Air Quality Impact Assessment

Macquarie Park Data Centre

Client: Stockland Development Pty Limited

ABN: 71 000 064 835

Prepared by

AECOM Australia Pty Ltd
17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

10-Nov-2020

Job No.: 60628128

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Table of Contents

List of Figures

List of Tables

1.0 Introduction

AECOM Australia Pty Ltd has been commissioned to undertake an air quality impact assessment (AQIA) for the proposed Data Centre to be constructed at 33-39 Talavera Road, Macquarie Park. The following report assesses the potential air quality emissions associated with the Data Centre construction and the operation of the Data Centre emergency generators.

The objective of the assessment is to address the requirements of the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning industry and Environment (DPIE).

1.1 Project Background

In response to a proposal to construct a Data Centre at 33-39 Talavera Road, Macquarie Park, SEARs were sought from NSW DPIE. The SEARs issued for the project included a range of Key Issues, which need to be addressed as part of the planning response. Specific requirements were listed in relation to an air quality impact assessment, which needed to be addressed by this assessment. The air quality related SEARs issued for this project are as follows (reproduced from SEARs issued for SD-10467)

5. *Air quality – including:*
    - *an assessment of the air quality impacts of the development during construction and operation, prepared in accordance with the relevant Environment Protection Authority guidelines. The assessment must include:*
        - *scenarios which assess construction works, realistic operations, back-up generator testing and a justified worst-case scenario*
        - *justification for the proposed back-up power source and any alternatives considered*
        - *an assessment of emissions from the back-up generators against the standards of concentration outlined in the Protection of the Environment Operations (Clean Air) Regulation 2010 (including, but not limited to, polycyclic aromatic hydrocarbons (PAHs) and oxides of nitrogen (NOx) impacts)*
        - *an assessment of criteria pollutants in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2016)*
    - *details of any mitigation, management and monitoring measures (including for back-up generators) required to ensure compliance with section 128 of the Protection of the Environment Operations Act 1997.*

The project scope has been developed to address the requirements outlined above. The scope described in **Section 1.2** outlines the approach and where in the document specific areas required by the SEARs have been addressed.

1.2 Project Scope

The project scope has been developed in a staged approach to enable the comprehensive assessment of the air quality aspects of this project. The areas of concern addressed are as follows:

1. Consideration of the dust impacts during demolition of the existing site buildings and during construction of the new Data Centre building;
2. Assessment of the operation of the emergency generator operation during ongoing maintenance activities.

Note: the operation of all emergency generators operating at once has not been assessed as the realistic worst-case scenario due to the low expected frequency and duration of an emergency outage event. The likelihood of Macquarie Park power outages has been discussed below in **Section 2.2** as part of the demonstration of the expected low levels of outages that may affect the Data Centre.

The scope of work for the AQIA and the corresponding section of the report has been provided in **Table 1**.

Table 1 Project Scope and Corresponding Report Section

Project Scope Item	Report Section
Description of the proposed Data Centre and its emergency generators	**Section 2.0**
Identification of the expected air pollutants of primary concern	**Section 2.4**
Description of the relevant federal and state legislation pertaining to this development	**Section 3.0**
Identification of applicable assessment criteria	**Section 4.0**
Analysis of the existing pollutant levels in the Macquarie Park area	**Section 5.0**
Description of the Construction Assessment methodology	**Section 6.0**
Description of the Operational Assessment methodology	**Section 8.0**
Identification of Modelling Scenarios	**Section 6.0**
Description of the Emissions from the Emergency Generators	**Section 8.3, Appendix A**
Construction assessment results	**Section 10.1**
Operational assessment results	**Section 10.2**
Project conclusion	**Section 0**
Detailed meteorology analysis	**Appendix D**
GRAL comparison with CALPUFF	**Appendix C**

In addition to the project scope, the items listed in the SEAR's have been identified and the section of the report where the items have been addressed have been listed in **Table 2**.

Table 2 Report Section where SEARs Requirements are Addressed

SEARs Item	Report Section
Scenarios which assess construction works, realistic operations, back-up generator testing and a justified worst-case scenario	**Section 6.0**
Justification for the proposed back-up power source and any alternatives considered	**Section 2.3**
An assessment of emissions from the back-up generators against the standards of concentration outlined in the Protection of the Environment Operations (Clean Air) Regulation 2010 (including, but not limited to, polycyclic aromatic hydrocarbons (PAHs) and oxides of nitrogen (NOx) impacts)	**Section 3.2.2** and **Section 9.1.3**
An assessment of criteria pollutants in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2016)	**Section 8.0** and **Section 10.0**
Details of any mitigation, management and monitoring measures (including for back-up generators) required to ensure compliance with section 128 of the Protection of the Environment Operations Act 1997	**Section 10.1.4**

2.0 Project Description

The Macquarie Park Data Centre project (Data Centre) is to include the construction and operation of a data centre in the commercial area of Macquarie Park, approximately 12 km to the Northwest of the Sydney CBD. This proposal includes consideration of site preparation works, bulk earthworks and utility installation along with other infrastructure, and for the construction of the building, ancillary facilities and associated site works for the use of the data centre. In addition, this impact assessment also considers the impacts from the operation of the Data Centre post construction.

