average impacts, as power outages are typically much shorter in duration. The assessment adopts a conservative approach by assuming generator operation over a full 24-hour period. Comparison against annual average criteria is not meaningful in this context given that generator use is limited to occasional, short-term operation during emergency scenarios.

Assessment of annual average impacts is presented separately under Scenario 2 (maintenance testing).

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 7. The emissions adopted for Scenario 1 reflect the operational profile of the Proposal over that averaging period (refer Section 5.2.2).

7.1.1.1. 24-Hour (Daily) PM₁₀ and PM_{2.5} Concentrations

Table 18 shows the predicted 24-hour PM₁₀ and PM_{2.5} concentrations at the considered receptors under Scenario 1. No background concentrations are included within this table.

Table 18 Predicted incremental 24-hour PM₁₀ and PM_{2.5} concentrations – Scenario 1

Receptor	Maximum 24-hour average concentration (µg·m ⁻³)	
	PM ₁₀	PM _{2.5}
Criterion	50	25
Max. % of criterion	24.6	49.2
R1	6.9	6.9
R2	10.6	10.6
R3	8.7	8.7
R4	5.1	5.1
R5	5.1	5.1
R6	10.8	10.8
R7	11.5	11.5
R8	12.3	12.3
R9	5.6	5.6
R10	6.9	6.9
R11	5.8	5.8
R12	10.2	10.2
R13	4.9	4.9
R14	4.2	4.2
R15	5.0	5.0
R16	0.8	0.8
R17	0.7	0.7
R18	0.6	0.6
R19	1.1	1.1
R20	1.6	1.6
R21	1.6	1.6
R22	3.1	3.1
R23	3.1	3.1
R24	4.0	4.0
R25	1.2	1.2
R26	0.9	0.9
R27	1.8	1.8
R28	0.9	0.9
R29	1.2	1.2
R30	1.6	1.6
R31	1.1	1.1
R32	1.7	1.7

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
R33	2.3	2.3

Note: all PM is assumed to be $<1\ \mu\text{g}$ in diameter and therefore assessed as PM_{2.5}. In this instance, emissions of PM_{2.5} will be the same as PM₁₀ (PM_{2.5} is a subset of PM₁₀) and therefore the results will be consistent between PM₁₀ 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 all back-up generators for an entire 24-hour period).

Table 18 indicates that the highest 24-hour average PM₁₀ and PM_{2.5} incremental concentrations related to the Proposal are predicted at receptor R8. A contemporaneous analysis of the 24-hour PM₁₀ 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.

Table 19 and Table 20 present the predicted maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal through Scenario 1, with the corresponding background included for each day. Results are presented in Table 19 and Table 20 for those receptors at which the greatest impacts have been predicted (refer Table 18).

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.

For PM₁₀, the highest incremental and cumulative impacts (refer Table 19) occur at receptor R8. For PM_{2.5}, the corresponding highest incremental and cumulative impacts are predicted at receptor R8 and receptor R1 respectively (refer Table 20).

Both Table 19 and Table 20 shows exceedances of the 24-hour PM₁₀ and PM_{2.5} criteria which are driven primarily by background concentrations, prior to inclusion of the Proposal's incremental contributions (refer Appendix D).

Figure 10 presents an isopleth plot of incremental 24-hour PM₁₀ concentrations for Scenario 1, illustrating the spatial distribution of predicted particulate matter concentrations around the Proposal site. No additional exceedances of the 24-hour PM₁₀ or PM_{2.5} criteria are predicted at any assessed receptor as a result of emergency generator operation.

Further interpretation of these results is provided in Section 8.2

Table 19 Summary of contemporaneous 24-hour PM₁₀ concentrations – Scenario 1

Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R8			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R8		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
10/10/2021	3.0	125.2	128.2	27/11/2021	12.3	17.6	29.9
9/10/2021	< 0.1	125.2	125.3	14/02/2021	10.1	16.9	27.0
21/08/2021	< 0.1	73.5	73.6	26/11/2021	9.9	5.6	15.5
22/08/2021	< 0.1	73.5	73.6	7/01/2021	9.4	11.3	20.7
19/01/2021	7.4	24.5	31.9	15/02/2021	9.2	15.0	24.2
15/01/2021	0.4	31.3	31.7	28/11/2021	9.1	21.3	30.4
28/11/2021	9.1	21.3	30.4	27/01/2021	9.1	11.2	20.3
27/11/2021	12.3	17.6	29.9	27/12/2021	9.0	12.1	21.1
2/03/2021	6.7	22.9	29.6	6/05/2021	8.9	14.5	23.4
20/09/2021	< 0.1	29.2	29.3	5/03/2021	8.4	18.6	27.0
These data represent the highest Cumulative Impact 24-hour PM ₁₀ predictions (outlined in red) as a result of the operation of the Proposal				These data represent the highest Incremental Impact 24-hour PM ₁₀ predictions (outlined in blue) as a result of the operation of the Proposal.			

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

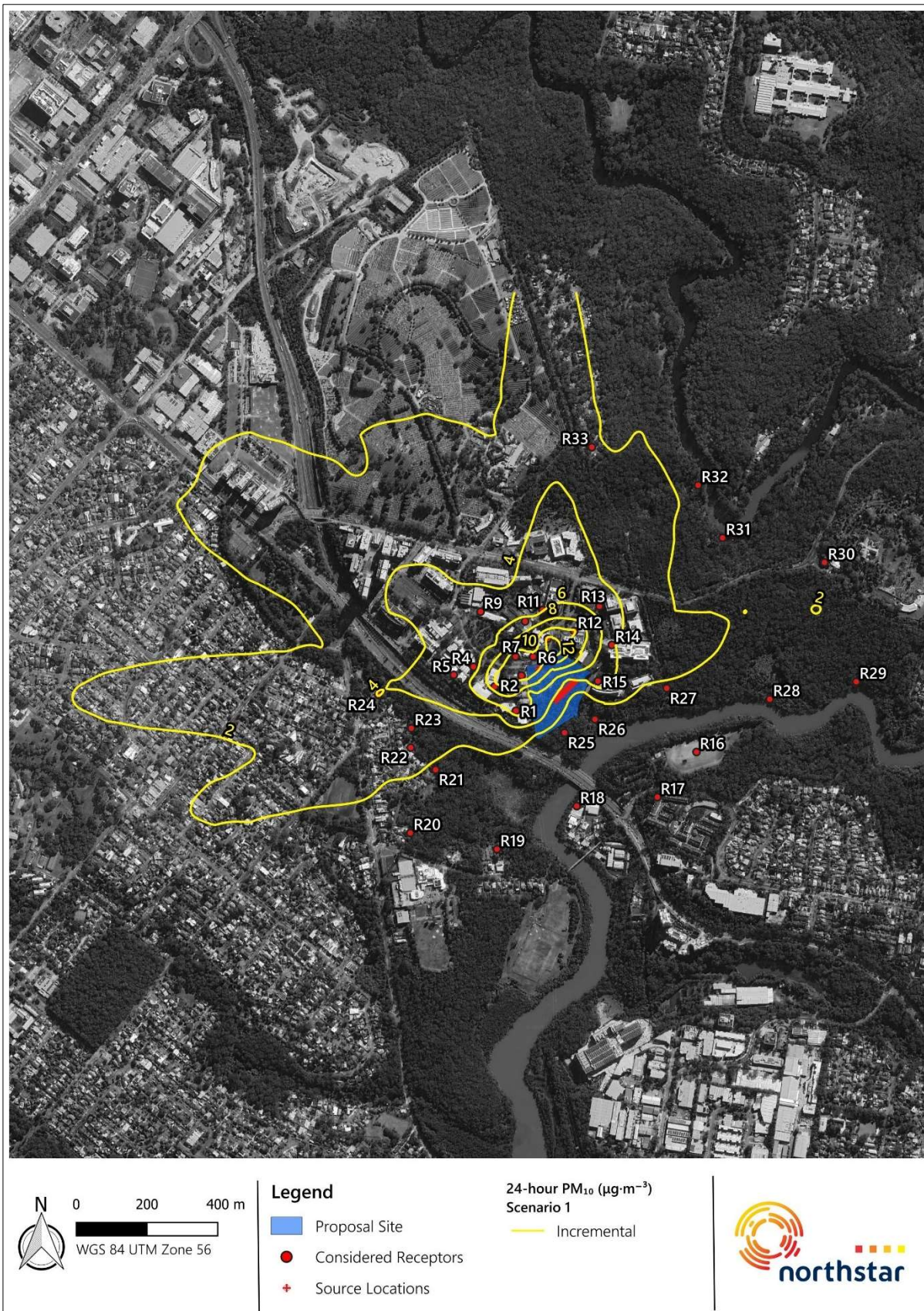
Table 20 Summary of contemporaneous 24-hour PM_{2.5} concentrations – Scenario 1

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R1			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R8		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
9/10/2021	2.0	213.1	215.1	27/11/2021	12.3	6.8	19.1
22/08/2021	0.3	129.4	129.7	14/02/2021	10.1	6.4	16.5
10/10/2021	< 0.1	93.6	93.7	26/11/2021	9.9	3.6	13.5
21/08/2021	< 0.1	67.9	68.0	7/01/2021	9.4	3.8	13.2
20/09/2021	< 0.1	30.6	30.7	15/02/2021	9.2	4.1	13.3
4/05/2021	0.1	23.6	23.7	28/11/2021	9.1	6.0	15.1
27/10/2021	1.6	18.5	20.1	27/01/2021	9.1	5.1	14.2
30/04/2021	0.2	19.9	20.1	27/12/2021	9.0	3.6	12.6
27/04/2021	< 0.1	18.2	18.3	6/05/2021	8.9	2.7	11.6
14/08/2021	0.5	17.6	18.1	5/03/2021	8.4	7.5	15.9
These data represent the highest Cumulative Impact 24-hour PM _{2.5} predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM _{2.5} predictions (outlined in blue) as a result of the operation of the Proposal.			

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 all back-up generators for an entire 24-hour period).

Figure 10 Predicted 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 (NO₂) under the assumptions of Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for NO₂ is 1 hour as specified in Table 7. Note that impacts have not been compared with the annual average criterion for NO₂ 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 NO₂ and nitric oxide (NO), conversion of NO_x predictions to NO₂ concentrations may be performed. Within this AQIA, the Janssen method (Method 3) has been adopted as outlined in Section 5.2.6.

The predicted maximum 1-hour average NO₂ concentrations resulting from the Proposal operations under Scenario 1 are presented in Table 21.

Table 21 Predicted 1-hour NO₂ concentrations – Scenario 1

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)		
	1-hour average		
	Incr.	Bkg.	Cumul.
Criterion	164		
Max % of criterion	75.8	10.0	77.9
R1	100.3	2.1	102.3
R2	69.3	4.1	73.4
R3	102.9	4.1	107.0
R4	72.7	16.4	89.1
R5	74.2	16.4	90.6
R6	42.2	4.1	46.3
R7	92.7	4.1	96.8
R8	85.4	2.1	87.5
R9	69.3	4.1	73.4
R10	59.2	2.1	61.2
R11	57.1	2.1	59.2
R12	85.4	2.1	87.5
R13	92.5	4.1	96.6
R14	88.6	4.1	92.7
R15	43.8	4.1	47.9
R16	69.3	4.1	73.4
R17	54.7	4.1	58.8
R18	73.6	4.1	77.7
R19	71.6	4.1	75.7
R20	95.7	6.2	101.9
R21	92.4	8.2	100.6

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)		
	1-hour average		
	Incr.	Bkg.	Cumul.
R22	85.2	6.2	91.3
R23	82.7	4.1	86.8
R24	88.6	< 0.1	88.7
R25	29.6	4.1	33.7
R26	44.5	4.1	48.6
R27	89.4	4.1	93.5
R28	70.3	4.1	74.4
R29	88.6	8.2	96.8
R30	114.5	2.1	116.6
R31	119.6	8.2	127.8
R32	108.7	8.2	116.9
R33	124.4	< 0.1	124.4

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

The results indicate no predicted exceedances of cumulative NO₂ concentrations under Scenario 1. In addition, no further exceedances of the 1-hour NO₂ criterion are predicted at any assessed receptor as a result of emergency generator operation.

Figure 11 presents a contour plot of the predicted 1-hour incremental NO₂ impacts for Scenario 1, based on the Janssen method for converting NO_x to NO₂ (refer Section 5.2.6).

Further discussion is provided in Section 8.2.

Figure 11 Predicted incremental 1-hour NO₂ 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 AQIA (refer Section 5.2.2).

Presented in Table 22 to Table 24 are the predicted concentrations of CO, SO₂, 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. relevant to the operation of all 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 22.

The results presented in Table 23 indicate that predicted incremental impacts of SO₂ at all receptors are less than 0.1 % 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 24 show no exceedances of the 1-hour criteria for benzene (C₆H₆) are predicted at any identified receptors. The maximum predicted impact for benzene (C₆H₆) is experienced at receptor R7 (6.9 % of the relevant criterion).

A contour plot of the predicted 99.9th percentile 1-hour incremental benzene impact (C₆H₆) under Scenario 1 is presented in Figure 12.

Table 22 Predicted 15-minutes, 1-hour and 8-hour average CO concentrations – Scenario 1

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	1.5	16.5	18.0	3.8	41.7	45.5	9.2	64.0	73.2
R1	0.8	16.5	17.3	0.6	12.5	13.1	0.5	6.4	6.9
R2	1.4	16.5	17.9	1.1	12.5	13.6	0.7	6.4	7.1
R3	0.9	16.5	17.4	0.7	12.5	13.2	0.6	6.4	7.0
R4	0.6	16.5	17.1	0.4	12.5	12.9	0.4	6.4	6.8
R5	0.6	16.5	17.1	0.4	12.5	12.9	0.4	6.4	6.8
R6	1.5	16.5	18.0	1.1	12.5	13.6	0.9	6.4	7.3
R7	1.5	16.5	18.0	1.1	12.5	13.6	0.9	6.4	7.3
R8	1.4	16.5	17.9	1.0	12.5	13.5	0.9	6.4	7.3
R9	0.6	16.5	17.1	0.4	12.5	12.9	0.4	6.4	6.8
R10	0.9	16.5	17.4	0.7	12.5	13.2	0.6	6.4	7.0
R11	0.8	16.5	17.3	0.6	12.5	13.1	0.4	6.4	6.8
R12	1.3	16.5	17.8	1.0	12.5	13.5	0.7	6.4	7.1
R13	0.9	16.5	17.4	0.7	12.5	13.2	0.4	6.4	6.8
R14	1.4	16.5	17.9	1.0	12.5	13.5	0.3	6.4	6.7
R15	1.5	16.5	18.0	1.1	12.5	13.6	0.4	6.4	6.8
R16	0.4	16.5	16.9	0.3	12.5	12.8	< 0.1	6.4	6.5
R17	0.4	16.5	16.9	0.3	12.5	12.8	< 0.1	6.4	6.5
R18	0.5	16.5	17.0	0.4	12.5	12.9	< 0.1	6.4	6.5
R19	0.4	16.5	16.9	0.3	12.5	12.8	0.1	6.4	6.5
R20	0.3	16.5	16.8	0.2	12.5	12.7	0.1	6.4	6.5
R21	0.3	16.5	16.8	0.2	12.5	12.7	0.2	6.4	6.6
R22	0.3	16.5	16.8	0.3	12.5	12.8	0.2	6.4	6.6
R23	0.4	16.5	16.9	0.3	12.5	12.8	0.2	6.4	6.6
R24	0.4	16.5	16.9	0.3	12.5	12.8	0.3	6.4	6.7
R25	0.7	16.5	17.2	0.5	12.5	13.0	0.2	6.4	6.6
R26	0.9	16.5	17.4	0.7	12.5	13.2	0.1	6.4	6.5
R27	0.8	16.5	17.3	0.6	12.5	13.1	0.1	6.4	6.5
R28	0.3	16.5	16.8	0.2	12.5	12.7	<0.1	6.4	6.5
R29	0.3	16.5	16.8	0.2	12.5	12.7	0.1	6.4	6.5
R30	0.3	16.5	16.8	0.3	12.5	12.8	0.2	6.4	6.6
R31	0.4	16.5	16.9	0.3	12.5	12.8	0.1	6.4	6.5
R32	0.4	16.5	16.9	0.3	12.5	12.8	0.2	6.4	6.6
R33	0.4	16.5	16.9	0.3	12.5	12.8	0.2	6.4	6.6

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

Table 23 Predicted 1-hour and 24-hour SO₂ concentrations – Scenario 1

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	215			57		
Max. % of criterion	< 0.1	45.2	45.2	< 0.1	27.5	27.6
R1	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R2	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R3	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R4	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R5	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R6	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R7	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R8	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R9	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R10	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R11	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R12	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R13	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R14	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R15	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R16	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R17	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R18	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R19	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R20	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R21	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R22	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R23	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R24	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R25	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R26	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R27	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R28	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R29	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R30	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R31	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R32	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R33	< 0.1	97.2	97.3	< 0.1	15.7	15.8

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

Table 24 Predicted incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Scenario 1

Receptor	Predicted 1-hour (99.9 th %ile) average concentration (mg·m ⁻³)				
	PAHs	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	6.9	0.2	0.3	1.0
Max % at boundary	< 0.1	6.8	0.2	0.3	1.0
R1	1.57E-08	1.06E-03	3.81E-04	2.66E-04	1.07E-04
R2	2.38E-08	1.60E-03	5.78E-04	4.03E-04	1.63E-04
R3	1.77E-08	1.19E-03	4.30E-04	3.00E-04	1.21E-04
R4	1.05E-08	7.07E-04	2.55E-04	1.78E-04	7.18E-05
R5	1.11E-08	7.47E-04	2.70E-04	1.88E-04	7.59E-05
R6	2.83E-08	1.90E-03	6.87E-04	4.79E-04	1.93E-04
R7	2.96E-08	1.99E-03	7.19E-04	5.01E-04	2.02E-04
R8	2.87E-08	1.93E-03	6.98E-04	4.86E-04	1.96E-04
R9	1.10E-08	7.43E-04	2.68E-04	1.87E-04	7.54E-05
R10	1.80E-08	1.21E-03	4.37E-04	3.04E-04	1.23E-04
R11	1.26E-08	8.50E-04	3.07E-04	2.14E-04	8.63E-05
R12	2.18E-08	1.47E-03	5.30E-04	3.70E-04	1.49E-04
R13	1.24E-08	8.39E-04	3.03E-04	2.11E-04	8.52E-05
R14	9.08E-09	6.11E-04	2.21E-04	1.54E-04	6.21E-05
R15	1.14E-08	7.67E-04	2.77E-04	1.93E-04	7.79E-05
R16	2.74E-09	1.85E-04	6.66E-05	4.64E-05	1.87E-05
R17	3.16E-09	2.13E-04	7.70E-05	5.36E-05	2.17E-05
R18	2.80E-09	1.89E-04	6.81E-05	4.75E-05	1.92E-05
R19	3.78E-09	2.55E-04	9.20E-05	6.41E-05	2.59E-05
R20	5.69E-09	3.83E-04	1.38E-04	9.63E-05	3.89E-05
R21	5.62E-09	3.78E-04	1.37E-04	9.52E-05	3.84E-05
R22	6.05E-09	4.08E-04	1.47E-04	1.03E-04	4.14E-05
R23	5.85E-09	3.94E-04	1.42E-04	9.92E-05	4.00E-05
R24	7.45E-09	5.02E-04	1.81E-04	1.26E-04	5.10E-05
R25	7.53E-09	5.07E-04	1.83E-04	1.28E-04	5.15E-05
R26	5.70E-09	3.84E-04	1.39E-04	9.67E-05	3.90E-05
R27	4.32E-09	2.91E-04	1.05E-04	7.32E-05	2.95E-05
R28	2.88E-09	1.94E-04	6.99E-05	4.87E-05	1.97E-05
R29	3.59E-09	2.42E-04	8.72E-05	6.08E-05	2.45E-05
R30	5.04E-09	3.39E-04	1.22E-04	8.54E-05	3.45E-05
R31	4.59E-09	3.09E-04	1.12E-04	7.78E-05	3.14E-05
R32	4.72E-09	3.18E-04	1.15E-04	8.00E-05	3.23E-05
R33	7.13E-09	4.81E-04	1.73E-04	1.21E-04	4.88E-05

Figure 12 Predicted 99.9th percentile incremental 1-hour benzene impacts – Scenario 1



7.2. Scenario 2 – Maintenance Testing

Presented below are the results of the modelling assessment under the assumptions of Scenario 2 (refer Section 5.2.2) with two generators operating concurrently at 100 % load within the specified daytime testing hours of between 7:00 AM and 6:00 PM.

7.2.1. Particulate Matter

7.2.1.1. Annual average TSP, PM₁₀ and PM_{2.5} Concentrations

The predicted annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from Scenario 2 operations are presented in Table 25. Predicted incremental concentrations of TSP, PM₁₀ and PM_{2.5} at all receptor locations are low. The Proposal operation under the modelled testing regime is predicted to not result in any exceedances of the relevant criteria.

Table 25 Predicted annual average TSP, PM₁₀ and PM_{2.5} concentrations – Scenario 2

Receptor	Annual average concentration (µg·m ⁻³)								
	TSP			PM ₁₀			PM _{2.5}		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	90			25			8		
Max. % of criterion	< 0.1	31.3	31.4	< 0.1	54.8	55.0	< 0.1	91.3	91.9
R1	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R2	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R3	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R4	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R5	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R6	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R7	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R8	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R9	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R10	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R11	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R12	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R13	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R14	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R15	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R16	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R17	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R18	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R19	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R20	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4

Receptor	Annual average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)								
	TSP			PM ₁₀			PM _{2.5}		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R21	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R22	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R23	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R24	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R25	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R26	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R27	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R28	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R29	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R30	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R31	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R32	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4
R33	< 0.1	28.2	28.3	< 0.1	13.7	13.8	< 0.1	7.3	7.4

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

7.2.1.2. 24-hour (Daily) PM₁₀ and PM_{2.5} Concentrations

Table 26 presents the maximum 24-hour average PM₁₀ and PM_{2.5} concentrations predicted under Scenario 2. No background concentrations are included within this table.

Table 26 Predicted incremental 24-hour PM₁₀ and PM_{2.5} concentrations – Scenario 2

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
Criterion	50	25
Max. % of criterion	0.6	1.2
R1	0.1	0.1
R2	0.2	0.2
R3	0.2	0.2
R4	0.1	0.1
R5	< 0.1	< 0.1
R6	0.3	0.3
R7	0.3	0.3
R8	0.3	0.3
R9	0.1	0.1
R10	0.2	0.2
R11	0.1	0.1
R12	0.2	0.2
R13	0.1	0.1
R14	0.1	0.1

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
R15	< 0.1	< 0.1
R16	< 0.1	< 0.1
R17	< 0.1	< 0.1
R18	< 0.1	< 0.1
R19	< 0.1	< 0.1
R20	< 0.1	< 0.1
R21	< 0.1	< 0.1
R22	< 0.1	< 0.1
R23	< 0.1	< 0.1
R24	< 0.1	< 0.1
R25	< 0.1	< 0.1
R26	< 0.1	< 0.1
R27	< 0.1	< 0.1
R28	< 0.1	< 0.1
R29	< 0.1	< 0.1
R30	< 0.1	< 0.1
R31	< 0.1	< 0.1
R32	< 0.1	< 0.1
R33	< 0.1	< 0.1

Note: all PM is assumed to be <1 μg in diameter and therefore assessed as PM_{2.5}. In this instance, emissions of PM_{2.5} will be the same as PM₁₀ (PM_{2.5} is a subset of PM₁₀) and therefore the results will be consistent between PM₁₀ 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 should be considered to be highly conservative.

Table 26 indicates that the highest 24-hour average PM₁₀ and PM_{2.5} incremental concentrations related to the Proposal are predicted at receptor R8.

As per Scenario 1, a contemporaneous analysis of the 24-hour PM₁₀ 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.

Table 27 and Table 28 present the predicted maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal through Scenario 2, with the corresponding background included for each day. Results are presented in Table 27 and Table 28 for those receptors at which the greatest impacts have been predicted (refer Table 26).

For PM₁₀ the highest incremental impacts are predicted at receptor R8 whilst for PM_{2.5} the highest cumulative impacts are predicted at receptor R1. Cumulative impacts are primarily due to high background PM₁₀ and PM_{2.5} levels, and no exceedances of the corresponding 24-hour average PM₁₀ or PM_{2.5} criteria are predicted under Scenario 2.

Table 27 Summary of contemporaneous 24-hour PM₁₀ concentrations – Scenario 2

Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R1			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R8		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
9/10/2021	< 0.1	125.2	125.3	28/11/2021	0.3	21.3	21.6
10/10/2021	< 0.1	125.2	125.3	27/01/2021	0.3	11.2	11.5
22/08/2021	< 0.1	73.5	73.6	14/02/2021	0.3	16.9	17.2
21/08/2021	< 0.1	73.5	73.6	27/11/2021	0.3	17.6	17.9
15/01/2021	< 0.1	31.3	31.4	19/01/2021	0.3	24.5	24.8
20/09/2021	< 0.1	29.2	29.3	7/01/2021	0.3	11.3	11.6
23/01/2021	< 0.1	27.9	28.0	8/01/2021	0.3	13.2	13.5
26/10/2021	< 0.1	27.8	27.9	27/12/2021	0.3	12.1	12.4
8/10/2021	< 0.1	27.1	27.2	21/11/2021	0.3	8.1	8.4
4/05/2021	< 0.1	26.7	26.8	6/05/2021	0.3	14.5	14.8
These data represent the highest Cumulative Impact 24-hour PM ₁₀ predictions (outlined in red) as a result of the operation of the Proposal				These data represent the highest Incremental Impact 24-hour PM ₁₀ predictions (outlined in blue) as a result of the operation of the Proposal.			

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

Table 28 Summary of contemporaneous 24-hour PM_{2.5} concentrations – Scenario 2

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R1			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R8		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
9/10/2021	< 0.1	213.1	213.2	28/11/2021	0.3	6.0	6.3
22/08/2021	< 0.1	129.4	129.5	27/01/2021	0.3	5.1	5.4
10/10/2021	< 0.1	93.6	93.7	14/02/2021	0.3	6.4	6.7
21/08/2021	< 0.1	67.9	68.0	27/11/2021	0.3	6.8	7.1
20/09/2021	< 0.1	30.6	30.7	19/01/2021	0.3	10.6	10.9
4/05/2021	< 0.1	23.6	23.7	7/01/2021	0.3	3.8	4.1
30/04/2021	< 0.1	19.9	20.0	8/01/2021	0.3	3.9	4.2
27/10/2021	< 0.1	18.5	18.6	27/12/2021	0.3	3.6	3.9
27/04/2021	< 0.1	18.2	18.3	21/11/2021	0.3	1.7	2.0
15/08/2021	< 0.1	17.9	18.0	6/05/2021	0.3	2.7	3.0
These data represent the highest Cumulative Impact 24-hour PM _{2.5} predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM _{2.5} predictions (outlined in blue) as a result of the operation of the Proposal.			

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

A contour isopleth plot of the predicted incremental 24-hour PM₁₀ concentrations associated with the Proposal under Scenario 2 are presented in Figure 13 to allow examination of the distribution of particulate matter in the area surrounding the Proposal site.

Figure 13 Predicted incremental 24-hour PM_{10} impacts – Scenario 2



Source: Northstar

7.2.2. Nitrogen Dioxide

This section presents the predicted nitrogen dioxide (NO₂) concentrations under Scenario 2. The relevant assessment criteria for NO₂, as specified in Table 7 are based on 1-hour and annual averaging periods.

The predicted maximum 1-hour and annual average NO₂ concentrations resulting from the assumptions under Scenario 2 are presented in Table 29.

The results indicate that predicted incremental and cumulative NO₂ concentrations are below the criteria at all surrounding receptor locations. The performance of the Proposal under Scenario 2 does not result in any exceedances of the criteria for NO₂.

Table 29 Predicted 1-hour and annual average NO₂ concentrations – Scenario 2

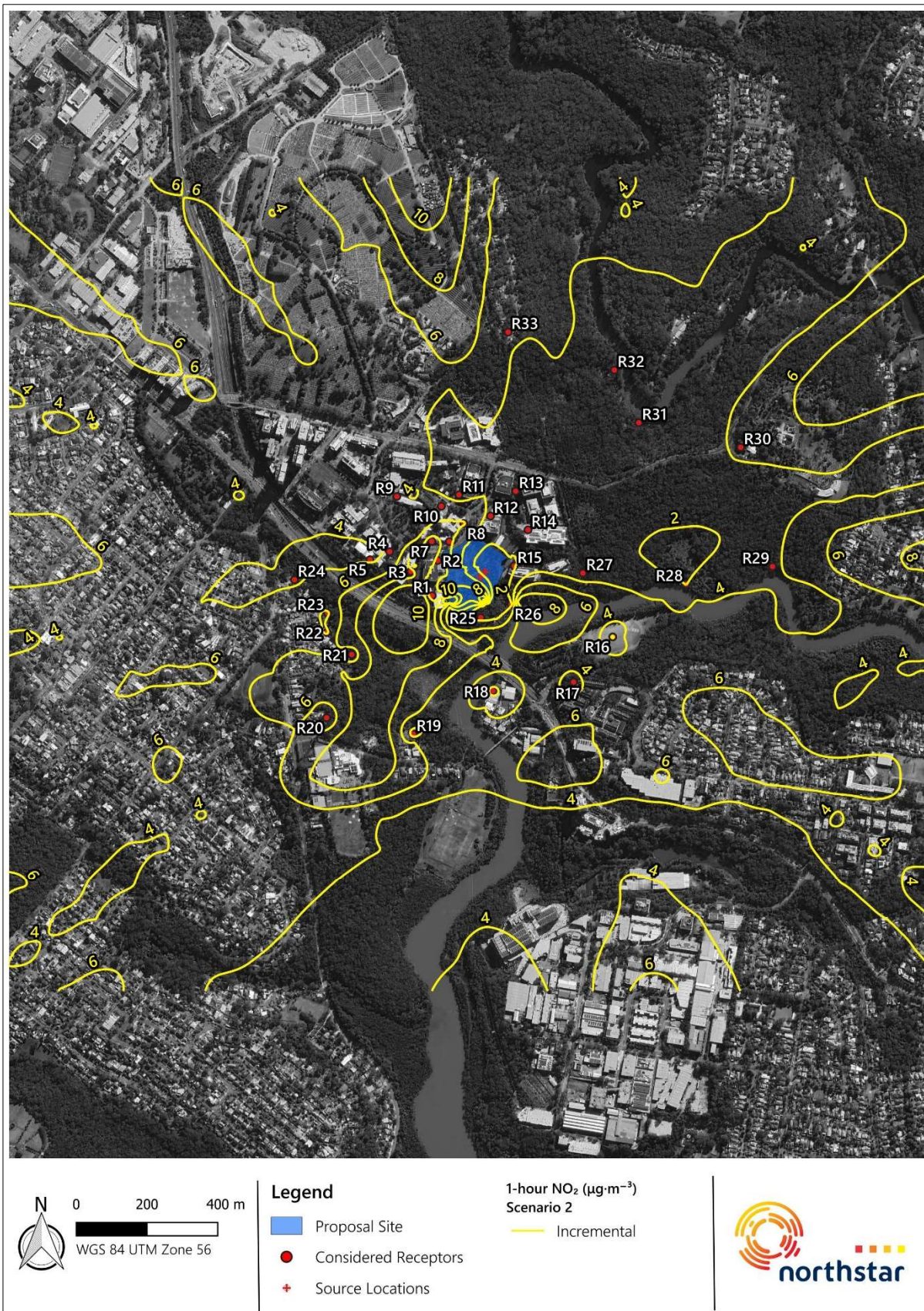
Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	164			31		
Max % of criterion	5.6	15.0	16.9	0.7	23.2	23.9
R1	6.6	2.1	8.6	< 0.1	7.2	< 7.3
R2	7.6	4.1	11.7	0.2	7.2	7.4
R3	6.5	4.1	10.6	0.1	7.2	7.3
R4	4.2	16.4	20.6	0.1	7.2	7.3
R5	3.9	16.4	20.3	< 0.1	7.2	< 7.3
R6	6.7	6.2	12.8	0.2	7.2	7.4
R7	9.2	6.2	15.4	0.2	7.2	7.4
R8	6.2	2.1	8.2	0.2	7.2	7.4
R9	4.2	4.1	8.3	0.1	7.2	7.3
R10	4.9	2.1	6.9	0.2	7.2	7.4
R11	3.3	2.1	5.4	0.1	7.2	7.3
R12	3.7	4.1	7.8	0.1	7.2	7.3
R13	3.0	4.1	7.1	< 0.1	7.2	< 7.3
R14	3.1	4.1	7.2	< 0.1	7.2	< 7.3
R15	1.9	4.1	6.0	< 0.1	7.2	< 7.3
R16	1.8	< 0.1	1.8	< 0.1	7.2	< 7.3
R17	2.3	2.1	4.3	< 0.1	7.2	< 7.3
R18	1.4	< 0.1	1.4	< 0.1	7.2	< 7.3
R19	3.1	< 0.1	3.2	< 0.1	7.2	< 7.3
R20	4.0	4.1	8.1	< 0.1	7.2	< 7.3
R21	4.6	6.2	10.8	< 0.1	7.2	< 7.3
R22	3.8	8.2	12.0	< 0.1	7.2	< 7.3
R23	3.8	4.1	7.9	< 0.1	7.2	< 7.3
R24	3.8	< 0.1	3.8	< 0.1	7.2	< 7.3
R25	1.4	4.1	5.5	< 0.1	7.2	< 7.3

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R26	1.4	4.1	5.5	< 0.1	7.2	< 7.3
R27	2.5	4.1	6.6	< 0.1	7.2	< 7.3
R28	1.9	2.1	4.0	< 0.1	7.2	< 7.3
R29	3.7	8.2	11.9	< 0.1	7.2	< 7.3
R30	4.3	2.1	6.4	< 0.1	7.2	< 7.3
R31	2.6	24.6	27.2	< 0.1	7.2	< 7.3
R32	3.2	24.6	27.8	< 0.1	7.2	< 7.3
R33	4.8	2.1	6.9	< 0.1	7.2	< 7.3

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

Figure 14 shows a contour plot of the predicted 1-hour incremental NO₂ impacts for Scenario 1, based on the Janssen method for converting NO_x to NO₂ (refer Section 5.2.6).

Figure 14 Predicted incremental 1-hour NO₂ impacts – Scenario 2



Source: Northstar

7.2.3. All Other Pollutants

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

Presented in Table 30 to Table 32 are the predicted concentrations of CO, SO₂, PAHs, VOCs and formaldehyde at varying averaging periods at the surrounding receptors. The predicted incremental concentrations for all of the abovementioned pollutants are below the relevant criteria for all averaging periods at all receptors.

A contour plot of the predicted 99.9th percentile 1-hour incremental benzene (C₆H₆) impact under Scenario 2 is presented in Figure 15.

Table 30 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
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

Receptor	Carbon monoxide (CO) concentration (mg·m ⁻³)								
	15-minute			1-hour			8-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
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 31 Predicted 1-hour and 24-hour SO₂ concentrations – Scenario 2

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	215			57		
Max. % of criterion	< 0.1	45.2	45.2	< 0.1	27.5	27.6
R1	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R2	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R3	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R4	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R5	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R6	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R7	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R8	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R9	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R10	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R11	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R12	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R13	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R14	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R15	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R16	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R17	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R18	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R19	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R20	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R21	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R22	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R23	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R24	< 0.1	97.2	97.3	< 0.1	15.7	15.8

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R25	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R26	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R27	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R28	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R29	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R30	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R31	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R32	< 0.1	97.2	97.3	< 0.1	15.7	15.8
R33	<0.1	97.2	97.3	<0.1	15.7	15.8

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

Table 32 Predicted incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Scenario 2

Receptor	Predicted 1-hour (99.9 th %ile) average concentration (mg·m ⁻³)				
	PAHs	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	0.3	< 0.1	< 0.1	< 0.1
Max. % at boundary	< 0.1	0.3	< 0.1	< 0.1	< 0.1
R1	8.83E-10	5.95E-05	2.15E-05	1.50E-05	6.04E-06
R2	1.09E-09	7.32E-05	2.64E-05	1.84E-05	7.44E-06
R3	6.50E-10	4.38E-05	1.58E-05	1.10E-05	4.45E-06
R4	4.44E-10	2.99E-05	1.08E-05	7.52E-06	3.04E-06
R5	3.49E-10	2.35E-05	8.48E-06	5.91E-06	2.39E-06
R6	1.27E-09	8.57E-05	3.09E-05	2.16E-05	8.70E-06
R7	1.38E-09	9.30E-05	3.36E-05	2.34E-05	9.45E-06
R8	1.32E-09	8.90E-05	3.21E-05	2.24E-05	9.04E-06
R9	4.25E-10	2.86E-05	1.03E-05	7.21E-06	2.91E-06
R10	8.72E-10	5.88E-05	2.12E-05	1.48E-05	5.97E-06
R11	5.65E-10	3.80E-05	1.37E-05	9.57E-06	3.86E-06
R12	9.31E-10	6.27E-05	2.26E-05	1.58E-05	6.37E-06
R13	4.66E-10	3.14E-05	1.13E-05	7.89E-06	3.19E-06
R14	4.49E-10	3.03E-05	1.09E-05	7.62E-06	3.07E-06
R15	3.87E-10	2.61E-05	9.41E-06	6.56E-06	2.65E-06
R16	1.15E-10	7.74E-06	2.79E-06	1.95E-06	7.86E-07
R17	1.27E-10	8.58E-06	3.10E-06	2.16E-06	8.72E-07
R18	1.14E-10	7.68E-06	2.77E-06	1.93E-06	7.80E-07
R19	1.32E-10	8.92E-06	3.22E-06	2.24E-06	9.06E-07
R20	2.01E-10	1.36E-05	4.89E-06	3.41E-06	1.38E-06
R21	2.49E-10	1.68E-05	6.06E-06	4.23E-06	1.71E-06
R22	2.32E-10	1.56E-05	5.63E-06	3.93E-06	1.59E-06
R23	2.21E-10	1.49E-05	5.38E-06	3.75E-06	1.51E-06
R24	2.31E-10	1.55E-05	5.61E-06	3.91E-06	1.58E-06
R25	3.12E-10	2.10E-05	7.59E-06	5.29E-06	2.14E-06
R26	2.37E-10	1.60E-05	5.76E-06	4.01E-06	1.62E-06
R27	1.69E-10	1.14E-05	4.12E-06	2.87E-06	1.16E-06
R28	1.21E-10	8.12E-06	2.93E-06	2.04E-06	8.25E-07
R29	1.26E-10	8.50E-06	3.07E-06	2.14E-06	8.63E-07
R30	1.87E-10	1.26E-05	4.54E-06	3.17E-06	1.28E-06
R31	1.60E-10	1.08E-05	3.89E-06	2.71E-06	1.10E-06
R32	1.56E-10	1.05E-05	3.78E-06	2.64E-06	1.06E-06
R33	2.25E-10	1.52E-05	5.47E-06	3.81E-06	1.54E-06

Figure 15 Predicted 99.9th percentile incremental 1-hour benzene impacts – Scenario 2



Source: Northstar

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 Proposal is anticipated to include the following relevant characteristics:

- 49 standby generators in total, comprising 48 × 3 MW units for the critical IT load and one (1) × 1 MW unit for office / FOH and associated safety features;
- A maintenance testing regime totalling up to 132.3 hours, based on testing of the 48 critical IT load generators and the one 'house' generator; and
- Total diesel fuel storage capacity of up to 955 kL or approximately 812.5 t covering all generators.

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 (NO₂) 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 information presented in Section 2.3.2.1 and the anticipated diesel fuel storage capacity (refer Section 2.2) the Proposal site is considered a non-scheduled activity for chemical storage and electricity generation under the POEO Act. Correspondingly, the Proposal must comply with the concentration standards for non-scheduled activities outlined in Schedule 2, Part 3 of the POEO CAR (refer Section 3.2).

Table 33 below compares the emissions from individual data centre generators at the Proposal site against the respective concentration standards.

Table 33 POEO CAR – Standards of concentrations comparison

Air impurity	Standard of concentration (mg·m ⁻³) ^(A)	Standby generator emissions ^(B) (per generator)
Solid particles (total)	100	4.0 mg·m ⁻³ at 100 % load (CAT C175-20)
		12.3 mg·m ⁻³ at 100 % load (CAT DE1100 GC)

Notes: (a): Standard of emissions concentration under dry, 273 K, 101.3 kPa, 7 % O₂ conditions

(b): The Proposal's generator emissions above are based on the mg·Nm⁻³ generator emission data in Appendix E, assumed as dry, 273 K, 101.3 kPa and 5 % O₂ content, which were then converted into 7 % O₂ content as per the POEO CAR requirements.

Table 33 shows that the respective concentration standards can be met with the use of the standby diesel generators at the Proposal site.

8. DISCUSSION

This section evaluates the potential air quality impacts associated with the Proposal during both construction and operational phases. Potential impacts have been assessed in the context of relevant legislation, including the POEO Act, POEO CAR and associated guidance published by NSW EPA. This discussion summarises the assessment findings, highlighting identified risks and the potential impacts on surrounding receptors and the broader environment.