2.1 Site Location and Context

The Data Centre is to be located on land legally designated as Lot 1 in DP 633221, local address 11-17 Khartoum Road and 33-39 Talavera Road, Macquarie Park (see **Figure 1** below). The Site is situated within the suburb of Macquarie Park, which is part of the City of Ryde Local Government Area (LGA). More broadly, the Site is located approximately 12 km northwest of the Sydney CBD, approximately 850 m southeast of Macquarie University, and 550 m southeast of Macquarie Shopping Centre, measured along Talavera Road. The Site is also located approximately 600 m northwest of Lane Cove Road and the on-ramp to the M2 motorway, also measured along Talavera Road.

The Site sits adjacent to commercial properties to the southwest and the southeast and is located within a B7 Business Park Zone under the *Ryde Local Environmental Plan 2014* (Ryde LEP). The surrounding areas contain a mix of B4 Mixed Use and B3 Business Park land uses.

The surroundings of the Site are characterised by a mixture of lower density older warehouse and office spaces, and higher density, more recently developed office buildings. This is the manifestation of an urban area which is in transition between an ageing and a newer urban fabric.

Macquarie Park metro station is located approximately 750 m southwest of the Site, and Macquarie University metro station is located approximately 750 m northwest of the Site. The Site is also serviced by high frequency bus services along Talavera and Khartoum Roads, with one bus stop along each of the Site frontages. The surrounding area is characterised by commercial buildings and land uses, consistent with the character of Macquarie Park as a business precinct.

The overall site area to be developed is 3.003 ha, with a northwest frontage facing Khartoum Road, and a northeast frontage facing Talavera Road. The proposed Data Centre development will only occupy the south eastern portion of the Site, and occupy approximately 50% of the total Site area (see **Figure 2** below).

Vehicular access to the Site is currently provided off Khartoum Road and Talavera Road via two existing 8 m wide, dual direction crossings. An additional vehicular access point and service lane is provided on the south western corner of the site, also off Khartoum Road. This additional access point is approximately 6 m wide and provides singular vehicle direction around the southern boundary of the Site.