8.1. Construction Phase Assessment

The construction phase risk assessment for the Proposal, presented in Section 6, indicates that dust soiling impacts pose a medium risk level for earthworks, construction, trackout, and construction-traffic activities. In terms of human health impacts, these activities are considered to pose a low risk, assuming no mitigation measures are 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 Assessment

The predicted impacts of operational phase activities under a justified worst-case scenario (Scenario 1) and a 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), the dispersion modelling assumes 49 generators operating simultaneously to meet critical IT load and associated building services.

The dispersion modelling results for Scenario 1 indicate no additional exceedances of the relevant short-term criteria for NO_2 , PM_{10} and $\text{PM}_{2.5}$ at any assessed sensitive receptor, even under continuous operation at 100 % load (refer Section 7.1). To provide context, a theoretical assessment of statistical probability (p) has been carried out to illustrate the likelihood of a hypothetical exceedance, if one were ever to occur. Under this scenario, the maximum annual probability is:

- NO_2 : $p = 0.00011$
- PM_{10} : $p = 0.0027$; and
- $\text{PM}_{2.5}$: $p = 0.0027$.

These values represent the statistical likelihood of one additional exceedance under a hypothetical worst-case scenario and do not reflect any predicted exceedances from the dispersion modelling.

To further characterise the likelihood of such a hypothetical exceedance coinciding with a power outage, network reliability information from the Ausgrid 2024 Distribution and Transmission Annual Planning Report (DTAPR) (Ausgrid, 2024) has been reviewed. Based on the DTAPR and associated network reliability statistics, the average unplanned outage duration per year per customer over a 10 year period from financial year 2013 (2013 / 2014) to financial year 2023 (2023 / 2024) equated to approximately 74.0 minutes, although the exact duration of power outages requiring standby generators cannot be determined. This corresponds to a probability of $p=0.000141$ or approximately 0.014 % of the time per year ($74.0 / (8\,760 \times 60)$).

Figure 17 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 a 10 year period from financial year 2013 / 2014 to financial year 2023 / 2024.

The combined probability of both a power outage and a hypothetical exceedance occurring simultaneously is obtained by multiplying the respective probabilities. These values are extremely small and are summarised in Table 34, showing the percentage chance of such an event occurring over various timeframes. Overall, the results demonstrate that no exceedances are predicted at sensitive receptors under Scenario 1. Even in a conservative hypothetical scenario, the likelihood of an exceedance coinciding with a power outage is extremely low.

The Proposal is to be connected to a new Ausgrid precinct wide 132 kV STSS and is sited in proximity to the Ausgrid 132 kV transmission network², where power outages are expected to be significantly shorter than the network-wide average. The reported statistics include less reliable power lines, whereas an outage on the 132 kV network would result in a widespread Sydney-wide outage.

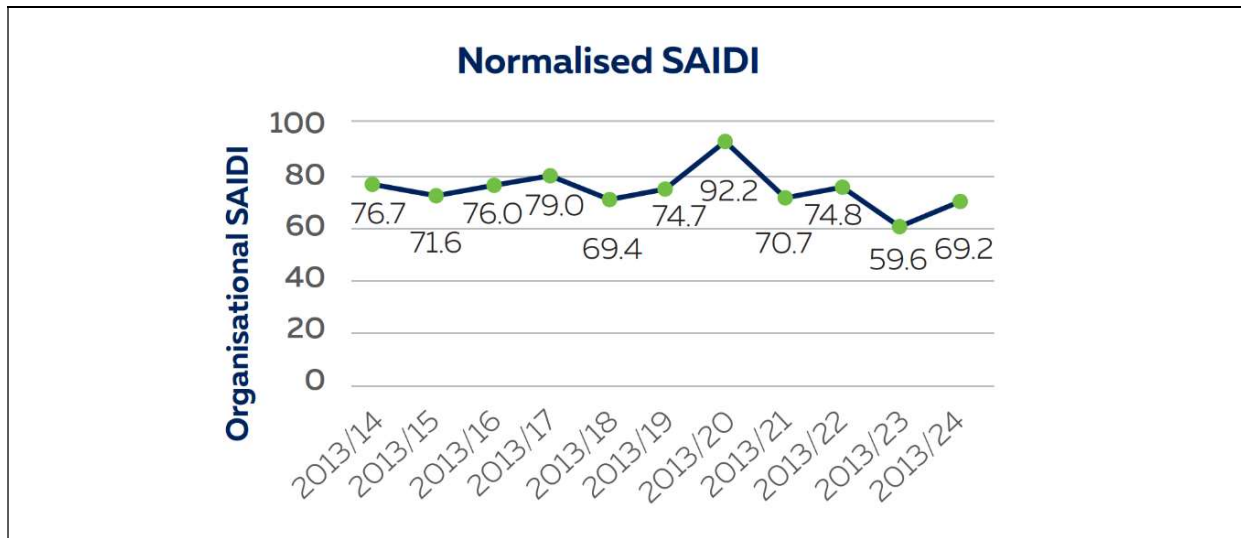
Table 34 Probability of a short-term exceedance during a power outage

Number of years	Probability of a short term exceedance during a power outage (%)		
	1 hour NO ₂	24 hour PM ₁₀	24 hour PM _{2.5}
100	0.0002	0.0039	0.0039
200	0.0003	0.0077	0.0077
500	0.0008	0.0193	0.0193
1 000	0.0016	0.0386	0.0386
1 250	0.0020	0.0482	0.0482

Note: These probabilities are based on theoretical inputs used to contextualise risk. The dispersion modelling predicts no additional exceedances of the short term criteria for NO₂, PM₁₀ and PM_{2.5} under Scenario 1.

² <https://dtapr.ausgrid.com.au/>

Figure 16 Ausgrid SAIDI performance information



Source: (Ausgrid, 2024)

8.2.2. Scenario 2 (Maintenance Testing)

Annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from Scenario 2 are predicted to comply with the relevant impact assessment criteria, with no exceedances predicted.

Under Scenario 2, no additional exceedances of the cumulative impact assessment criteria for 24-hour PM₁₀ and 24-hour PM_{2.5} are predicted as a result of the Proposal. While several exceedances of the 24-hour PM₁₀ and PM_{2.5} criteria are identified in Table 27 and Table 28, these are attributable to elevated background concentrations that already exceed the respective criteria and are not related to emissions from the Proposal.

For 1-hour and annual average NO₂, no cumulative exceedances are predicted due to the Proposal. Predicted incremental and cumulative 1-hour NO₂ concentrations remain below the relevant criteria at all considered receptor locations.

Predicted concentrations of CO, SO₂, PAHs, VOCs, and CH₂O across all assessed averaging periods are also below the relevant impact assessment criteria at all receptor locations under Scenario 2.

Correspondingly, it is anticipated that under operation of the testing schedule, as outlined in Section 2.3.2, that no significant air quality impacts are predicted to be experienced at sensitive receptors during routine operations.

8.2.3. Odour

Operational phase activities will not result in any odour emissions, except for the periodic operation of the diesel-fuelled generators for testing and back-up power generation purposes, as outlined in Section 2.3.3.

Toluene (C_7H_8) and xylene (C_8H_{10}) emissions have been assessed and compared against the relevant odour impact assessment criteria.

No exceedances of the relevant odour criteria are predicted during either emergency or realistic operations.

8.2.4. 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 particle standards.

Although the operations may be exempt from the relevant emission limit regulations (i.e. in-stack emission concentrations), the Applicant would not be exempt from ensuring the emissions do not exceed ambient air quality criteria.

8.3. Cumulative Impacts

A desktop survey identified local data centres with similar emissions profiles to assess potential cumulative impacts. The Proposal's cumulative air quality impacts were evaluated alongside these sources, including during emergency and realistic operations.

A semi-quantitative probability based analysis estimated potential cumulative impacts at sensitive receptors, finding a low probability of simultaneous operations or testing at nearby data centres, and therefore a low likelihood of cumulative impacts occurring.

9. MITIGATION

This section outlines the measures proposed to mitigate potential air quality impacts and manage associated risks during the construction and operational phases of the Proposal. The measures are designed to ensure compliance with the POEO Act, POEO CAR and relevant guidance, reducing residual impacts to the extent reasonably practicable.

9.1. Construction Phase

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.

With the implementation of the mitigation measures as part of a Construction Environmental Management Plan (CEMP) that the remaining construction-phase risks associated with the Proposal are appropriate and acceptable.

Recommended construction phase mitigation measures consummate to the nature and scale of the Proposal are provided in Appendix B

9.2. Operational Phase

Based on the Scenario 2 dispersion modelling, the maintenance testing schedule is not predicted to cause exceedances at any sensitive receptors. To minimise impacts, testing must be undertaken in accordance with Section 2.3 and emergency generator use should be limited to essential events only.

The assessment indicates that normal operations are not expected to cause additional exceedances of relevant air quality criteria at any identified receptors. Both the worst-case emergency scenario and the realistic maintenance testing scenario have been evaluated. Under realistic operation, predicted incremental concentrations for all assessed pollutants remain below the applicable criteria.

To further minimise potential impacts, maintenance must be carried out as outlined in Section 2.3.2, and operation of the emergency generators should be limited to the minimum practicable extent.

As the Proposal is not likely to constitute a scheduled activity under the POEO Act (refer Section 3.1), it is anticipated that an EPL will not be required. In this context, NSW EPA's role is advisory, and any conditions to manage or mitigate potential air quality impacts would be set by the consent authority.

To reduce pollutant emissions and maintain flexibility for future emissions control, the following measures may be implemented:

Design Safeguards

- Ensure the design, installation and operation of the standby generators and enclosures do not preclude the future retrofitting of additional Air Pollution Control (APC) equipment.

Operational Limits

- Ensure generator operation (including testing) does not exceed 200 hours per year.
- Ensure that on site diesel fuel storage does not exceed 2 000 t at any time.

Note: For the purposes of calculating annual operational hours, concurrent testing of multiple generators is counted as a single hour. For example, five generators tested simultaneously over one hour would count as one hour toward the annual limit.

To address cumulative impacts, coordination protocols may be established with nearby data centres and relevant industries to minimise overlap in generator testing. This may include agreed testing windows, a testing register that can be provided on request, and notification procedures for identified receptors during emergency and maintenance events.

It is anticipated that any future development approval would restrict operation of the standby generators to emergency and testing purposes only and prohibit their use for electricity export or load-curtailement. Conditions may also require periodic emissions testing of the standby generator units.

10. CONCLUSION

This AQIA has been prepared by Northstar for Logic Projects on behalf of the Applicant for the proposed construction and operation of the Julius Avenue Data Centre (SSD-80018208).

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 on the Proposal site, and combustion emissions from standby diesel generator engines during operations.

Data from available sources, including information provided by the Applicant and publicly accessible environmental data, were utilised. The emergency use of diesel generators is predicted to have the potential to lead to the exceedance of air quality criteria at nearby sensitive receptor locations from associated emissions to air. The routine testing under the parameters assessed was not predicted to result in any exceedances of the air quality criteria at any receptor location.

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. With the implementation of the mitigation measures as part of a Construction Environmental Management Plan (CEMP) that the remaining construction-phase risks associated with the Proposal are appropriate and acceptable.

During the operational phase and based upon the information presented in this AQIA, the normal operation of the Proposal is not considered likely to result in additional exceedances of the relevant air quality criteria at any identified receptor location. Scenarios replicating the worst-case and a realistic case for maintenance testing operations have been considered in the assessment.

The predicted incremental concentrations for all assessed pollutants are shown to be below the relevant criteria under realistic operations where the back-up generators are operated under an appropriate testing schedule.

11. REFERENCES

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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 $\mu\text{g}\cdot\text{m}^{-3}$ and not 50 $\mu\text{g}/\text{m}^3$; and,
- 0.2 kilograms per hectare per hour would be presented as 0.2 $\text{kg}\cdot\text{ha}^{-1}\cdot\text{hr}^{-1}$ and not 0.2 $\text{kg}/\text{ha}/\text{hr}$.

Commonly used SI-derived and non-SI units

Symbol	Name	Quantity
$\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$	gram per square metre per second	rate of mass deposition per unit area
$\text{g}\cdot\text{s}^{-1}$	gram per second	rate of mass emission
$\text{kg}\cdot\text{ha}^{-1}\cdot\text{hr}^{-1}$	kilogram per hectare per hour	rate of mass deposition per unit area
$\text{kg}\cdot\text{m}^{-3}$	kilogram per cubic metre	density
$\text{L}\cdot\text{s}^{-1}$	litres per second	volumetric rate
m^2	square metre	area
m^3	cubic metre	volume
$\text{m}\cdot\text{s}^{-1}$	metre per second	speed and velocity
$\text{mg}\cdot\text{m}^{-3}$	milligram per cubic metre	mass concentration per unit volume
$\text{mg}\cdot\text{Nm}^{-3}$	milligram per normalised cubic metre (of air)	mass concentration per unit volume
$\mu\text{g}\cdot\text{m}^{-3}$	microgram per cubic metre	mass concentration per unit volume
$\text{mg}\cdot\text{m}^{-3}$	milligram per cubic metre	mass concentration per unit volume
Pa	pascal	pressure
ppb	parts per billion (1×10^{-9})	volumetric concentration
pphm	parts per hundred million (1×10^{-5})	volumetric concentration
ppm	parts per million (1×10^{-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 EPA	New South Wales Environment Protection Authority
NT	Northern Territory
OEMP	operational environmental management plan
O ₃	ozone
OU	odour unit
OU·m ³ ·s ⁻¹	odour units times metres cubed per second
OU·s ⁻¹	odour units per second
Pb	lead
PM	particulate matter
PM ₁₀	particulate matter with an aerodynamic diameter of 10 µm or less
PM _{2.5}	particulate matter with an aerodynamic diameter of 2.5 µm or less
ROM	run of mine
SA	South Australia
SEPP	State Environmental Protection Policy
SO _x	oxides of sulphur

Abbreviation	Term
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 Risk Assessment Methodology

Provided below is a summary of the risk assessment methodology applied in this AQIA which is based upon the UK IAQM's *Guidance on the assessment of dust from demolition and construction* (IAQM, 2024) and adapted by Northstar.

Adaptions to the Published Methodology Made by Northstar

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

- **PM₁₀ criterion:** an amended criterion representing the annual average PM₁₀ 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 Proposal site boundary; and,
- At a distance greater than 50 m from the route used by construction vehicles on public roads, beginning from the Proposal site entrance and extending past 250 m from the Proposal site entrance(s).

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

Receptor ID	Location	Land use	Screening distance (m)		
			Proposal site boundary (250 m)	Proposal site entrance(s) (250 m)	Proposal site cons. route(s) (50m)
R1	Julius Avenue, North Ryde	Commercial	45	127	128
R2	Julius Avenue, North Ryde	Commercial	17	29	29
R3	Julius Avenue, North Ryde	Commercial	97	107	68
R4	Julius Avenue, North Ryde	Commercial	149	150	48
R5	Julius Avenue, North Ryde	Commercial	211	206	104
R6	Julius Avenue, North Ryde	Child Care Centre	23	34	16
R7	Julius Avenue, North Ryde	Commercial	42	42	25
R8	Julius Avenue, North Ryde	Commercial	34	99	19
R9	Julius Avenue, North Ryde	Commercial	203	202	52
R10	Julius Avenue, North Ryde	Recreation	121	128	86
R11	Julius Avenue, North Ryde	Commercial	113	167	72
R12	Julius Avenue, North Ryde	Commercial	72	133	48
R13	Delhi Road, North Ryde	Commercial	168	205	40
R14	Richardson Place, North Ryde	Commercial	101	117	34
R15	Richardson Place, North Ryde	Commercial	26	37	18
R16	Rotary Athletics Field	Recreation	359	379	357
R17	Walkers Drive, Lane Cove North	Residential	317	395	383
R18	Epping Road, Lane Cove North	Industrial	223	365	360
R19	Magdala Road, North Ryde	Residential	333	523	523
R20	Magdala Road, North Ryde	Residential	445	573	543
R21	Gilda Road, North Ryde	Residential	297	388	352
R22	Gilda Road, North Ryde	Residential	355	399	337
R23	Gilda Road, North Ryde	Residential	346	368	294
R24	Gilda Road, North Ryde	Residential	425	426	309
R25	Fairyland Track, Great North Walk	Recreation	25	168	169
R26	Fairyland Track, Great North Walk	Recreation	51	121	113
R27	Fairyland Track, Great North Walk	Recreation	232	215	215
R28	Fairyland Track, Great North Walk	Recreation	509	511	511
R29	Fullers Bridge, Great North Walk	Recreation	749	702	766
R30	Northern Suburbs Memorial Gdns	Recreation	729	672	672
R31	Ironbarks, Great North Walk	Recreation	532	431	431
R32	Carters Creek, Great North Walk	Recreation	611	481	481
R33	Lane Cove River Tourist Park	Recreation	578	438	438

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	Screening	Comments
Demolition	250 m from boundary, 250 m from site entrance(s)	Not applicable	Receptors identified within the screening distance.
Earthworks	250 m from boundary, 250 m from site entrance(s)	Not screened	
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 – Risk from Construction Activities

Step 2 of the assessment categorises dust-generating activities as demolition, earthworks, construction, track-out (material transported onto public roads), and construction traffic, by their 'dust emissions magnitude' (Small, Medium, or Large), as defined 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 site area	< 18 000m 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 which would be prone to suspension when dry due to small particle size)
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
Material moved	< 20 000 t	20 000 t to 100 000 t	> 100 000 t
Earthworks timing	wet months only	any time of the year	any time of the year

Activity	Small	Medium	Large
Construction			
Total building volume	< 12 000 m ³	12 000 m ³ to 75 000 m ³	> 75 000 m ³
Piling	no	yes	yes
Concrete batching	no	yes	yes
Sandblasting	no	no	yes
Materials	metal cladding or timber	concrete	concrete
Trackout (within 100 m of construction site entrance)			
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 000m 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 which would be prone to suspension when dry due to small particle size)
Earthworks traffic – material moved	< 20 000 t	20 000 t to 100 000 t	> 100 000 t
Construction traffic - total building volume	< 12 000 m ³	12 000 m ³ to 75 000 m ³	> 75 000 m ³
Total traffic heavy vehicles movements per day when compared to existing heavy vehicle traffic	< 10 % of heavy vehicle movement contribution by Proposal	10 % to 50 % of heavy vehicle movement contribution by Proposal	> 50 % of heavy vehicle movement contribution by Proposal

The Proposal's construction will deliver a state of the art data centre, integrating essential servicing and infrastructure. Site preparation will involve tree clearing, earthworks, and retaining structures, along with civil works and utilities servicing. The facility will feature eight (8) data halls with a maximum power capacity of 120 MW, supported by upper level mechanical equipment and rooftop plant. Additional structures include a five (5) storey office and front of house (FOH) building, a five (5) storey enclosed generator gantry to the rear, and car parking. The Proposal also includes a new Ausgrid precinct wide 132 kV STSS and the wider development will be enhanced by landscaping and offset planting, with final planting numbers to be confirmed.

Demolition activities are not applicable as the Proposal site has remained vacant since excavation and vegetation clearing in 2009.

Bulk earthworks are required at the Proposal site to achieve target cut / fill balances in relation to building and road levels. The impacted area includes the primary land use of the data centre and the ancillary land use of office premises, resulting in a total site development area of 28 630 m². It is anticipated that between 5 and 10 heavy earth-moving vehicles will be active at any one time during the earthworks phase.

The ground floor will feature either a raft or suspended slab. The floor system for the data halls and front-of-house areas will include prestressed concrete beams and slabs. Chiller rooms and cooling tower platforms will use a composite steel and concrete flooring system, supported by structural or prefabricated steel modules. Columns may be precast or cast in-situ with reinforced concrete. Structural walls for lateral stability will be cast in-situ reinforced concrete. The façade from Ground to Level 1 will include non-load-bearing precast concrete panels, with lightweight cladding or non-load-bearing panels above. Additional materials in the design include window glazing, metal cladding, and perforated metal batten screens. Lateral stability will be provided by reinforced concrete stair walls, lift core walls, and shear walls.

The total building volume is anticipated to exceed 75 000 m³ with potential piling required for foundations. On site concrete batching is not anticipated. The buildings will be supported by pad footings, with in-ground services placed clear of the foundations. Vertical structural elements will primarily consist of structural steel, reducing dead weight and maximising off-site prefabrication.

The Proposal site is located in a middle-ring suburb of Sydney, northwest of the CBD, with construction traffic utilising the existing road network. Access to the Proposal site will be via the local road network, starting from Epping Road, a major arterial route, leading onto Delhi Road and then to Julius Avenue. Richardson Place, which runs east to south of the Proposal site provides additional access via Julius Avenue.

Given the scale of the Proposal, it is conservatively assumed that up to 50 outbound HDV movements will be required daily during construction. While no unpaved road lengths exist in the surrounding area, the Proposal site itself will have unpaved sections of less than 50 m during works.

Based upon the discussion provided above and the criteria presented in Table B3, the assessed dust emission magnitudes are as presented in Table B4.

Table B4 Construction phase impact categorisation of dust emission magnitude

Activity	Dust emission magnitude
Demolition	Not applicable
Earthworks and enabling works	Medium
Construction	Large
Track-out	Medium
Construction traffic routes	Large

Step 3 – Sensitivity of the Area

Step 3 of the assessment process requires defining the area's sensitivity, which considers:

- The sensitivities of identified land use values to dust deposition and human health impacts.
- The proximity and number of those receptors locations;
- In the case of PM₁₀, the local background concentration; and
- Site-specific factors, like the presence of natural shelters e.g. trees to reduce wind-blown dust risk.

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 B5 below. It is noted that user expectations of amenity levels (dust soiling) are dependent on existing deposition levels.

Table B5 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 Property would not reasonably be expected to be diminished in appearance, aesthetics, or value by soiling; or 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 The appearance, aesthetics or value of their property could be diminished by soiling; or 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 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	<i>Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.</i>	<i>Parks and places of work.</i>	<i>Dwellings, museums, and other culturally important collections, medium- and long-term car parks and car showrooms</i>

Land use value	Low	Medium	High
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	<i>Public footpaths, playing fields, parks, and shopping street.</i>	<i>Office and shop workers but would generally not include workers occupationally exposed to PM₁₀.</i>	<i>Residential properties, hospitals, schools, and residential care homes.</i>

Receptors within 250 m of the Proposal site are predominately commercial, industrial and office use in nature including the Riverside Corporate Park and are considered to have a 'medium' land use value. It is noted that an early learning preschool centre is located opposite the Proposal site on Julius Avenue, whilst recreational use is found to within 100 m at Newbiggin Close and within the Great North Walk including the North Ryde Fairyland Circuit and adjoining areas of Lane Cove National Park. For a conservative assessment, a 'high' land use value overall has been attributed given the proximity of the preschool facility to the Proposal site boundary.

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 B6 below.

Table B6 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.

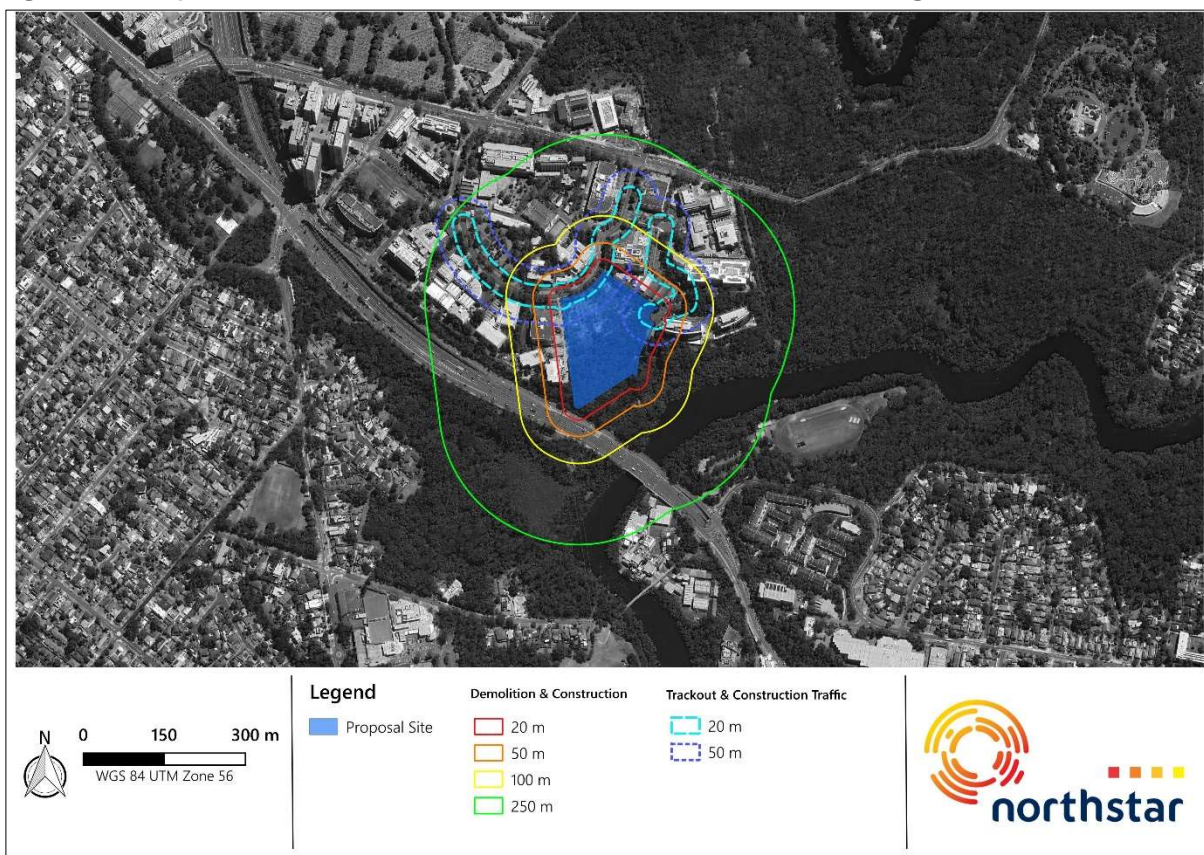
(b): With regard to potential 'construction traffic' impacts, the distance criteria of less than 20 m and less than 50 m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50 m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity 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 are shown to account for potential construction routes, with access points determined based on the accompanying site layout drawings.

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 B5 needs to be considered.

It is estimated that up to 10 receptors are within 50 m and up to 100 receptors positioned within a distance of 250 m from the Proposal site boundary. Considering both the sensitivity of receptors and their numbers within specified distances from the footprint, the sensitivity to dust soiling impacts is assessed as 'medium'.

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



Source: Northstar

Human Health Impacts

The assessed land use value (as described in Table B5) 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;
- Conclusions drawn from local meteorological data that represent the area including seasonality;
- 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 B7. The background annual average PM₁₀ concentration at Macquarie Park AQMS in 2021 was 13.2 µg·m⁻³ (refer Table D1). Together with the calculated land use value, this classifies the sensitivity as 'low' for human health impacts related to the Proposal.

Table B7 IAQM guidance for categorising the sensitivity of an area of 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
		> 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 B8 for each activity determine the risk category with no mitigation applied.

Table B8 Pre-mitigated risk of dust impacts from construction related activities

Sensitivity of area	Pre-mitigated dust emission magnitude		
	Small	Medium	Large
Demolition			
Low	Negligible	Low risk	Medium risk
Medium	Low risk	Medium risk	High risk
High	Medium risk	Medium risk	High risk
Earthworks, Construction and Trackout			
Low	Negligible	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	Low risk	Low risk
Medium	Negligible	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 B4, the resulting risk of air quality impacts (without mitigation) is as presented in Table B9.

Table B9 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
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, N/A. = Not Applicable, Neg. = Negligible

Table B9 summarises that dust soiling impacts are considered a medium risk for construction, earthworks, trackout, and construction-traffic activities. Human health impacts from these activities are regarded as a low risk, assuming no mitigation measures are implemented during the construction phase.

These pre-mitigated risks have been assessed as such if no mitigation measures were to be applied to control emissions associated with construction-phase 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).

The mitigation measures presented in Table B10 are commensurate with the risks associated for the Proposal and are recommended to be applied during the construction stage to ensure construction dust will be adequately managed.

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

Table B10 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 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	Undertake 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 100m of 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
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
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

Identified mitigation		Unmitigated risk
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·h ⁻¹ on surfaced and 15 km·h ⁻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
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

Identified mitigation		Unmitigated risk
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

APPENDIX C

Meteorology

Meteorological Stations

A meteorological modelling exercise has been performed to characterise the meteorology of the Proposal 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) and Air Quality Monitoring Stations (AQMS) operated by the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW).

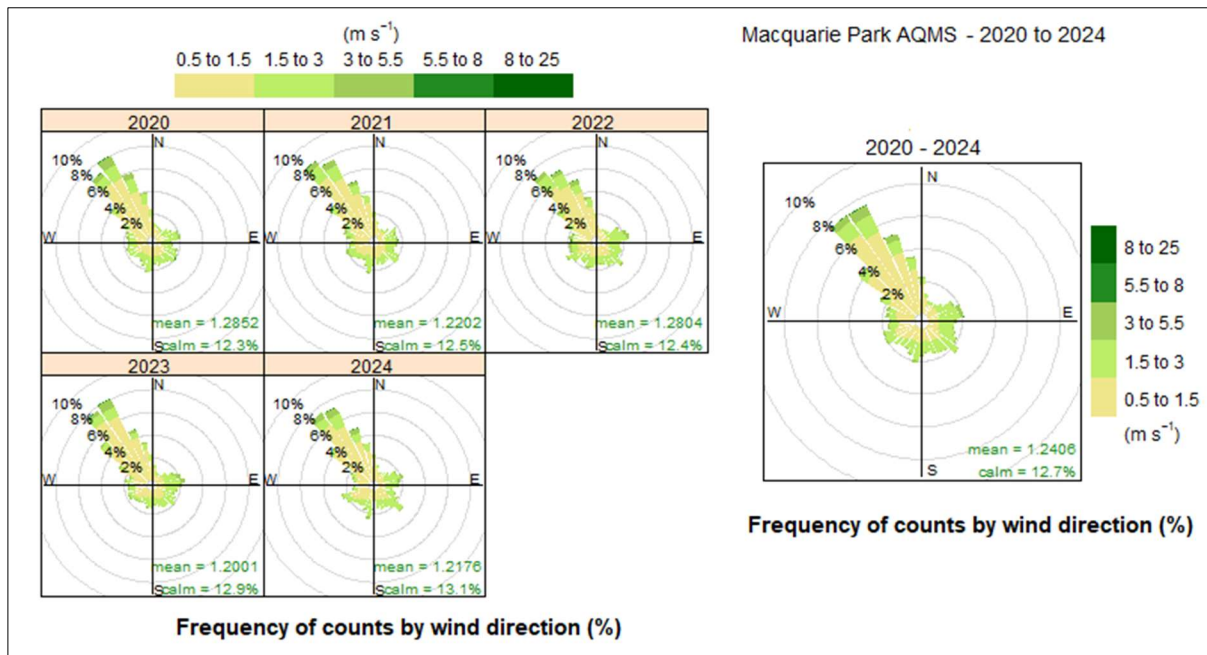
As outlined in Section 4.3, meteorological conditions at Macquarie Park AQMS, located approximately 4.4 km to the north west of the Proposal site, have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2020 to 2024) are presented in Figure C1. The annual wind speed frequency distribution for the four-year period is presented in Figure C2.

The wind roses presented in Appendix C indicate that from 2020 to 2024, winds at Macquarie Park AQMS show similar wind distribution patterns across the years assessed, with a predominant north westerly wind direction.

The majority of wind speeds experienced at Macquarie Park AQMS between 2019 and 2023 are generally in the range 0.5 meters per second ($\text{m}\cdot\text{s}^{-1}$) to $5.5 \text{ m}\cdot\text{s}^{-1}$ with the highest wind speeds (greater than $5.5 \text{ m}\cdot\text{s}^{-1}$) occurring from primarily north-westerly directions. Winds of this speed are rare and occur during 0.3 % of the observed hours during the years. Calm winds (less than $0.5 \text{ m}\cdot\text{s}^{-1}$) are more common and occur during 12.7 % of hours on average across the years between 2020 and 2024.

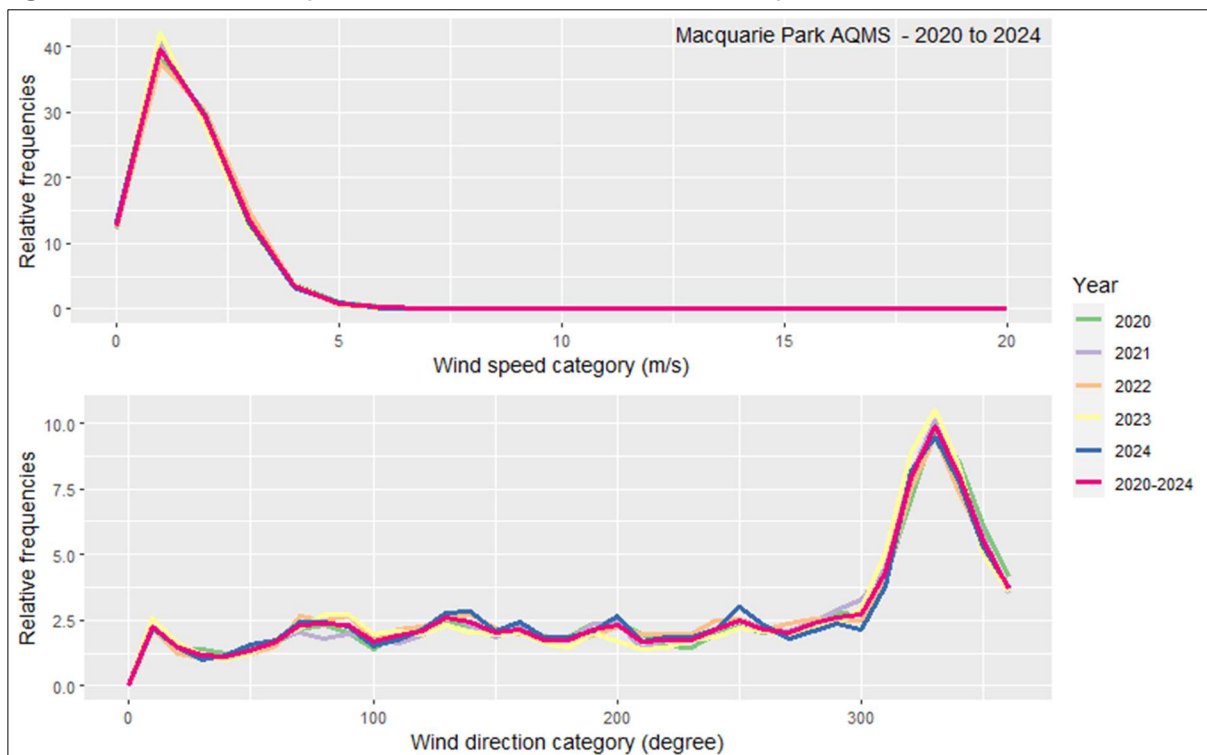
The correlation coefficients between each year and the five-year period for the distribution of wind direction and wind speed are summarised in Table C1. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table C1.

Figure C1 Annual wind roses – Macquarie Park AQMS (2020 to 2024)



Source: Northstar

Figure C2 Annual wind speed and direction distributions – Macquarie Park AQMS (2020 to 2024)



Source: Northstar

Table C1 Correlation coefficient analysis – Macquarie Park AQMS (2020 – 2024)

Parameter	Wind speed		Wind direction		Aggregated rank
	Corr.	Rank	Corr.	Rank	
2020	0.9994	3	0.9920	4	4
2021	0.9996	2	0.9952	1	1
2022	0.9985	4	0.9945	2	3
2023	0.9983	5	0.9913	5	5
2024	0.9999	1	0.9932	3	2
2020 - 2024	1	-	1	-	-

Note: Corr. = correlation

Wind speed observations for each year correlated well against the wind speed over the four-year period, with each year having a correlation coefficient greater than 0.99. The year 2024 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 0.99. The year 2021 is the highest ranked for correlation against the wind direction over the five-year period.

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

Meteorological Processing

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

In absence of any measured onsite meteorological data, site representative meteorological data for this Proposal was generated using the CALMET meteorological processor in a format suitable for using in the CALPUFF dispersion model (refer Section 5.2.1).

CALMET is a meteorological data processor that generates three-dimensional wind and temperature fields across a gridded modelling domain. It serves as the meteorological pre-processor for the CALPUFF modelling system. 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). The TAPM model is cited in the 'Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia' (Barclay & Scire, 2011) as a suitable prognostic meteorological model for applications involving complex meteorological conditions.

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

The parameters used in TAPM and CALMET modelling are presented in Table C2. Further, as per (Barclay & Scire, 2011), the seven critical parameters used in the CALMET modelling are presented in Table C3.

Table C2 CALMET and TAPM meteorological parameters

TAPM v 4.0.5	
Modelling period	1 January 2021 to 31 December 2021
Centre of analysis	324 117 mE, 6 258 397 mS (UTM)
Number of grid points	25 x 25 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km, 300 m)
Terrain	AUSLIG 9 second DEM
Data assimilation	Macquarie Park AQMS
CALMET	
Modelling period	1 January 2021 to 31 December 2021
Southwest corner of analysis	323 000 mE, 6 253 500 mS (UTM Coordinates)
Meteorological grid domain (resolution)	10 km x 10 km (0.1 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

Table C3 Seven critical meteorological parameters used in CALMET

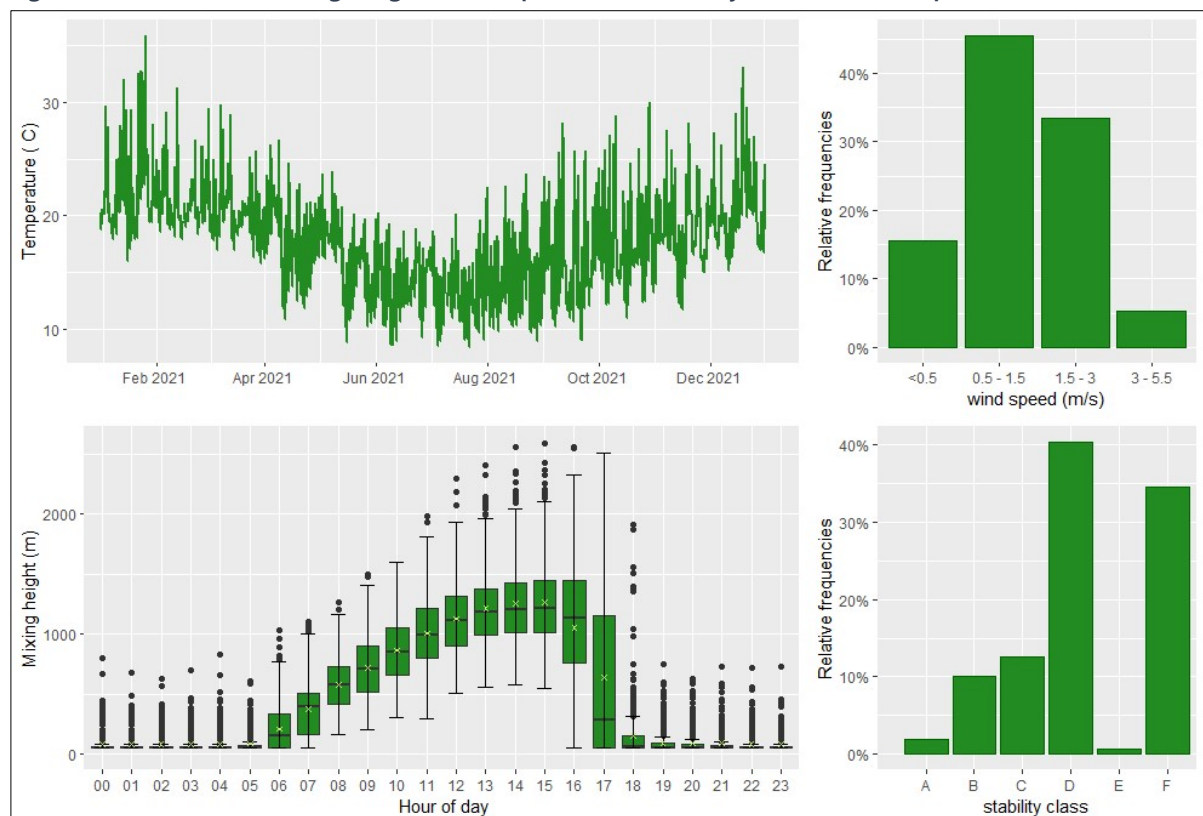
Parameter	Value
TERRAD	1.5
IEXTRP	1
BIAS (NZ)	0 × 10
R1 and R2	0, 0
RMAX1 and RMAX2	0, 0

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

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Proposal site during 2021 period are illustrated in Figure C3.

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.