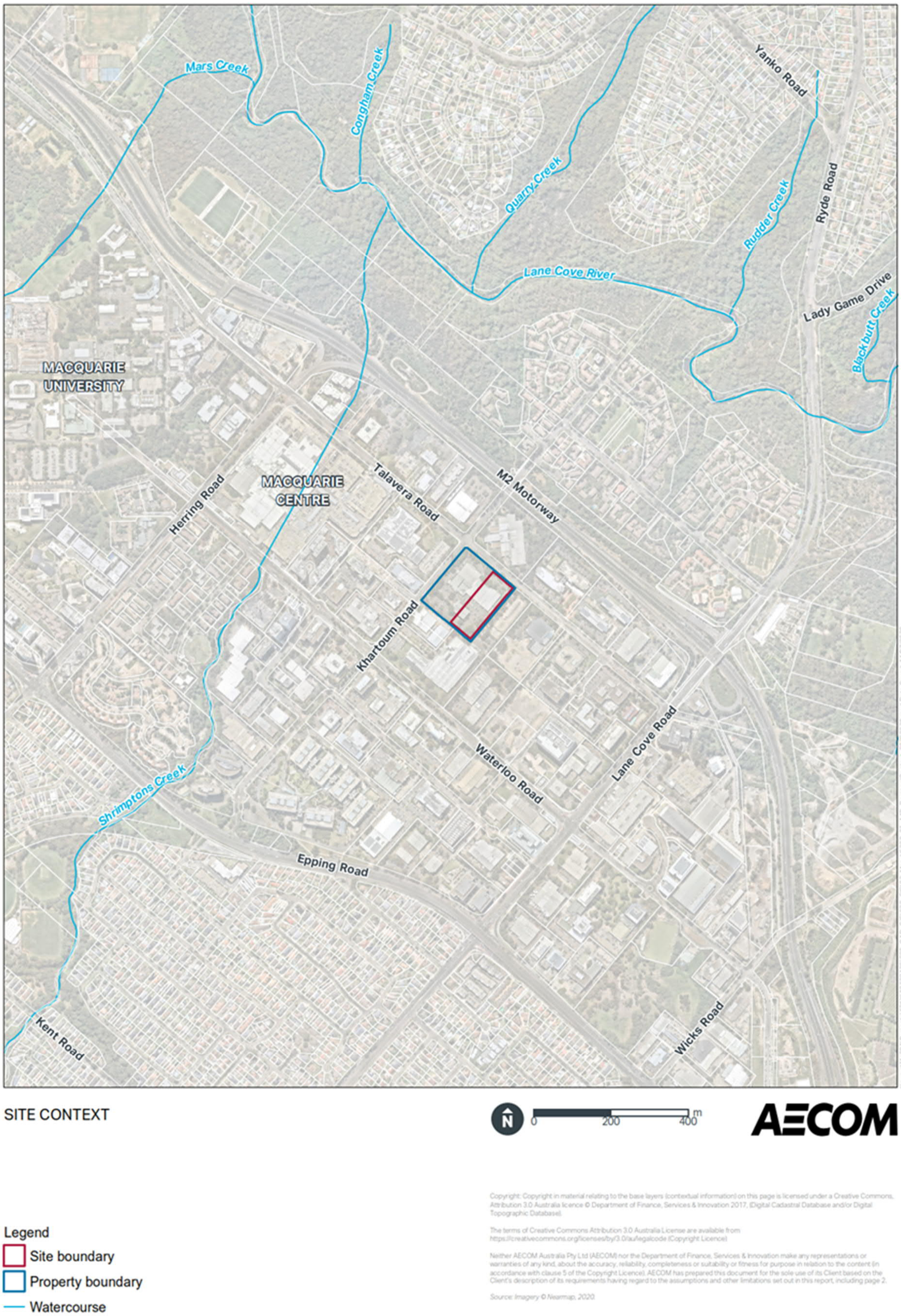
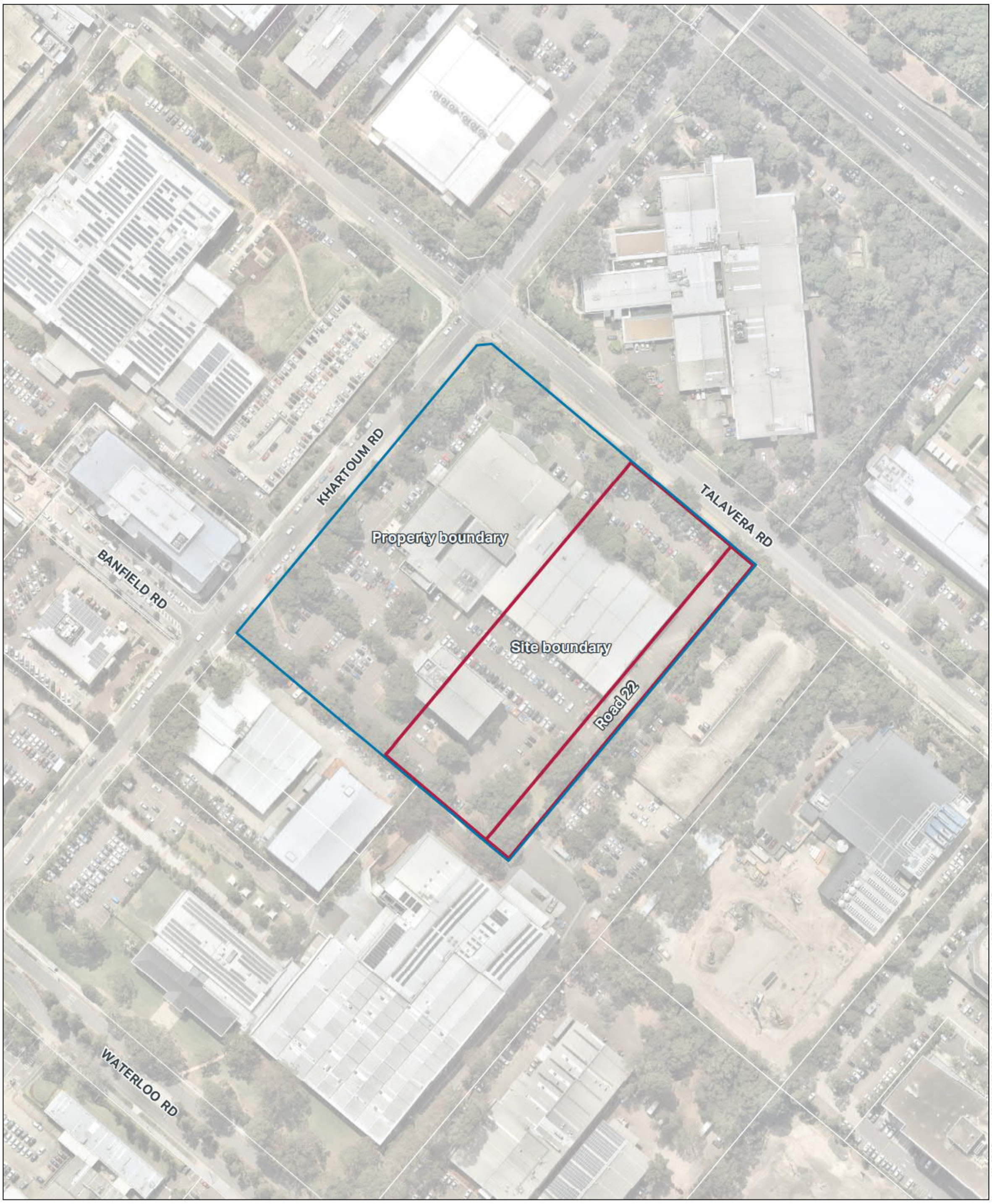


Figure 1 Proposed Site Locality Map



SITE LOCATION

0 50 100 m

AECOM

Legend
- Site boundary and Road 22
- Property boundary

Figure 2 Data centre site plan

2.2 Data Centre Emergency Generators

Continuous, uninterrupted supply of electricity is critical to the operation of the Data Centre. As part of the proposed facility design, 18 diesel generators have been included to supply the required emergency electricity (diesel generator location and stack locations shown in **Figure 3**). The role of these generators is to provide an uninterrupted power supply to the Data Centre in the event of a site power outage. If triggered, all 18 diesel generators would be started automatically and would continue to operate until the power is restored.