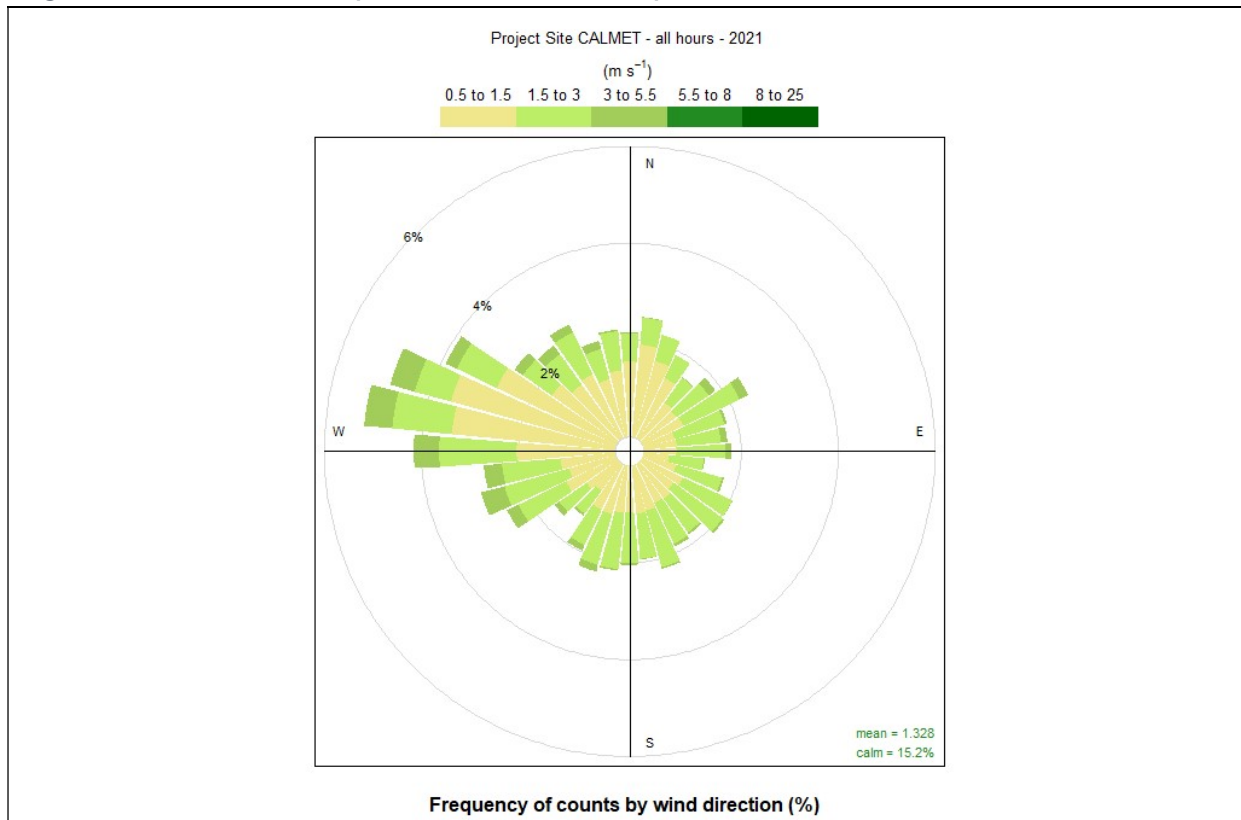
Figure C3 Predicted mixing height, wind speed, and stability class at the Proposal site (2021)



Source: Northstar

The modelled wind speed and direction at the Proposal site during 2021 are presented in Figure C4.

Figure C4 Predicted wind speed and direction – Proposal site (2021)



Source: Northstar

APPENDIX D

Background Air Quality

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

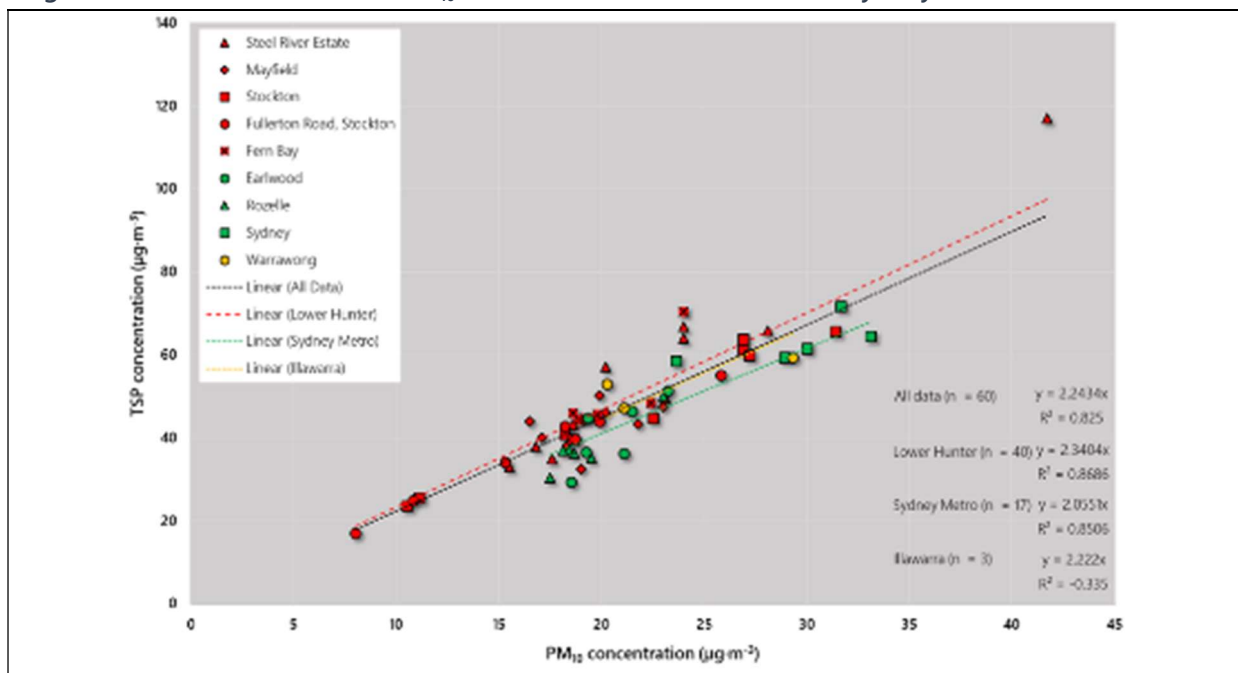
- The sources of air pollutant emissions around the Proposal site and representative AQMS; and
- The variability of particulate matter concentrations (often impacted by natural climate variability).

Background air quality monitoring data used within this AQIA has been adopted from Macquarie Park Air Quality Monitoring Station (AQMS), managed by NSW DCCEEW and located approximately 4.4 km to the north west of the Proposal site. Specifically, air quality monitoring data for the year 2021 (consistent with meteorological modelling [refer Appendix C]) has been adopted for use in this AQIA. Summary statistics for the selected data are presented in Table D1.

TSP concentrations are not measured at any AQMS surrounding the Proposal site. Figure D1 presents an analysis of co-located TSP and PM₁₀ measurements from the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions. Based on measurements collected across these regions, the analysis supports deriving a general TSP:PM₁₀ ratio of 2.0551 : 1 (i.e., PM₁₀ accounts for approximately 49 % of TSP) using Sydney Metropolitan data. In the absence of more specific information, this ratio has been applied in this AQIA, resulting in a background annual average TSP concentration of 27.1 $\mu\text{g}\cdot\text{m}^{-3}$.

Graphs presenting the daily varying PM₁₀ and PM_{2.5} data, and hourly varying NO₂ data, recorded at Macquarie Park AQMS in 2021 are presented in Figure D2, Figure D3 and Figure D4 respectively.

Figure D1 Co-located TSP and PM₁₀ measurements – Lower Hunter, Sydney Metro and Illawarra



Source: Northstar

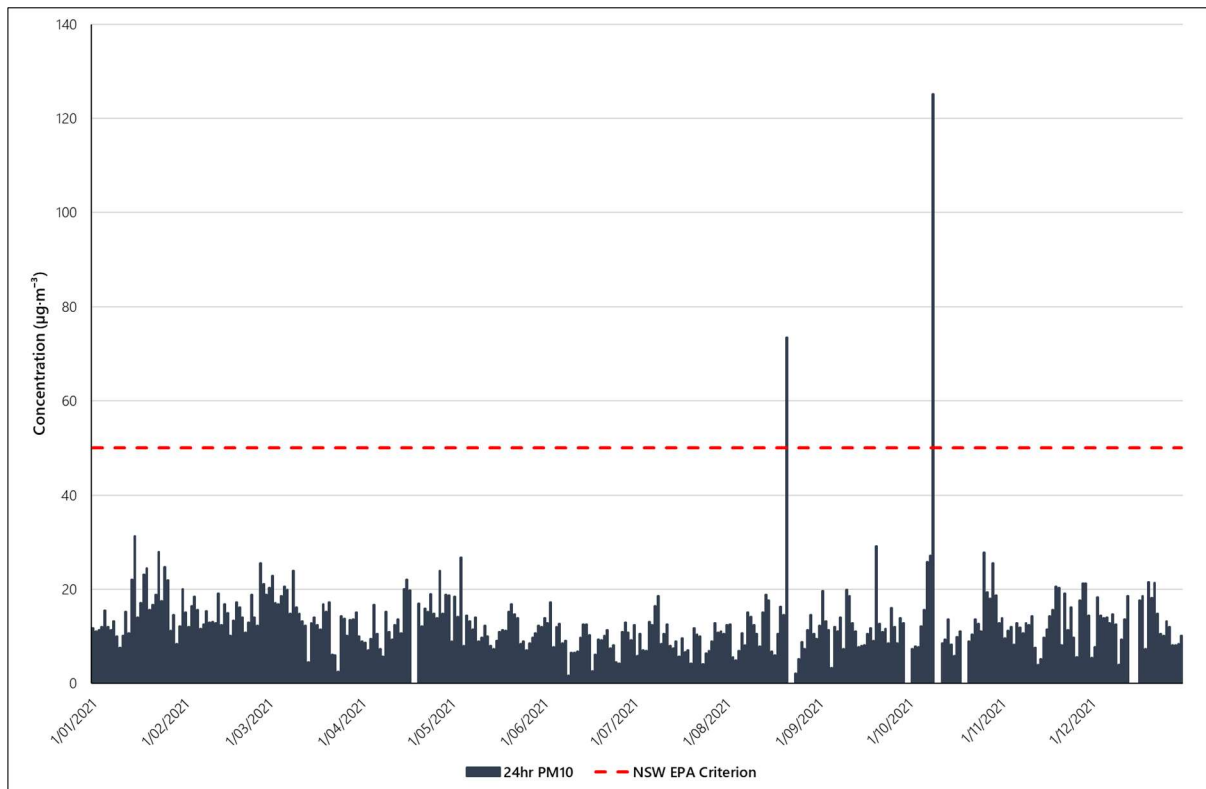
Table D1 Background air quality statistics – Macquarie Park AQMS (2021)

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	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	mg·m ⁻³	mg·m ⁻³	mg·m ⁻³
Statistics									
Data Points (nb)	-	352	357	355	8188	8154	8020	8020	8481
Mean	27.1	13.2	7.3	0.7	0.9	7.2	0.5	0.4	0.4
Standard deviation	-	8.5	14.4	1.8	3.5	8.3	0.4	0.3	0.3
Skew ¹	-	7.8	10.9	3.8	9.9	2.8	20.4	20.4	13.8
Kurtosis ²	-	94.0	136.4	20.7	153.7	25.4	575.2	575.2	243.3
Minimum	-	1.7	-0.6	0.0	-5.7	-6.2	-0.2	-0.1	-0.1
Percentiles									
25 th	-	9.2	3.7	0.0	0.0	2.1	0.3	0.3	0.3
50 th	-	12.3	5.1	0.0	0.0	4.1	0.5	0.4	0.4
75 th	-	15.2	7.3	0.0	0.0	10.3	0.5	0.4	0.4
90 th	-	19.4	10.4	2.6	2.9	18.5	0.7	0.5	0.5
95 th	-	22.1	13.1	5.2	5.7	22.6	0.8	0.6	0.6
97 th	-	25.1	17.6	5.2	5.7	26.7	0.8	0.6	0.6
98 th	-	26.7	18.5	5.2	8.6	28.7	1.0	0.8	0.8
99 th	-	28.5	47.0	6.4	14.3	32.8	1.2	0.9	0.9
Maximum	-	125.2	213.1	15.7	97.2	149.7	16.5	12.5	6.4
Data Capture (%)	96.2	96.2	97.5	97.0	93.2	92.8	91.3	91.3	96.6

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.

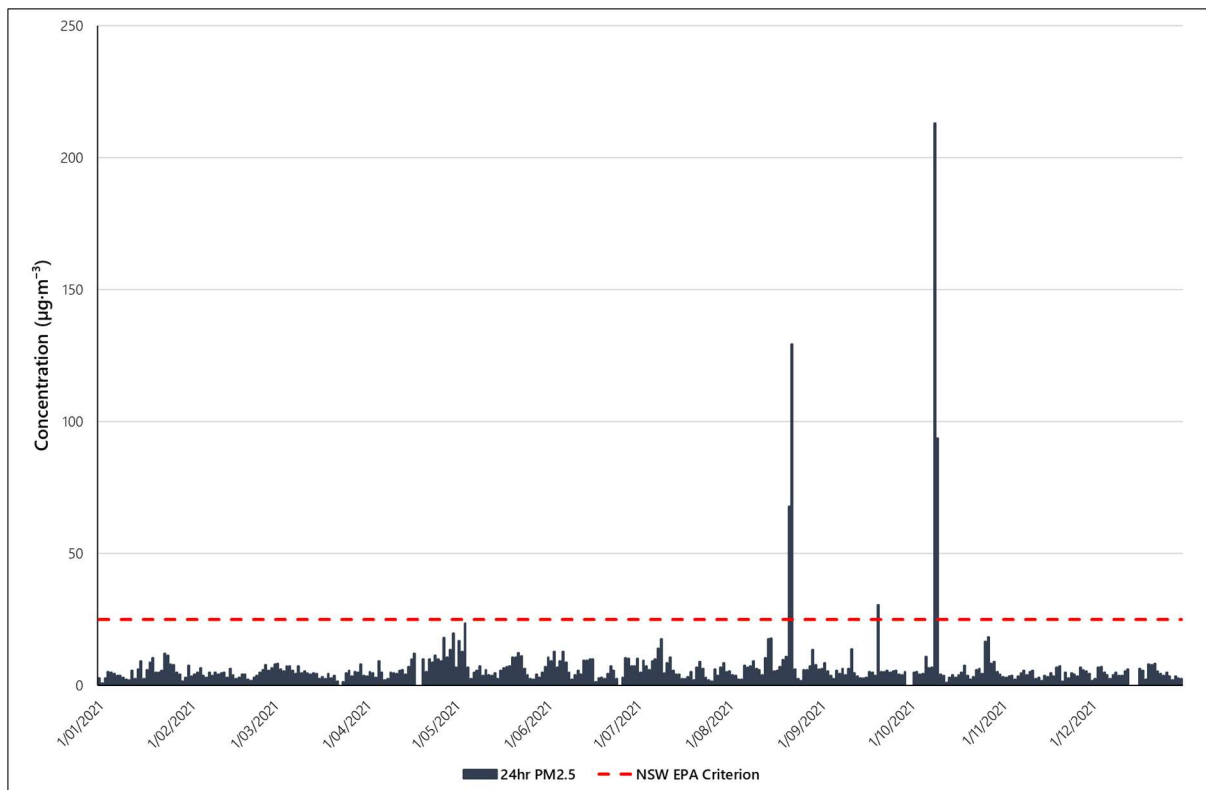
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive kurtosis represents a more peaked distribution, and negative kurtosis represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure D2 Daily varying PM₁₀ measurements – Macquarie Park AQMS (2021)



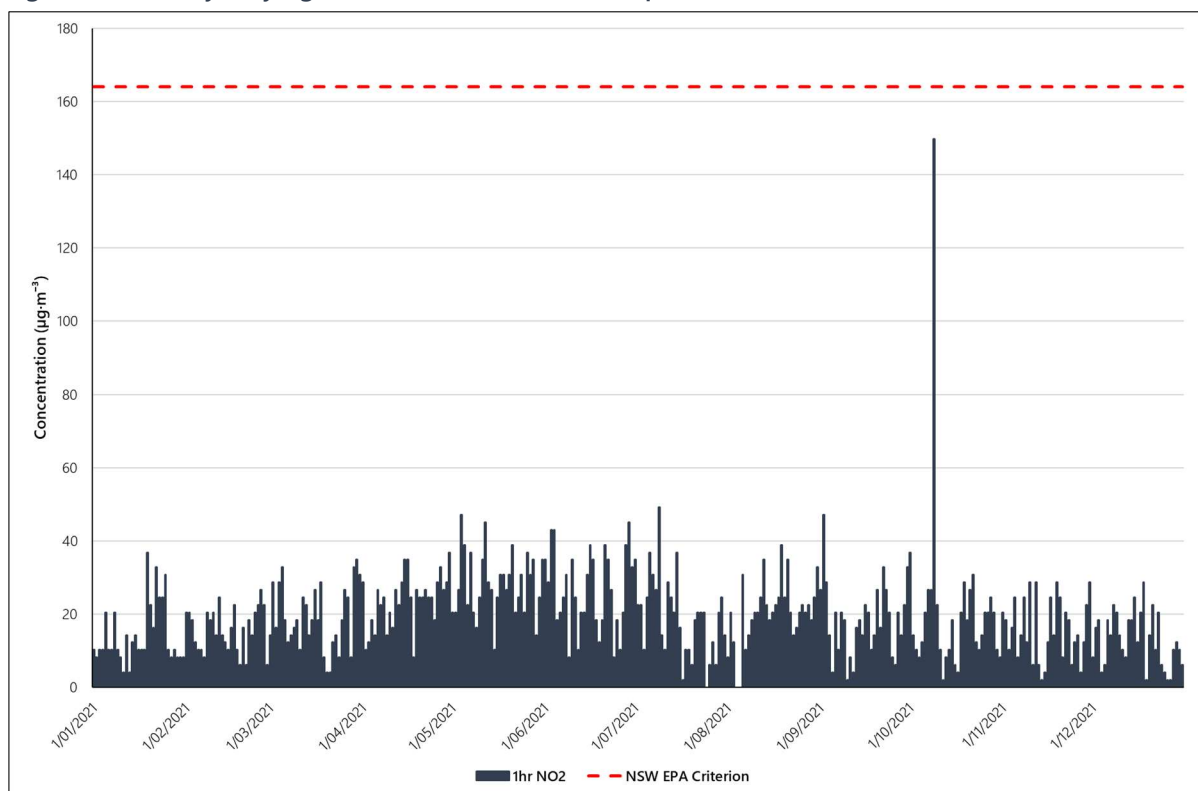
Source: Northstar

Figure D3 Daily varying PM_{2.5} measurements – Macquarie Park AQMS (2021)



Source: Northstar

Figure D4 Hourly varying NO₂ measurements – Macquarie Park AQMS (2021)



Source: Northstar

It can be observed from Figures D2 to D4 that in 2021, the Macquarie Park AQMS recorded several exceedances of the respective 24-hour PM₁₀ and PM_{2.5} criteria. Table D2 provides further details on the 24-hour PM₁₀ and PM_{2.5} exceedances recorded at the Macquarie Park AQMS in 2021.

Table D2 24-hour PM₁₀ & PM_{2.5} criteria exceedances at Macquarie Park AQMS in 2021

Date	Measured concentration (µg·m ⁻³)	Comments
24-hour PM₁₀ concentrations		
21 August 2021	73.5	Exceptional – hazard reduction burning
9 October 2021	125.2	Exceptional – hazard reduction burning
24-hour PM_{2.5} concentrations		
21 August 2021	67.9	Exceptional – hazard reduction burning
22 August 2021	129.4	Exceptional – hazard reduction burning
20 September 2021	30.6	Exceptional – hazard reduction burning
9 October 2021	213.1	Exceptional – hazard reduction burning
10 October 2021	93.7	Exceptional – hazard reduction burning

The New South Wales annual compliance report (NSW DPE, 2023) attributes exceptional PM_{10} and $\text{PM}_{2.5}$ events in 2021 primarily to hazard reduction burns, particularly in the Sydney region. On 9 October 2021, Macquarie Park AQMS recorded one of the highest daily PM_{10} averages ($125.2 \mu\text{g}\cdot\text{m}^{-3}$) and the highest $\text{PM}_{2.5}$ average ($213.1 \mu\text{g}\cdot\text{m}^{-3}$), with exceedances also observed for $\text{PM}_{2.5}$ on 10 October ($93.7 \mu\text{g}\cdot\text{m}^{-3}$). The PM_{10} monitor was in alarm mode for part of 9 October and 10 October 2021.

Plumes from hazard reduction burns north of Sydney contributed to these exceedances, which were classified as exceptional events under the National Environment Protection (Ambient Air Quality) Measure (NEPM) framework. The exceptional event day at Macquarie Park AQMS on 9 October is further described in Appendix B of (NSW DPE, 2023).

APPENDIX E

Generator Technical Specifications

Package Performance

Low Emissions

Performance	Standby	Mission Critical
Frequency	50 Hz	50 Hz
Gen set power rating with fan	3120 ekW	3120 ekW
Gen set power rating with fan @ 0.8 power factor	3900 kVA	3900 kVA
Emissions	Low Emissions	Low Emissions
Performance number	EM1364-06	EM1366-06

Fuel Consumption

100% load with fan – L/hr (gal/hr)	802.1 (211.9)	802.1 (211.9)
75% load with fan – L/hr (gal/hr)	637.5 (168.4)	637.5 (168.4)
50% load with fan – L/hr (gal/hr)	439.9 (116.2)	439.9 (116.2)
25% load with fan – L/hr (gal/hr)	252.9 (66.8)	252.9 (66.8)

Cooling System

Radiator air flow restriction (system) – kPa (in. water)	0.12 (0.48)	0.12 (0.48)
Radiator air flow – m ³ /min (cfm)	3334 (117739)	3334 (117739)
Engine coolant capacity – L (gal)	440.0 (116.2)	440.0 (116.2)
Radiator coolant capacity – L (gal)	845.0 (222.2)	845.0 (222.2)
Total coolant capacity – L (gal)	1285 (338.4)	1285 (338.4)

Inlet Air

Combustion air inlet flow rate – m ³ /min (cfm)	305.5 (10786.9)	305.5 (10786.9)
--	-----------------	-----------------

Exhaust System

Exhaust stack gas temperature – °C (°F)	460.7 (861.2)	460.7 (861.2)
Exhaust gas flow rate – m ³ /min (cfm)	704.5 (24877.4)	704.5 (24877.4)
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)	1732 (98480)	1732 (98480)
Heat rejection to exhaust (total) – kW (Btu/min)	3034 (172533)	3034 (172533)
Heat rejection to aftercooler – kW (Btu/min)	374 (21288)	374 (21288)
Heat rejection to atmosphere from engine – kW (Btu/min)	196 (11145)	196 (11145)
Heat rejection from alternator – kW (Btu/min)	133 (7586)	133 (7586)

Emissions* (Nominal)

NOx mg/Nm ³ (g/hp-h)	2346.1 (4.99)	2346.1 (4.99)
CO mg/Nm ³ (g/hp-h)	255.0 (0.54)	255.0 (0.54)
HC mg/Nm ³ (g/hp-h)	43.0 (0.11)	43.0 (0.11)
PM mg/Nm ³ (g/hp-h)	4.6 (0.01)	4.6 (0.01)

Emissions* (Potential Site Variation)

NOx mg/Nm ³ (g/hp-h)	2815.3 (5.99)	2815.3 (5.99)
CO mg/Nm ³ (g/hp-h)	459.1 (0.98)	459.1 (0.98)
HC mg/Nm ³ (g/hp-h)	57.2 (0.14)	57.2 (0.14)
PM mg/Nm ³ (g/hp-h)	6.5 (0.02)	6.5 (0.02)

*mg/Nm³ levels are corrected to 5% O₂. Contact your local Cat dealer for further information.

PERFORMANCE DATA[EM1364]

February 9, 2025

Performance Number: EM1364

Change Level: 08

SALES MODEL:	C175-20	COMBUSTION:	DIRECT INJECTION
BRAND:	CAT	ENGINE SPEED (RPM):	1,500
MACHINE SALES MODEL:		HERTZ:	50
ENGINE POWER (BKW):	3,368.0	FAN POWER (KW):	84.0
GEN POWER WITH FAN (EKW):	3,120.0	ASPIRATION:	TA
COMPRESSION RATIO:	15.3	AFTERCOOLER TYPE:	SCAC
RATING LEVEL:	STANDBY	AFTERCOOLER CIRCUIT TYPE:	JW+OC+1AC, 2AC
PUMP QUANTITY:	2	AFTERCOOLER TEMP (C):	46
FUEL TYPE:	DIESEL	JACKET WATER TEMP (C):	99
MANIFOLD TYPE:	DRY	TURBO CONFIGURATION:	PARALLEL
GOVERNOR TYPE:	ADEM4	TURBO QUANTITY:	4
ELECTRONICS TYPE:	ADEM4	TURBOCHARGER MODEL:	GTB6251BN-48T-1.38
CAMSHAFT TYPE:	STANDARD	COMBUSTION STRATEGY:	LOW EMISSION
IGNITION TYPE:	CI	FUEL RATE (RATED RPM) NO LOAD (L/HR):	70.5
INJECTOR TYPE:	CR	PISTON SPD @ RATED ENG SPD (M/SEC):	11.0
FUEL INJECTOR:	4439454		
REF EXH STACK DIAMETER (MM):	457		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	ISO BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	ISO VOL FUEL CONSUMPTN (VFC)	ELEC SPEC FUEL CONSUMPTN (ESFC)	ISO ELEC SPEC FUEL CONSUMPTN (ESFC)
EKW	%	BKW	KPA	G/BKW-HR	G/BKW-HR	L/HR	L/HR	G/EKW-HR	G/EKW-HR
3,120.0	100	3,368	2,546	206.4	202.4	817.7	802.1	222.8	218.5
2,808.0	90	3,036	2,295	211.2	207.1	754.2	739.9	228.3	224.0
2,496.0	80	2,709	2,048	215.2	211.1	685.9	672.8	233.6	229.1
2,340.0	75	2,547	1,925	216.9	212.7	649.9	637.5	236.1	231.6
2,184.0	70	2,387	1,805	217.7	213.5	611.4	599.8	238.0	233.4
1,872.0	60	2,067	1,563	218.3	214.1	530.9	520.8	241.1	236.5
1,560.0	50	1,744	1,318	218.6	214.5	448.5	439.9	244.4	239.7
1,248.0	40	1,413	1,068	223.1	218.9	371.0	363.9	252.7	247.9
936.0	30	1,081	817	232.6	228.1	295.6	290.0	268.5	263.4
780.0	25	914	691	239.8	235.2	257.8	252.9	280.9	275.6
624.0	20	747	565	249.4	244.6	219.2	215.0	298.6	292.9
312.0	10	415	314	288.2	282.8	140.7	138.0	383.3	376.0

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP
EKW	%	BKW	KPA	DEG C	DEG C	KPA	DEG C	KPA	DEG C
3,120.0	100	3,368	297.2	50.8	634.2	231.7	460.7	299	227.9
2,808.0	90	3,036	283.7	49.6	615.1	218.2	447.8	286	220.2
2,496.0	80	2,709	262.7	48.5	595.2	200.1	437.5	265	208.4
2,340.0	75	2,547	249.5	47.9	584.8	189.3	433.4	251	200.9
2,184.0	70	2,387	232.9	47.3	574.7	176.3	431.2	235	190.7
1,872.0	60	2,067	194.8	46.1	553.1	147.4	428.0	197	169.1
1,560.0	50	1,744	154.1	44.9	529.5	117.4	422.9	156	147.0
1,248.0	40	1,413	116.4	43.6	501.5	91.6	413.0	118	123.9
936.0	30	1,081	82.2	42.4	464.5	69.0	393.8	84	100.6
780.0	25	914	66.2	41.8	442.7	58.8	380.7	68	89.1
624.0	20	747	51.6	41.3	411.2	49.3	357.9	53	78.0
312.0	10	415	26.9	40.8	317.2	32.4	281.2	29	56.5

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	ENGINE OUTLET WET EXH VOL FLOW RATE (0 DEG C AND 101 KPA)	ENGINE OUTLET DRY EXH VOL FLOW RATE (0 DEG C AND 101 KPA)
EKW	%	BKW	M3/MIN	M3/MIN	KG/HR	KG/HR	M3/MIN	M3/MIN
3,120.0	100	3,368	305.5	704.5	19,260.0	19,954.4	262.2	240.3
2,808.0	90	3,036	297.7	673.0	18,764.1	19,405.1	255.0	234.6
2,496.0	80	2,709	283.2	629.9	17,839.1	18,422.3	242.1	223.4
2,340.0	75	2,547	273.6	604.1	17,219.9	17,772.5	233.6	215.8
2,184.0	70	2,387	261.1	573.5	16,415.3	16,935.1	222.4	205.6
1,872.0	60	2,067	232.0	504.6	14,534.1	14,985.0	196.6	181.9
1,560.0	50	1,744	200.2	430.8	12,490.1	12,870.5	169.1	156.6
1,248.0	40	1,413	170.5	361.3	10,607.5	10,921.1	143.8	133.4
936.0	30	1,081	143.1	294.4	8,888.2	9,137.8	120.6	112.2
780.0	25	914	130.1	261.6	8,079.6	8,298.0	109.3	101.9
624.0	20	747	118.1	229.1	7,336.0	7,522.4	99.2	92.8
312.0	10	415	97.5	165.5	6,055.4	6,175.0	81.6	77.2

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1500 RPM

GENSET POWER WITH FAN	EKW	3,120.0	2,340.0	1,560.0	780.0	312.0
PERCENT LOAD	%	100	75	50	25	10
ENGINE POWER	BKW	3,368	2,547	1,744	914	415
TOTAL NOX (AS NO2)	G/HR	22,587	12,455	8,621	4,559	3,380
TOTAL CO	G/HR	2,458	3,349	2,475	1,481	1,223
TOTAL HC	G/HR	478	539	623	805	885
TOTAL CO2	KG/HR	2,188	1,729	1,185	663	359
PART MATTER	G/HR	53.1	121.3	163.5	147.6	69.9
TOTAL NOX (AS NO2) (CORR 5% O2)	MG/NM3	2,346.1	1,627.4	1,630.8	1,524.3	2,162.0
TOTAL CO (CORR 5% O2)	MG/NM3	255.0	437.9	471.7	500.0	784.0
TOTAL HC (CORR 5% O2)	MG/NM3	43.0	60.7	103.0	237.3	489.6
PART MATTER (CORR 5% O2)	MG/NM3	4.6	13.5	26.8	43.1	35.9
TOTAL NOX (AS NO2) (CORR 15% O2)	MG/NM3	870.6	603.9	605.2	565.6	802.2
TOTAL CO (CORR 15% O2)	MG/NM3	94.6	162.5	175.1	185.5	290.9
TOTAL HC (CORR 15% O2)	MG/NM3	16.0	22.5	38.2	88.1	181.7
PART MATTER (CORR 15% O2)	MG/NM3	1.7	5.0	10.0	16.0	13.3
TOTAL NOX (AS NO2) (CORR 5% O2)	PPM	1,143	793	794	742	1,053
TOTAL CO (CORR 5% O2)	PPM	204	350	377	400	627
TOTAL HC (CORR 5% O2)	PPM	80	113	192	443	914
TOTAL NOX (AS NO2) (CORR 15% O2)	PPM	424	294	295	276	391
TOTAL CO (CORR 15% O2)	PPM	76	130	140	148	233
TOTAL HC (CORR 15% O2)	PPM	30	42	71	164	339
TOTAL NOX (AS NO2)	G/HP-HR	4.99	3.64	3.67	3.70	6.05
TOTAL CO	G/HP-HR	0.54	0.98	1.05	1.20	2.19
TOTAL HC	G/HP-HR	0.11	0.16	0.27	0.65	1.58
PART MATTER	G/HP-HR	0.01	0.04	0.07	0.12	0.13
TOTAL NOX (AS NO2)	G/KW-HR	6.78	4.95	5.00	5.04	8.22
TOTAL CO	G/KW-HR	0.74	1.33	1.43	1.64	2.97
TOTAL HC	G/KW-HR	0.14	0.21	0.36	0.89	2.15
PART MATTER	G/KW-HR	0.02	0.05	0.09	0.16	0.17
TOTAL NOX (AS NO2)	LB/HR	49.80	27.46	19.01	10.05	7.45
TOTAL CO	LB/HR	5.42	7.38	5.46	3.26	2.70
TOTAL HC	LB/HR	1.05	1.19	1.37	1.78	1.95
TOTAL CO2	LB/HR	4,824	3,812	2,612	1,462	791
PART MATTER	LB/HR	0.12	0.27	0.36	0.33	0.15
OXYGEN IN EXH	%	10.1	11.4	11.9	13.1	15.3
DRY SMOKE OPACITY	%	1.0	2.0	4.2	5.3	2.0
BOSCH SMOKE NUMBER		0.68	0.79	0.97	1.07	0.83

CAT DE110 GC

Package Performance – DE1100 GC

Performance	Standby		Mission Critical	
Frequency	50 Hz		50 Hz	
Gen set power rating with fan	880 ekW		880 ekW	
Gen set power rating with fan @ 0.8 power factor	1100 KVA		1100 KVA	
Fueling strategy	Low Fuel Consumption		Low Fuel Consumption	
Performance number	DM9951-02		EM0447-01	
Fuel Consumption				
100% load with fan – L/hr (gal/hr)	226.4	(59.8)	226.4	(59.8)
75% load with fan – L/hr (gal/hr)	170.3	(45.0)	170.3	(45.0)
50% load with fan – L/hr (gal/hr)	117.4	(31.0)	117.4	(31.0)
25% load with fan – L/hr (gal/hr)	69.1	(18.3)	69.1	(18.3)
Cooling System				
Radiator air flow restriction (system) – kPa (in. water)	0.12	(0.48)	0.12	(0.48)
Radiator air flow – m³/min (cfm)	925	(32666)	925	(32666)
Engine coolant capacity – L (gal)	55	(14.5)	55	(14.5)
Radiator coolant capacity – L (gal)	49	(12.5)	49	(12.5)
Total coolant capacity – L (gal)	104	(27.5)	104	(27.5)
Inlet Air				
Combustion air inlet flow rate – m³/min (cfm)	66	(2332)	66	(2332)
Exhaust System				
Exhaust stack gas temperature – °C (°F)	508.7	(947.7)	508.7	(947.7)
Exhaust gas flow rate – m³/min (cfm)	180.1	(6359.7)	180.1	(6359.7)
Exhaust system backpressure (maximum allowable) – kPa (in. water)	6.7	(27)	6.7	(27)
Heat Rejection				
Heat rejection to jacket water – kW (Btu/min)	319	(18167)	319	(18167)
Heat rejection to exhaust (total) – kW (Btu/min)	818	(46518)	818	(46518)
Heat rejection to aftercooler – kW (Btu/min)	181	(10283)	181	(10283)
Heat rejection to atmosphere from engine – kW (Btu/min)	120	(6797)	120	(6797)
Heat rejection from alternator – kW (Btu/min)	49	(2789)	49	(2789)
Emissions* (Nominal)				
NOx mg/Nm³ (g/hp-h)	2966.9	(5.84)	2966.9	(5.84)
CO mg/Nm³ (g/hp-h)	308.9	(0.61)	308.9	(0.61)
HC mg/Nm³ (g/hp-h)	4	(0.01)	4	(0.01)
PM mg/Nm³ (g/hp-h)	14.1	(0.03)	14.1	(0.03)
Emissions* (Potential Site Variation)				
NOx mg/Nm³ (g/hp-h)	3589.9	(7.07)	3589.9	(7.07)
CO mg/Nm³ (g/hp-h)	577.6	(1.14)	577.6	(1.14)
HC mg/Nm³ (g/hp-h)	7.5	(0.02)	7.5	(0.02)
PM mg/Nm³ (g/hp-h)	27.5	(0.07)	27.5	(0.07)

*mg/Nm³ levels are corrected to 5% O₂. Contact your local Cat dealer for further information.

APPENDIX F

Cumulative Impacts

Cumulative Impacts

This section evaluates the potential for cumulative air quality impacts from the Proposal and local emission sources identified in Section 4.6, including the impacts on sensitive receptors during a power outage when emergency generators at both the Proposal site and nearby sources would be operating.

Proximity

Several nearby data centres, located within 3 km of the Proposal site in predominantly industrial and commercial areas, have been identified as potential contributors to cumulative air quality impacts at sensitive receptor locations. This assessment evaluates the combined effects of the Proposal and local emission sources, as detailed in Table 11 and illustrated in Figure 6 (refer Section 4.6).

Probability

Emergency Operations

The probability of all identified data centres operating simultaneously under an emergency scenario (power outage event) is tied to the reliability of the power feed they share, which is provided by the same distributor for the Sydney region. Ausgrid's 2024 DTAPR (Ausgrid, 2024) reported that the average unplanned outage duration per year per customer over a 10-year period from 2013/2014 to 2023/2024 equated to approximately 74.0 minutes, corresponding to a probability of $p = 0.000141$ for a power outage.

The reality of a power outage event is that facilities producing process emissions without emergency power back-up (such as dual power feeders or back-up generators) will likely cease emissions during a power outage event. Some emissions from material handling (such as the use of loaders) or road traffic will not be affected, but these are not considered further in this AQIA.

Realistic Operations

The probability of all data centres operating simultaneously during testing under realistic operational scenarios is influenced by testing limitations. For the Proposal site, the total hours of operation as quoted through the generator testing plan (refer Table 5). The testing schedule is anticipated to be constrained to up to 200 hours per year, based on the exemption for emergency electricity generation under the POEO CAR (refer Section 3.2).

Table F1 provides information on the number of standby generators installed at each identified data centre development and the corresponding maintenance testing operations, based on a review of publicly available online sources.

Table F1 Proximate data centre generators and associated testing hours

Data centre	Address	Component	
		Nb. generators	Testing hours
NEXTDC S1	4 Eden Park Drive, Macquarie Pk	12	N/A
NEXTDC S2	6/8 Giffnock Avenue, Macquarie Park	33	N/A
Macquarie Park DC	11-17 Khartoum Road, Macquarie Pk	19	183.5
Talavera Road DC Campus	17-23 Talavera Road, North Ryde	34	132.0
Fujitsu North Ryde DC	23 Waterloo Road, North Ryde	N/A	N/A
Lane Cove West DC	1 Sirius Road, Lane Cove West	121	175.0
Apollo Place DC	1 & 1A Apollo Place, Lane Cove West	28	28.0
Waterloo Road DC	44-50 Waterloo Road, Macquarie Pk	N/A	N/A
NEXTDC S5	269 Lane Cove Road, Macquarie Pk	60	170.0
1-5 Khartoum Road DC	1-5 Khartoum Road, Macquarie Pk	28	72.0
1-5 Khartoum Road BH DC	1-5 Khartoum Road, Macquarie Pk	19	N/A
Project Apollo DC	4-10 Talavera Road, Macquarie Pk	66	198.0

Note: N/A = Not publicly available

While specific details for some of the identified data centres are unavailable, it is assumed that their testing schedules align with the 200-hour exemption limit under the POEO CAR.

Emission testing schedules for multiple sites are typically uncoordinated between data centre operators, unless managed by the same proponent, in which case a standardised testing program may be implemented across multiple sites. Daytime testing is likely to be constrained to daytime hours by NSW EPA, and some overlap from simultaneous testing may occur during this period. While the Lane Cove West and Apollo Place data centre sites are not yet amalgamated, they may be in the future, which could influence the future testing schedule, though it is still likely to remain constrained to the 200 hours of testing. At this stage, each identified data centre facility's testing remains independently scheduled.

For this assessment, the testing schedule is constrained to 200 hours to standardise the approach. The probability of two facilities testing at the same time is calculated as $([200/8760]^2)$, which corresponds to a probability of $(p) = 0.00052$. Furthermore, the probability of all facilities testing concurrently is calculated as $([200/8760]^{12})$, resulting in a probability of $(p) = 2.01 \times 10^{-20}$.

This indicates a significantly low probability of simultaneous testing operations between all of the identified data centres.

Wind Frequency

The modelled wind rose for the meteorological data at the Proposal site has been used in this AQIA (refer Appendix C) has been analysed to determine the prevailing wind patterns at the Proposal site.

Figure F1 to Figure F12 presents the wind vectors (pathways) connecting the potential sources at the data centres to the discrete receptors utilised in this AQIA.

Table F2 presents the relevant wind vectors and affected receptors.

- Case 1 considers emissions from the Proposal site as the primary source, with potential cumulative impacts arising from interaction with emissions from proximate data centres such as NEXTDC S1 and Project Apollo.
- Case 2 considers emissions from a proximate data centre (e.g., NEXTDC S1) as the primary source, with potential cumulative impacts due to contributions from the Proposal site.