The operation of all emergency generators together, however, is expected to occur very infrequently and only when power to the Data Centre (and likely the whole Macquarie Park area) is interrupted. Electricity supply for the Data Centre has been designed to maximise availability with dual fully rated incoming grid supplies. The supplies are derived from independent sides of the zone substation to further decrease reliance on Standby Generators. The internal network configuration is to be set up utilising a self-healing mechanism which in most power outages will limit the quantity of operational sets to a single unit. Given the reliability of grid power in Macquarie park it is anticipated that an outage requiring more than a single generator to operate at any given time is highly unlikely.

Although the operation of the full contingent of emergency generators would be a rare event, maintenance of the generators would require regular operational testing to ensure the generators are in working order and that they can commence operation whenever needed in the event of a full zone power outage.

The testing schedule for the generators is expected to consist of the following actions:

- A monthly unloaded test would be conducted for each generator to ensure they start correctly. For the purpose of this assessment it is assumed each generator would operate at 10% capacity and would run for approximately 15 minutes a month.
- Each generator will be tested under load for one hour per generator per month. The assessment has assumed the following operational scenarios:
  - <u>Normal maintenance conditions:</u> 50% load with each generator operating for 1 hour
  - <u>Worst case maintenance conditions:</u> 100% Load with each generator operating for 15 minutes
- It is expected that no more than three generators would be tested per day, and testing would only occur during daytime hours (7am to 6pm). This is due to the operational limitations on the maintenance activities.

The generators themselves will be situated on multiple levels on the south-eastern facing portion of the building. The generator exhaust will be vented through two stack bundles positioned toward the northern and southern end of the Data Centre building (as shown in **Figure 3**).

The diesel generator units to be installed at the site are yet to be finalised. The two candidate generator models proposed for this development are as follows:

- Cat model 3516E
- Cummins model C3000D5e w/QSK78-G15

Emissions data for the assessment has been obtained from the engine specification data sheets provided by each manufacturer. Copies of the engine data sheets have been provided in **Appendix A** and the emissions data used in the impact assessment outlined in **Section 8.3**.