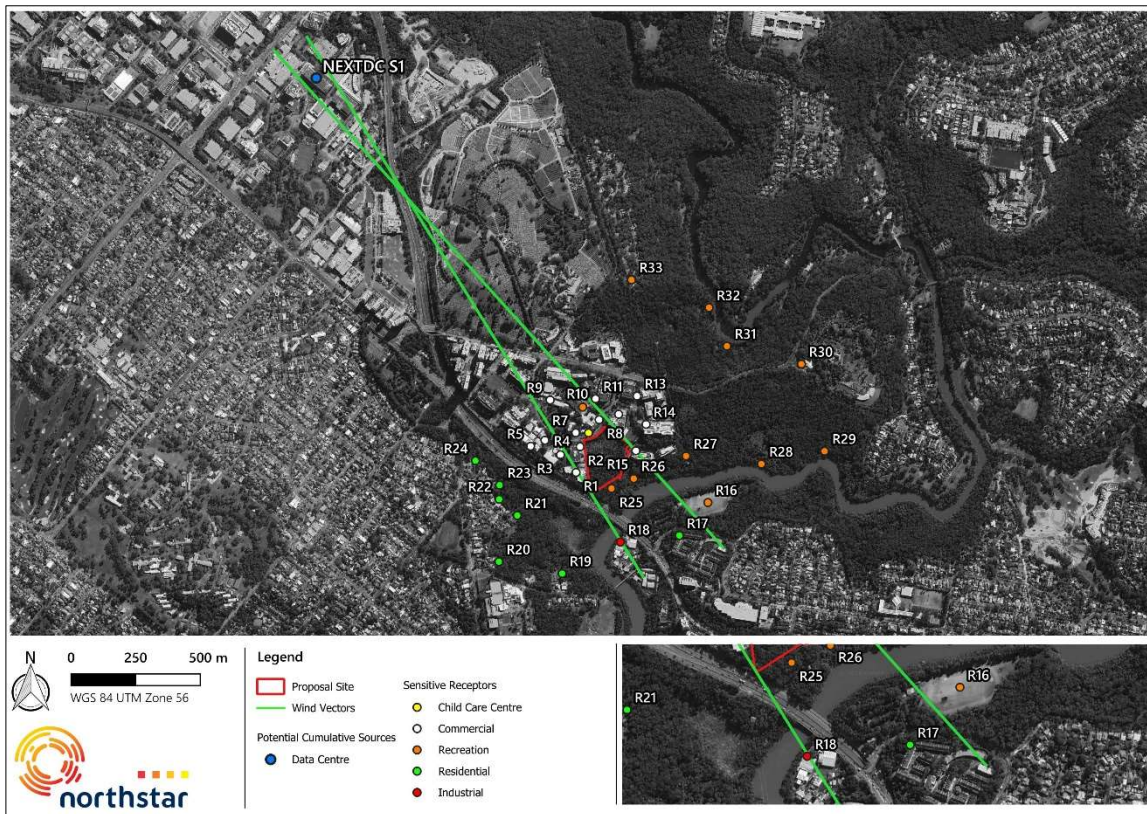
It is noted that while generator stack locations for the identified data centres are provided in the accompanying air quality assessment material, for the purposes of this assessment, wind vectors were measured to the respective lot boundaries to ensure a conservative approach. Where a publicly available air quality assessment has been reviewed, discrete receptors associated with the corresponding development have been presented in Table F2.

Table F2 Summary of wind vectors for potential cumulative impacts

Data centre	Case 1			Case 2		
	Wind vectors	Freq. of winds	Potentially affected receptors	Wind vectors	Freq. of winds	Potentially affected receptors
NEXTDC S1	140°-150°	0.018	N/A	320°-330°	0.033	R15, R17, R18, R25, R26
NEXTDC S2	125°-135°	0.022	N/A	305°-315°	0.035	R15, R16, R17, R25, R26
Macquarie Park Data Centre	135°-145°	0.020	N/A	315°-325°	0.033	R15, R17, R18, R25, R26
Talavera Road Data Centre Campus	135°-150°	0.030	None	315°-330°	0.049	R15, R17, R18, R25, R26
Fujitsu North Ryde Data Centre	130°-145°	0.030	N/A	310°-325°	0.051	R15, R17, R18, R25, R26
Lane Cove West Data Centre	335°-5°	0.088	N/A	155°-175°	0.045	R2, R6, R7, R8, R9, R10, R11, R12
Apollo Place Data Centre	340°-360°	0.058	R4, R6	160°-180°	0.040	R2, R6, R7, R8, R10, R11, R12
Waterloo Road Data Centre	130°-140°	0.022	N/A	310°-320°	0.034	R15, R17, R25, R26
NEXTDC S5	125°-140°	0.034	C2, C3, C5, H2	305°-320°	0.052	R15, R16, R17, R25, R26
1-5 Khartoum Road Data Centre	135°-145°	0.020	COM3, COM5, HOT1	315°-325°	0.033	R15, R17, R18, R25, R26
1-5 Khartoum Road BH Data Centre	135°-145°	0.020	N/A	315°-325°	0.033	R15, R17, R25, R26
Project Apollo Data Centre	145°-155°	0.021	R14, R17, R18	325°-335°	0.033	R15, R17, R18, R25, R26

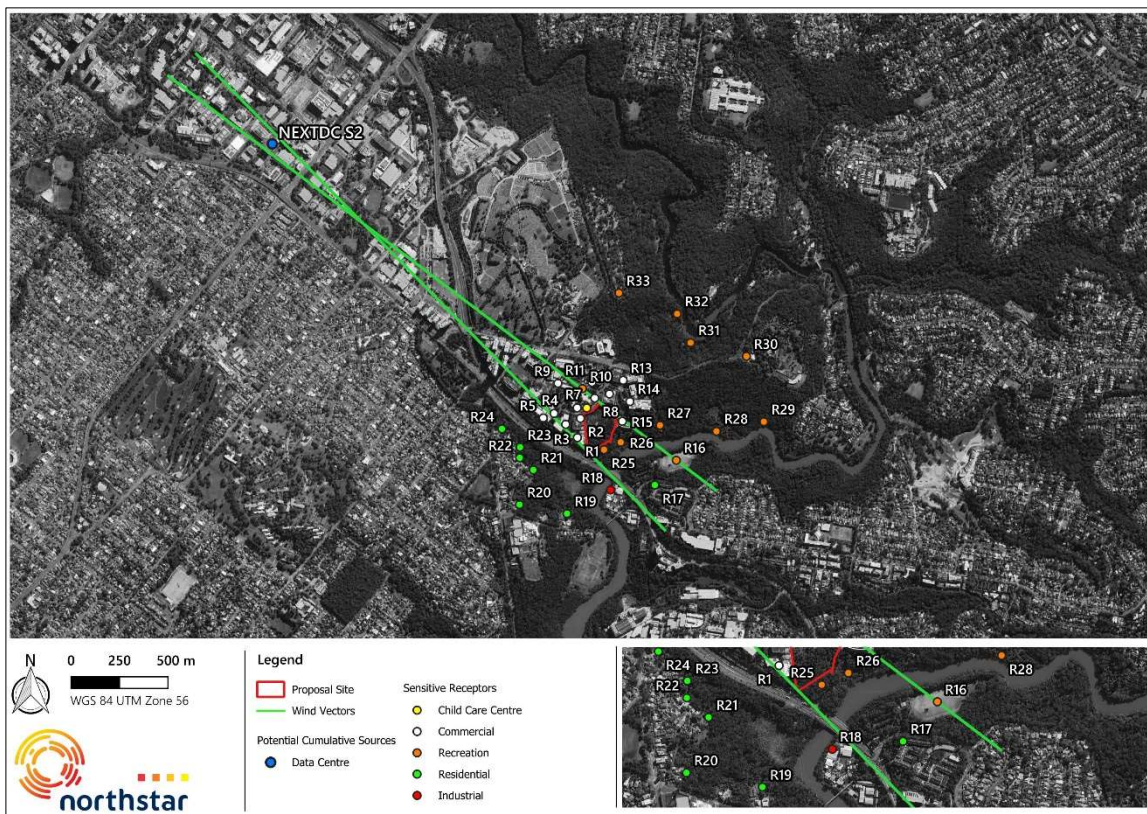
Note: NA = no receptors available, None = none of the identified discrete receptors impacted