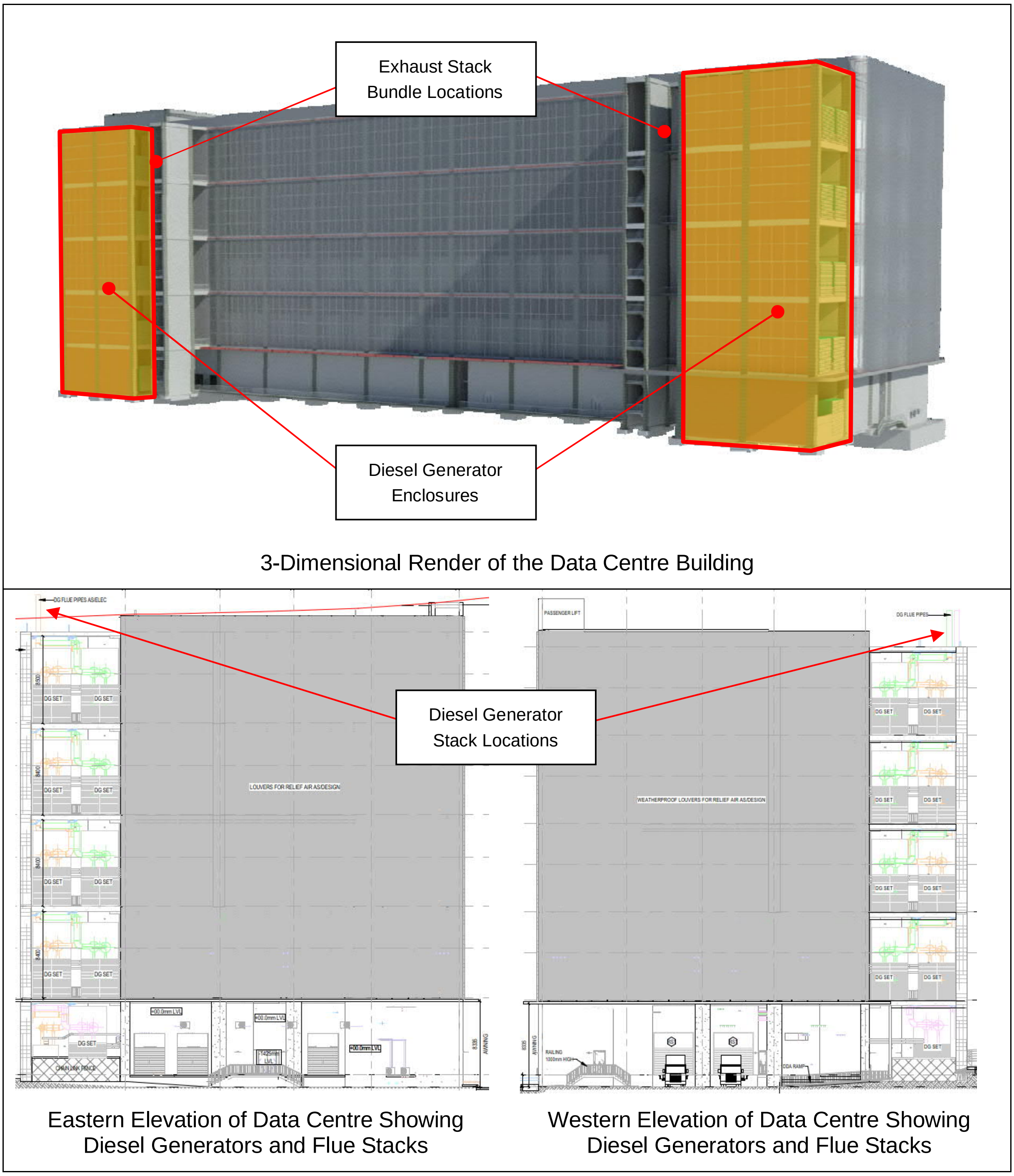


Figure 3 Data Centre Diesel Generator locations

2.3 Assessment of Alternative Options

Alternatives to the use of diesel generators are not currently considered feasible for a large-scale data centre. Diesel generators are well suited to the data centre industry due to their simple operation and maintenance, power delivery capacity, indefinite power supply potential and ability to commence operation very quickly if needed. Diesel generators are commonly used across the data centre industry worldwide with large number of generators currently in place throughout Sydney. New technology may in the future enable the replacement of the diesel generators, but for this proposal, such technology has not progressed to a point where this is feasible.

Examples of future technologies under development include the use of fuel cells or large industrial scale battery storage (Laurence, Dec. 2019). These technologies are not yet at a point where wholesale changes in the use of diesel generators is either technologically or financially feasible. As a result, diesel emergency generators are expected to be part of the data centre industry for some time to come.

2.4 Pollutants of Potential Concern

Diesel combustion is a well understood process. Emissions from emergency generators are expected to consist of a range of pollutants as listed in Version 3.0 of the *National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Combustion engines* (DEWHA 2008). Pollutants listed in Table 42 of the EETM for Combustion engines are as follows:

- Carbon Monoxide (CO)
- Fluoride Compounds (as HF)
- Oxides of Nitrogen (NO_X)
- Particulate Matter (PM_{10})
- Particulate Matter ($PM_{2.5}$)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Sulfur Dioxide (SO_2); and
- Total Volatile Organic Compounds (VOC)

Of the pollutants listed in the EETM, only CO, NO_X, $PM_{2.5}$, PAH and VOC have been included in this assessment. The other pollutants have been excluded for the following reasons:

- Fluoride compound emissions from diesel engine exhaust is listed as 0 kg/kWh. On this basis it has not been considered.
- The proportion of particulate emissions with particle sizes greater than $PM_{2.5}$ from diesel generators is small, with $PM_{2.5}$ emissions making up over 97% of the particulates emitted from a typical diesel generator (EETM, NPI 2008).

  In addition, $PM_{2.5}$ in NSW is largely the primary health indicator for particulate emissions. Given the importance of $PM_{2.5}$ and the predominance of $PM_{2.5}$ particulates in the Generator emissions, $PM_{2.5}$ has been included in the assessment and PM_{10} has been omitted.

  Note that the generator specifications used for the emissions data do not specify the particulate fraction. As a conservative measure, 100% of the emitted particulate matter has been assumed to be $PM_{2.5}$.
- Sulfur levels in diesel fuel in Australia have been getting lower and lower over the last 20 years following the implementation of strict fuel standards. This has reached a point whereby the emissions of SO_2 are insignificant and not commonly considered when assessing diesel emissions. On this basis, SO_2 has not been assessed.

3.0 Air Quality Regulatory Framework

Legislation relating to projects contributing to air quality in NSW can be broadly divided into either federal or state-based legislation and consists of several distinct pieces of legislation that need to be considered. As an overview, the legislation applicable to air quality in NSW has been summarised in **Figure 4**.