Figure F1 Wind vector angles – NEXTDC S1



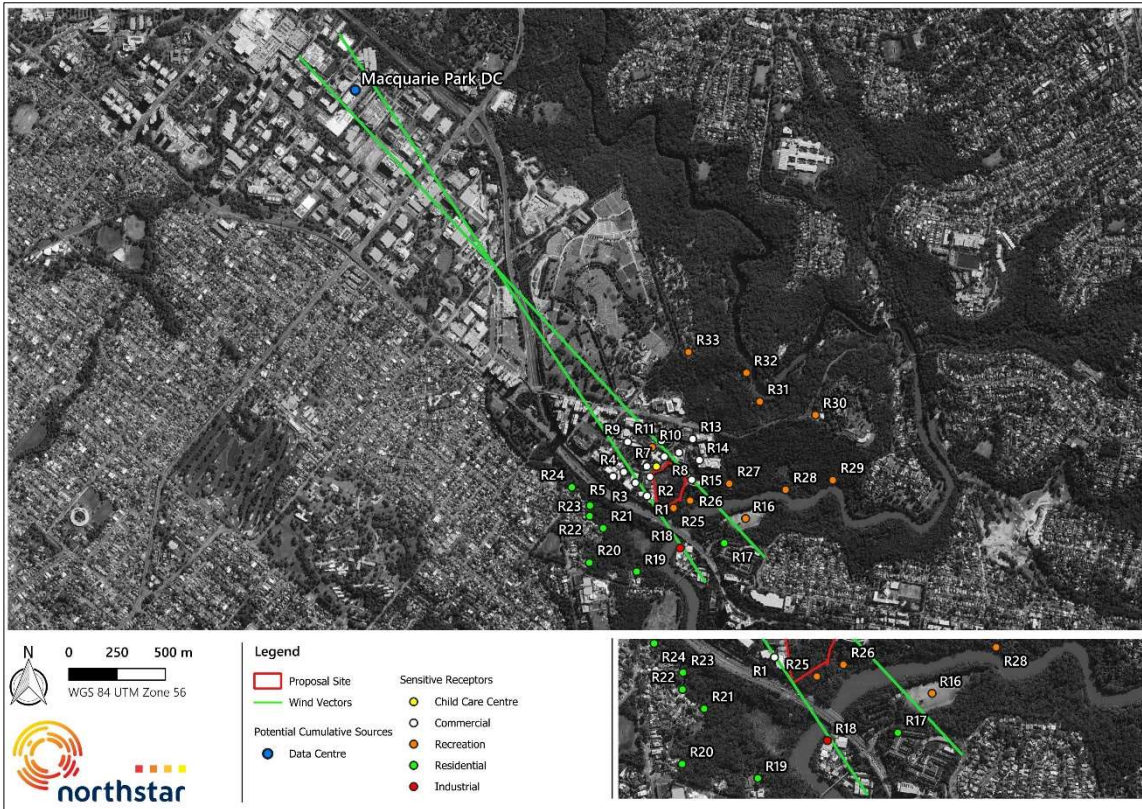
Source: Northstar

Figure F2 Wind vector angles – NEXTDC S2



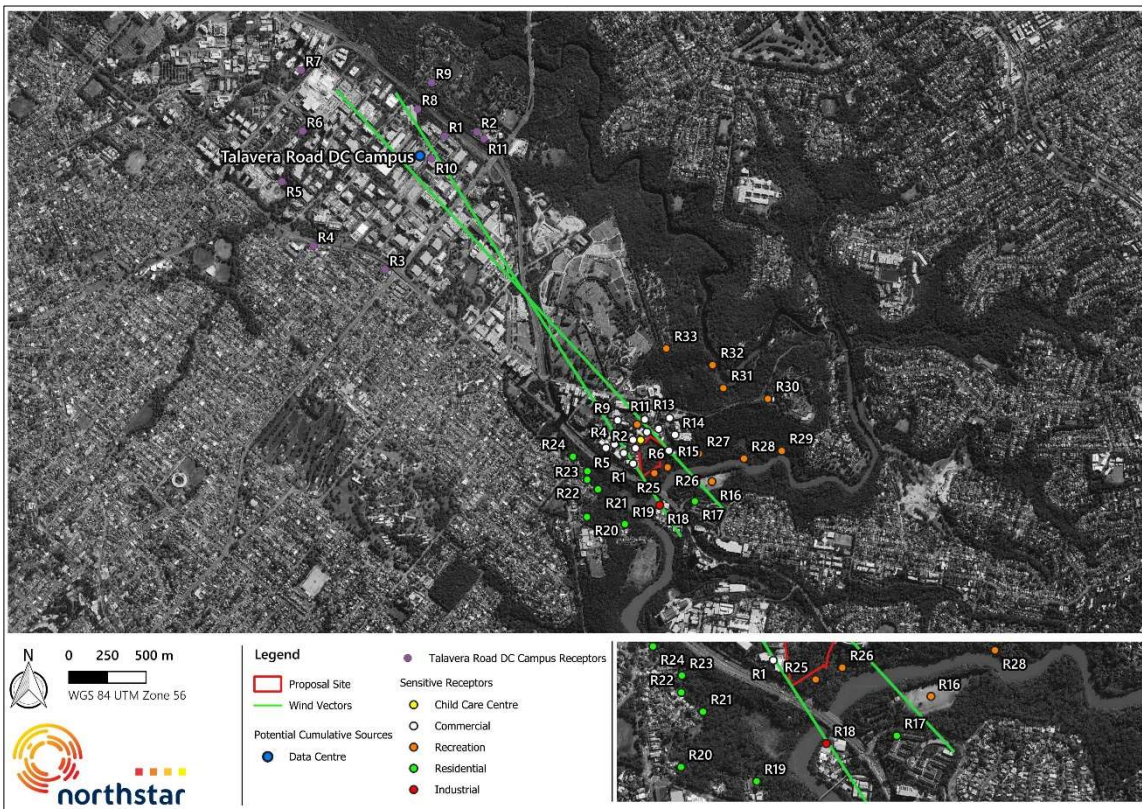
Source: Northstar

Figure F3 Wind vector angles – Macquarie Park Data Centre



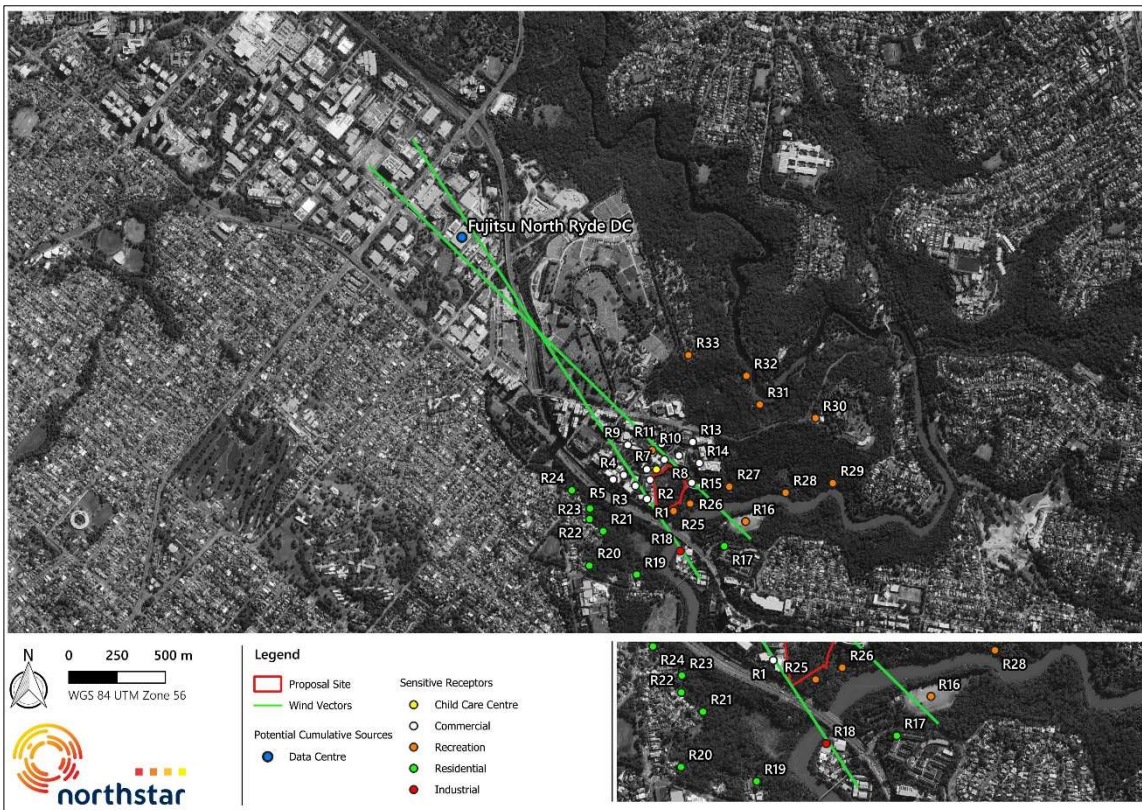
Source: Northstar

Figure F4 Wind vector angles – Talavera Road Data Centre Campus



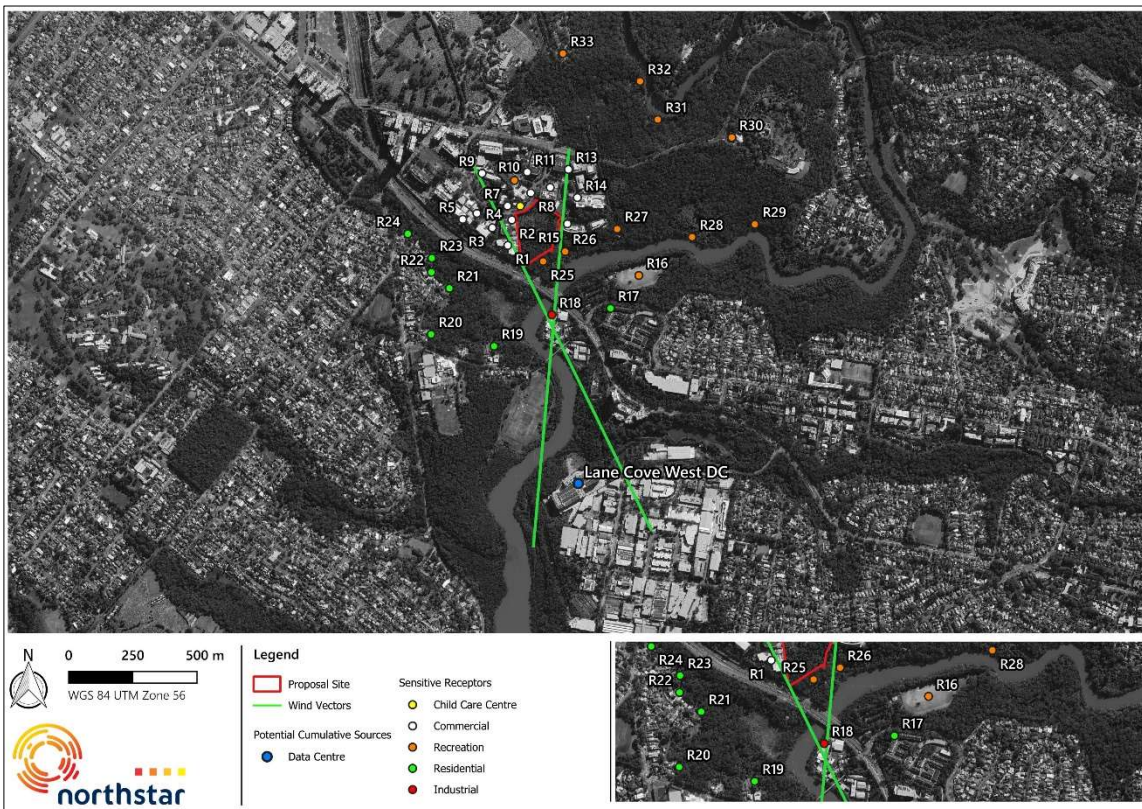
Source: Northstar

Figure F5 Wind vector angles – Fujitsu North Ryde Data Centre



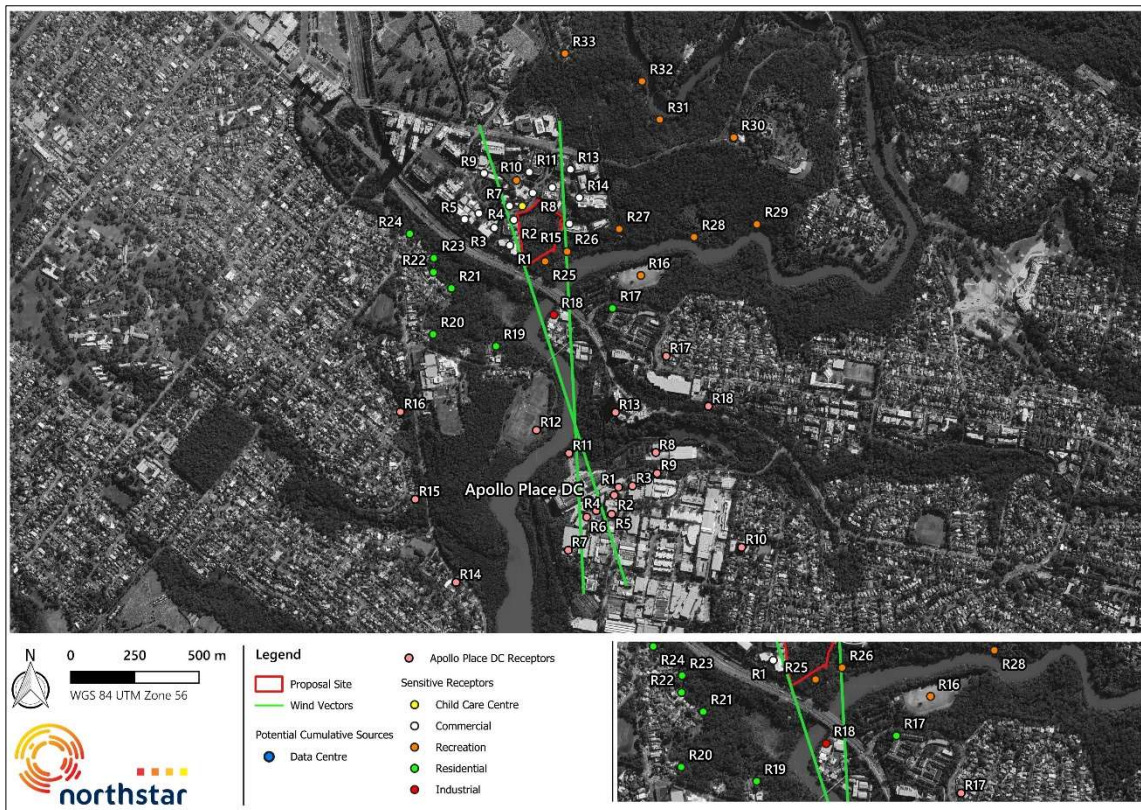
Source: Northstar

Figure F6 Wind vector angles – Lane Cove West Data Centre



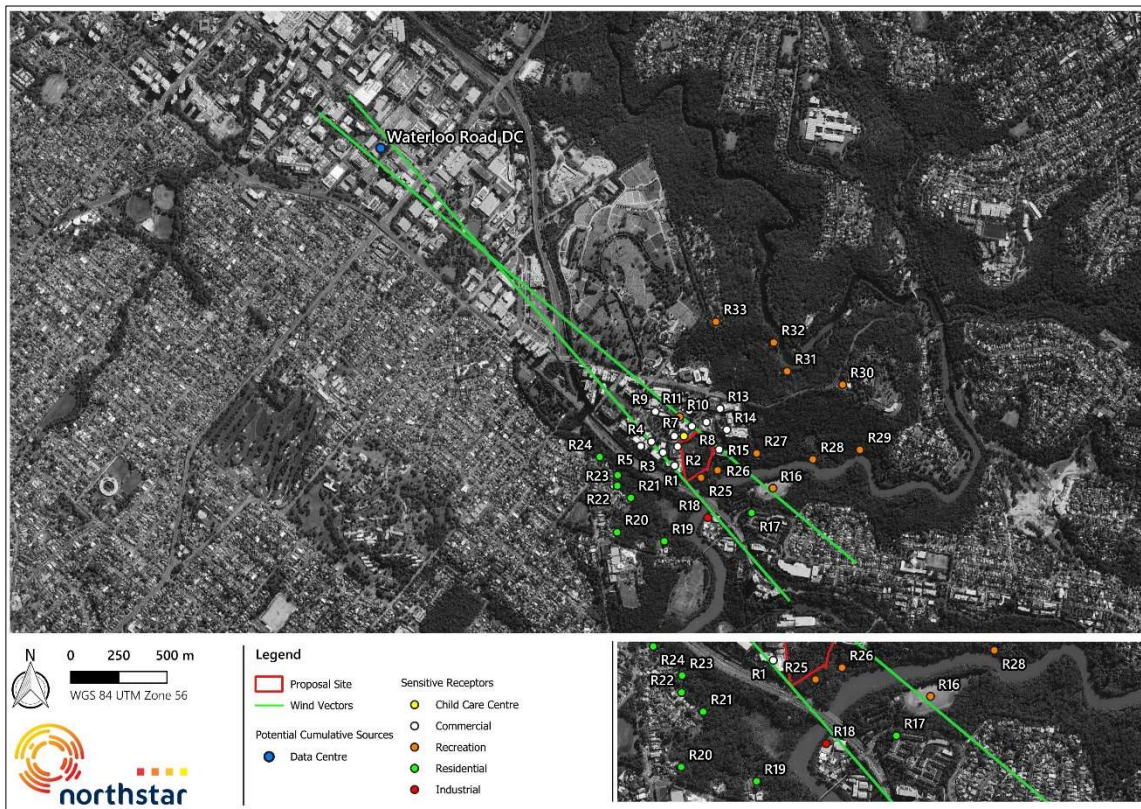
Source: Northstar

Figure F7 Wind vector angles – Apollo Place Data Centre



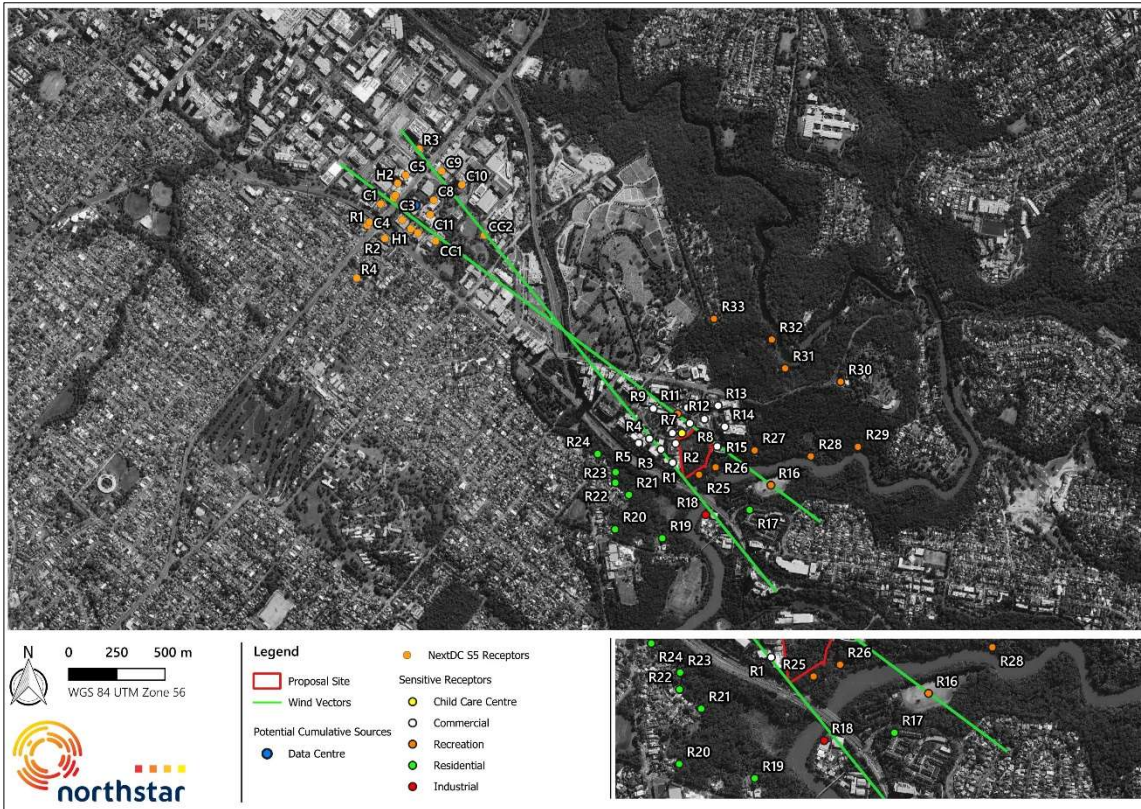
Source: Northstar

Figure F8 Wind vector angles – Waterloo Road Data Centre



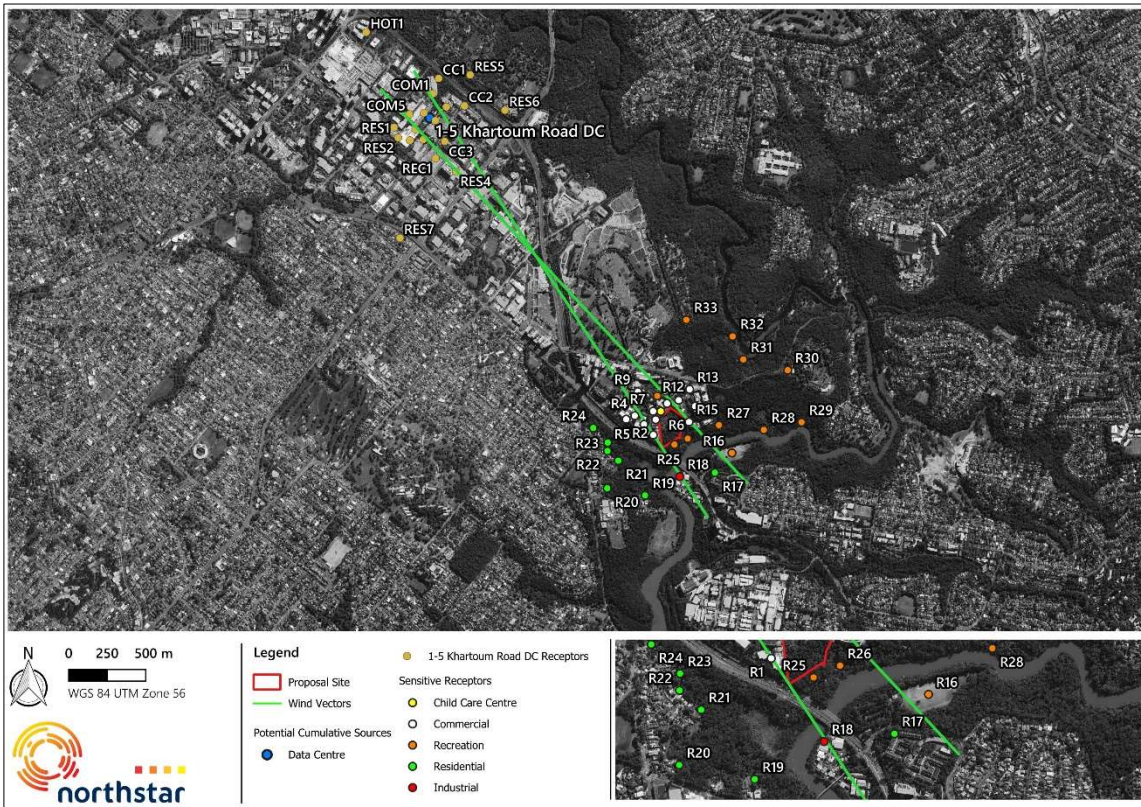
Source: Northstar

Figure F9 Wind vector angles – NEXTDC S5



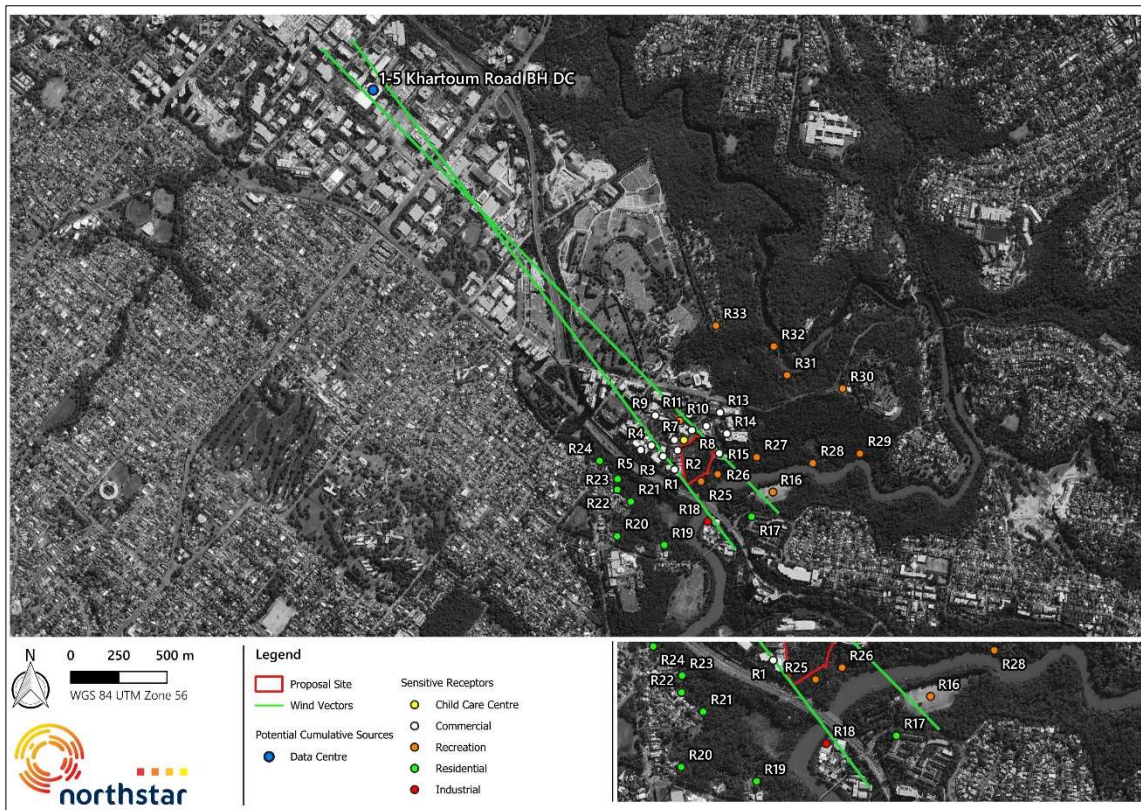
Source: Northstar

Figure F10 Wind vector angles – 1-5 Khartoum Road Data Centre



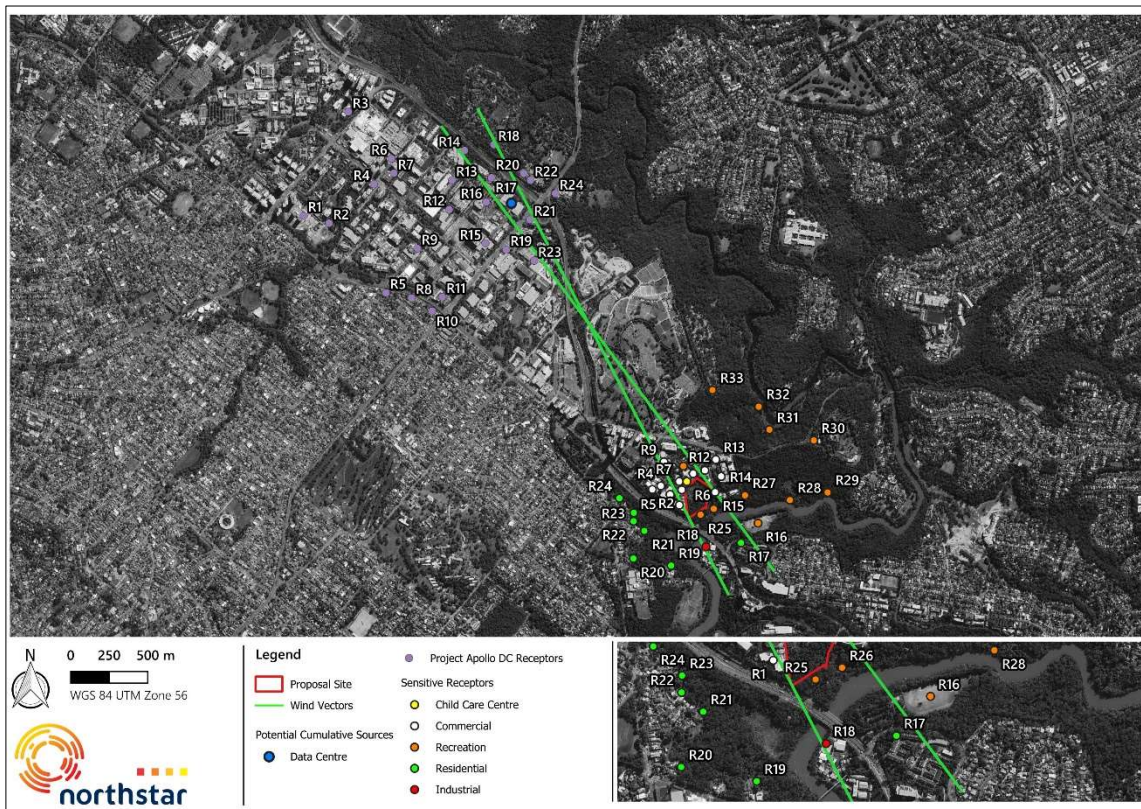
Source: Northstar

Figure F11 Wind vector angles – 1-5 Khartoum Road BH Data Centre



Source: Northstar

Figure F12 Wind vector angles – Project Apollo Data Centre



Source: Northstar

Probability of Cumulative Impacts

To provide a clearer indicator of potential cumulative air quality impacts, we have undertaken a semi-quantitative probability-based analysis to estimate their likelihood at affected receptors, considering both simultaneous operation and testing (refer Table F3). This approach offers a structured, probabilistic perspective on cumulative impacts, complementing previous assessments that have considered such effects to varying degrees.

A review of publicly available air quality assessments for those identified data centres in the locality (refer Figure 6) indicated that while some explicitly addressed cumulative impacts, others did not. However, all consented and operational data centres have undergone planning and assessment, where cumulative impacts would have been considered to varying degrees, whilst the proposed data centres remain under assessment within the SSDA framework.

Given this context, the cumulative impacts of the Proposal have been carefully considered, providing a structured analysis of cumulative air quality impacts. This should be evaluated within the existing regulatory framework that has already accounted for similar developments in the area.

Table F3 Cumulative impacts assessment – summary

Development	Scenario 1 (Justified Worst Case)						Realistic Case					
	Case 1			Case 2			Case 1			Case 2		
	Freq.	Outage probability	P (Product)	Freq.	Outage probability	P (product)	Freq.	Testing probability	P (product)	Freq.	Testing probability	P (product)
NEXTDC S1	0.018	0.000141	2.560E-06	0.033	0.000141	4.604E-06	0.018	0.000521	9.378E-06	0.033	0.000521	1.719E-05
NEXTDC S2	0.022	0.000141	3.139E-06	0.035	0.000141	4.991E-06	0.022	0.000521	1.146E-05	0.035	0.000521	1.824E-05
Macquarie Park DC	0.020	0.000141	2.866E-06	0.033	0.000141	4.621E-06	0.020	0.000521	1.042E-05	0.033	0.000521	1.719E-05
Talavera Road DC Campus	0.030	0.000141	4.250E-06	0.049	0.000141	6.891E-06	0.030	0.000521	1.563E-05	0.049	0.000521	2.553E-05
Fujitsu North Ryde DC	0.030	0.000141	4.250E-06	0.051	0.000141	7.197E-06	0.030	0.000521	1.563E-05	0.051	0.000521	2.657E-05
Lane Cove West DC	0.088	0.000141	1.244E-05	0.045	0.000141	6.359E-06	0.088	0.000521	4.585E-05	0.045	0.000521	2.345E-05
Apollo Place DC	0.058	0.000141	8.179E-06	0.040	0.000141	5.667E-06	0.058	0.000521	3.022E-05	0.040	0.000521	2.084E-05
Waterloo Road DC	0.022	0.000141	3.075E-06	0.034	0.000141	4.862E-06	0.022	0.000521	1.146E-05	0.034	0.000521	1.771E-05
NEXTDC S5	0.034	0.000141	4.830E-06	0.052	0.000141	7.277E-06	0.034	0.000521	1.771E-05	0.052	0.000521	2.709E-05
1-5 Khartoum Road DC	0.020	0.000141	2.866E-06	0.033	0.000141	4.621E-06	0.020	0.000521	1.042E-05	0.033	0.000521	1.719E-05
1-5 Khartoum Road BH DC	0.020	0.000141	2.866E-06	0.033	0.000141	4.621E-06	0.020	0.000521	1.042E-05	0.033	0.000521	1.719E-05
Project Apollo DC	0.021	0.000141	3.011E-06	0.033	0.000141	4.717E-06	0.021	0.000521	1.094E-05	0.033	0.000521	1.719E-05

Note: Freq. = Wind Frequency

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