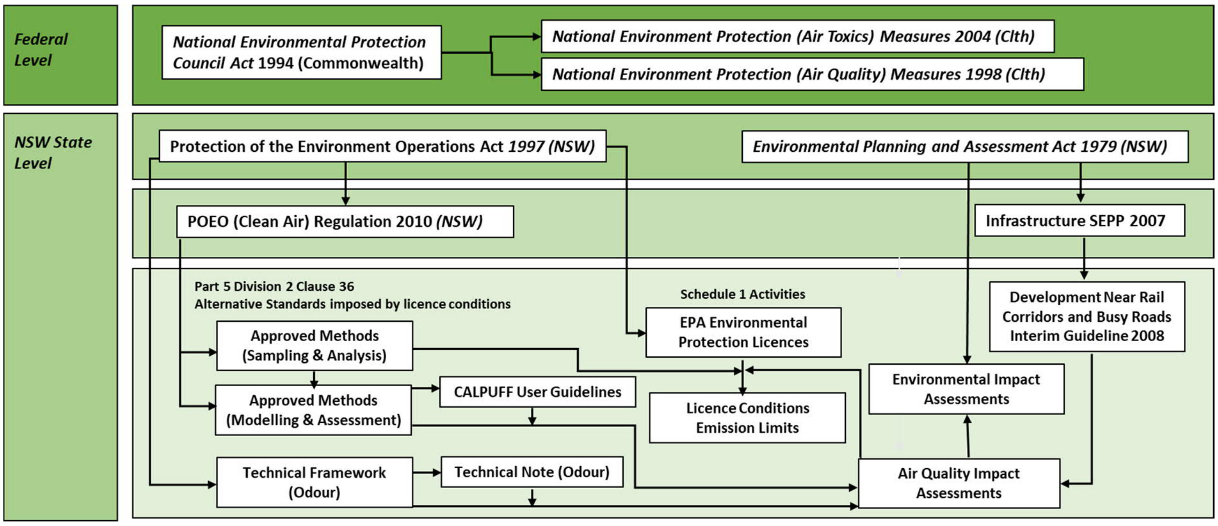


Figure 4 Air Quality Legislation relevant to NSW Impact Assessments

The following sections discuss the federal and state legislative instruments and outline how they relate to the Data Centre project.

3.1 Federal Legislation (National Environment Protection Measures)

National Environment Protection Measures (NEPMs) are broad framework-setting statutory instruments that outline agreed national objectives for protecting or managing particular aspects of the environment. Air quality from a federal perspective in NSW is governed by the *National Environment Protection (Ambient Air Quality) Measure (Clth)* (the Air Quality NEPM) as amended (2003). This NEPM provides guidance relating to air in the external environment, which does not include air inside buildings or structures.

The Air Quality NEPM outlines monitoring, assessment and reporting procedures for the following criteria pollutants:

- Carbon monoxide;
- Nitrogen dioxide;
- Sulfur dioxide;
- Particles as PM_{10} (particles with diameters less than or equal to 10 µm);
- Particles as $PM_{2.5}$ (particles with diameters less than or equal to 2.5 µm);
- Photochemical oxidants (as ozone); and
- Lead.

The Air Quality NEPM standards apply to air quality experienced by the general population within a region, and not to air quality in areas within the region affected by localised air emissions, such as heavily trafficked streets. The goal of the Air Quality NEPM was to achieve the standards with the allowable exceedances, as assessed in accordance with the associated monitoring protocol, by 2008 and the standards were set at a level intended to adequately protect human health and well-being.

The ambient air quality standards defined in the Air NEPM are listed in **Table 3**, with future goals for $PM_{2.5}$ displayed in **Table 4**.

Table 3 NEPM Air Quality Standards

Item	Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
1	Carbon monoxide	8 hours	9.0 ppm	1 day a year
2	Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year None
3	Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
4	Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year None
5	Lead	1 year	0.50 µg/m^3	None
6	Particles as PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3*	None None
7	Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	None None

Table 4 NEPM $PM_{2.5}$ goals by 2025

Pollutant	Averaging period	Maximum concentration
Particles as $PM_{2.5}$	1 day 1 year	20 µg/m^3 by 2025 7 µg/m^3 by 2025

In addition to the Air Quality NEPM, the *National Environment Protection (Air Toxics) Measure (Clth)* (Air Toxics NEPM) provides a framework for monitoring, assessing and reporting on ambient levels of air toxics. The purpose of this NEPM is to collect information to facilitate the development of standards for ambient air toxics.

The Air Toxics NEPM includes monitoring investigation levels for use in assessing the significance of monitored levels of air toxics with respect to human health. The monitoring investigation levels are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short term, it does not mean that adverse health effects automatically occur; rather some form of further investigation by the relevant jurisdiction of the cause of the exceedance is required. The relevant monitoring investigation levels defined in the Air Toxics NEPM are listed in **Table 5**.

Table 5 Air Toxics NEPM Air Quality Monitoring Investigation levels

Pollutant	Averaging period	Monitoring investigation level	Goal
Benzene	Annual average	0.003 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons	Annual average*	0.3 ng/m^3	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Formaldehyde	24 hours	0.04 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.

Pollutant	Averaging period	Monitoring investigation level	Goal
Toluene	24 hours Annual average	1 ppm 0.1 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.
Xylenes (as total of ortho, meta and para isomers)	24 hours Annual average	0.25 ppm 0.2 ppm	8-year goal is to gather sufficient data nationally to facilitate development of a standard.

In 2018, the intention to vary the NEPM was announced to strengthen the standards for Ozone, Nitrogen Dioxide and Sulfur Dioxide. The proposed variation to the NEPM was released in 2019 followed by a period of public consultation into the justification for the changes to the NEPM. The proposed changes to the NEPM have been summarised in **Table 6** along with the proposed dates for implementation and the standards that have been removed (designated by standards which have been crossed out).

Table 6 Changes to Ozone, Nitrogen Dioxide and Sulfur Dioxide NEPM Standards

Pollutant	Averaging Period	Maximum Concentration Standard	Maximum Allowable Exceedances
Nitrogen dioxide	1 hour 1 year	~~0.12 ppm~~ -> 0.09 ppm ~~0.03 ppm~~ -> 0.019 ppm	~~1 day a year~~ ~~None~~
Photochemical oxidants (as ozone)	~~1 hour~~ 4 -> 8 hours	~~0.10 ppm~~ ~~0.08 ppm~~ -> 0.09 ppm	~~1 day a year~~ ~~1 day a year~~
Sulfur dioxide	1 hour 1 day ~~1 year~~	~~0.20 ppm~~ -> 0.10 ppm ~~0.08 ppm~~ -> 0.02 ppm ~~0.02 ppm~~	~~1 day a year~~ ~~1 day a year~~ ~~None~~

Standards outlined in **Table 6** will be further reduced from 2025 as shown in **Table 7**.

Table 7 Changes to Ozone, Nitrogen Dioxide and Sulfur Dioxide NEPM Standards from 2025

Item	Pollutant	Averaging Period	Maximum Concentration Standard
2	Nitrogen dioxide	1 hour 1 year	~~0.09 ppm~~ -> 0.08 ppm ~~0.019 ppm~~ -> 0.015 ppm
3	Sulfur dioxide	1 hour	~~0.20 ppm~~ -> 0.075 ppm
4	Particles as $PM_{2.5}$	1 day 1 year	~~25 µg/m^3~~ -> 20 µg/m^3 ~~8 µg/m^3~~ -> 7 µg/m^3

These changes to the existing NEPM standards do not have a direct impact on the project as the NEPM does not apply to individual projects within NSW. However, state based impact assessment criteria used by bodies like the NSW EPA have typically followed closely and changes to criteria defined by the NEPM and there is no reason to expect that changes to the NEPM would not result in changes to state base legislation which is applicable to individual projects. On this basis, it is considered prudent to assess projects that may be operational for significant periods of time against likely future criteria values.

3.2 NSW Air Quality Legislation

As outlined in **Figure 4**, NSW has a multi-tiered approach to air quality legislation ranging from Acts to Regulations and air quality policies and guidance documents.

3.2.1 Protection of the Environment Operations (POEO) Act 1997

The *Protection of the Environment Operations Act 1997 (NSW)* (POEO Act 1997) consolidates several NSW Environmental legislative requirements under the one Act and integrates environmental protection licencing and the regulation of scheduled and non-scheduled activities within NSW.

The following sections of the POEO Act are relevant to Data Centre operations, particularly the use of emergency generators for electricity generation during power failures:

- ***Section 124*** includes the requirement to maintain plant in an efficient manner and to operate the plant in a proper and efficient manner.
- ***Section 125*** sets out the offence caused by the improper operation or maintenance of plant that results in air pollution.
- ***Section 128*** sets out the requirement to meet standards of air pollutants emitted from plant as described in the regulations (POEO (Clean Air) Regulations). In particular, the following points are relevant:
    - Air impurities must not be emitted in concentrations or rates in excess of the standards outlined in the regulations
    - The operator of plant not covered by the regulation, must operate plant using practical means to minimise air pollution if neither the standard of concentration nor rate of emission prescribed by the regulation has been met.
- ***Schedule 1*** lists the activities that are scheduled under the POEO Act and require an Environmental Protection Licence (EPL) to operate. The only activity that may have triggered the requirement for an EPL is the running of emergency generators for over 200 hours per year (refer Schedule 1, Clause 17(1A) of the Act). The emergency running of the generators for generation of electricity is expected to be in the range of 1 hour per year and up to 12 hours every 5-10 years based on the expected outage for the Macquarie Park power zone (which is currently being upgraded to improve capacity and reliability). Maintenance activities on the generators do not count toward the 200-hour threshold, but in any event, they are also expected to be far less than 200 hours per year. Consequently, the proposed Data Centre is a non-scheduled premise and does not trigger the requirements for an Environmental Protection License (EPL).

3.2.2 Protection of the Environment (Clean Air) Regulation 2010

The POEO (Clean Air) Regulation 2010 (Clean Air Regulation) regulates the emissions from a range of activities, including wood heaters, fires, motor vehicles & fuels, and industry (Part 5).

Part 5 of the regulation describes the requirements relevant to industrial facilities including:

- emission standards for a variety of different industry types; and
- emission standards for non-scheduled premises.

As the site is a non-scheduled premises, Data Centre operations need to be compared with Schedule 6 of the Clean Air Regulation, which has been outlined in **Table 8**.

Table 8 Clean Air Regulation: Schedule 6 Standards of concentration for non-scheduled premises

Air Impurity	Activity or Plant	Group*	Concentration
Solid Particles	Any activity or plant (except as listed below)	Group A	400 mg/m^3
		Group B	250 mg/m^3
		Group C	100 mg/m^3

Air Impurity	Activity or Plant	Group*	Concentration
Smoke	Any activity or plant in connection with which liquid or gaseous fuel is burnt	Group A, B or C	Ringelmann 1 or 20% opacity
* Given that the Data Centre is a new development, the activity is defined as Group C			

The project SEARs included a clause requesting assessment of emissions from the backup generators against standard concentrations outlined in the Clean Air Regulation. The two pollutants listed were Polycyclic Aromatic Hydrocarbons (PAHs) and Oxides of Nitrogen (NOx). However, Schedules 2, 3, and 4 (which include NOx standards) do not apply to the Data Centre as it is a Non-Scheduled Premises, and Schedule 6 (standards of concentration for non-scheduled premises) does not include a NOx standard. Thus, there is no applicable standard in the Regulation to compare with the modelled Data Centre NOx emissions.

PAHs are only listed briefly in the Clean Air Regulations under the *Part 5 Air impurities emitted from activities and plant, Division 1: Definitions*, which lists PAH as benzo(a)Pyrene equivalent. No further reference is made in the document either for Scheduled or Non-Scheduled premises. On this basis, no comparison can be made between modelled emissions from the Data Centre and Clean Air Regulation limits. The impacts expected as a result of the PAH emissions have been considered and assessed in accordance with the requirements of the Approved Methods for Modelling.

3.2.3 NSW EPA Air Quality Guidance

NSW EPA has published Approved Methods for both dispersion modelling and air pollutant sampling methods. Along with the methods for the measurement and assessment of air emissions, the approved methods for modelling also includes pollutant criteria against which predictions are compared when assessing the impact from a development.

4.0 Assessment Criteria

When assessing a project with significant air emissions, it is necessary to compare the impacts of the project with relevant air quality goals. Air quality standards or goals are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects.

The NSW EPA assessment has released criteria as part of their Approved Methods document (EPA 2016). The pollutant specific criteria and corresponding averaging period for individual pollutants are shown in **Table 9**.

Assessment of the impacts from the individual pollutants is based on the pollutant type. For the pollutants listed in **Table 9,** the assessable location is either at sensitive receptor locations or “at or beyond” the facility boundary.

NSW criteria for air pollutants are applied either as a maximum concentration (100th percentile) or as a lower percentile (99.9th percentile for PAH and VOC’s). Given that the operation of the generators at the Data Centre site will be both sporadic and short term in nature, the maximum 1-hour modelling results are more appropriate for comparison with the criteria. Given the complexity of the area around the Data Centre and the complexity of the proposed building on the Data Centre site itself, pollutant predictions were assessed at several designated sensitive receptor locations, which were positioned both on-site and off-site at representative locations surrounding the Data Centre.

Table 9 Air Quality Impact Assessment Criteria

Compound	Averaging Period	Criteria ($\mu g/m^3$)	Source
Nitrogen Dioxide	1 Hour Maximum	246	NSW Approved Methods
	Annual Average	62	NSW Approved Methods
	1 Hour Maximum	185	NEPM 2020-2025
	Annual Average	39	NEPM 2020-2025
	1 Hour Maximum	164	NEPM 2025+
	Annual Average	31	NEPM 2025+
Carbon Monoxide	1 Hour Maximum	30,000	NSW Approved Methods
	8 Hour Maximum	10,000	NSW Approved Methods
$PM_{2.5}$ Particulates	24 Hour Maximum	25	NSW Approved Methods
	Annual Average	8	NSW Approved Methods
	24 Hour Maximum	20	NEPM 2025+
	Annual Average	7	NEPM 2025+
VOC			
Acetaldehyde	99.9th Percentile	42	NSW Approved Methods
Benzene	99.9th Percentile	29	NSW Approved Methods
Formaldehyde	99.9th Percentile	20	NSW Approved Methods
Toluene	99.9th Percentile	360	NSW Approved Methods
Xylene	99.9th Percentile	190	NSW Approved Methods
PAH	99.9th Percentile	0.04*	NSW Approved Methods
* PAH as Benzo(a)Pyrene TEQ Shaded cells denote possible future criteria not currently adopted by NSW EPA			

5.0 Existing Environment

5.1 Meteorology

The NSW Environment, Energy and Science (EES); under the DPIE operate a network of ambient pollutant and meteorological data monitoring stations at several locations across the Sydney basin. The station nearest to the Data Centre site is located at the Macquarie University Sporting Fields approximately 1.8 km to the north northwest of the Data Centre building. The Data Centre and its proximity to the EES monitoring station in Macquarie Park is shown in **Figure 5**.

Figure 5 Location of EES Macquarie Park Monitoring Station and Proximity to Data Centre

The monitoring station at Macquarie Park has been in place since mid-2017 and does not have enough data to demonstrate that a single modelled year from this data set is representative of long-term meteorological conditions (as required by NSW EPA). To enable a meaningful long-term data comparison, the closest station with long term monitoring data (Bureau of Meteorology (BOM) station at Sydney Olympic Park) was selected for analysis. The BOM Sydney Olympic Park station is situated approximately 8.8 km to the southwest of the EES Macquarie Park station.

Although a comparison between the two stations has been undertaken as required by NSW EPA, it needs to be understood that monitoring stations positioned at significant distance from each other with significant influencing terrain conditions (as is the case due with the Land Cove River valley and Sydney Harbour dominating the winds for Macquarie Park and Olympic Park respectively) will likely have different meteorological patterns. The intent of the comparison is to show general similarities in the data sets.

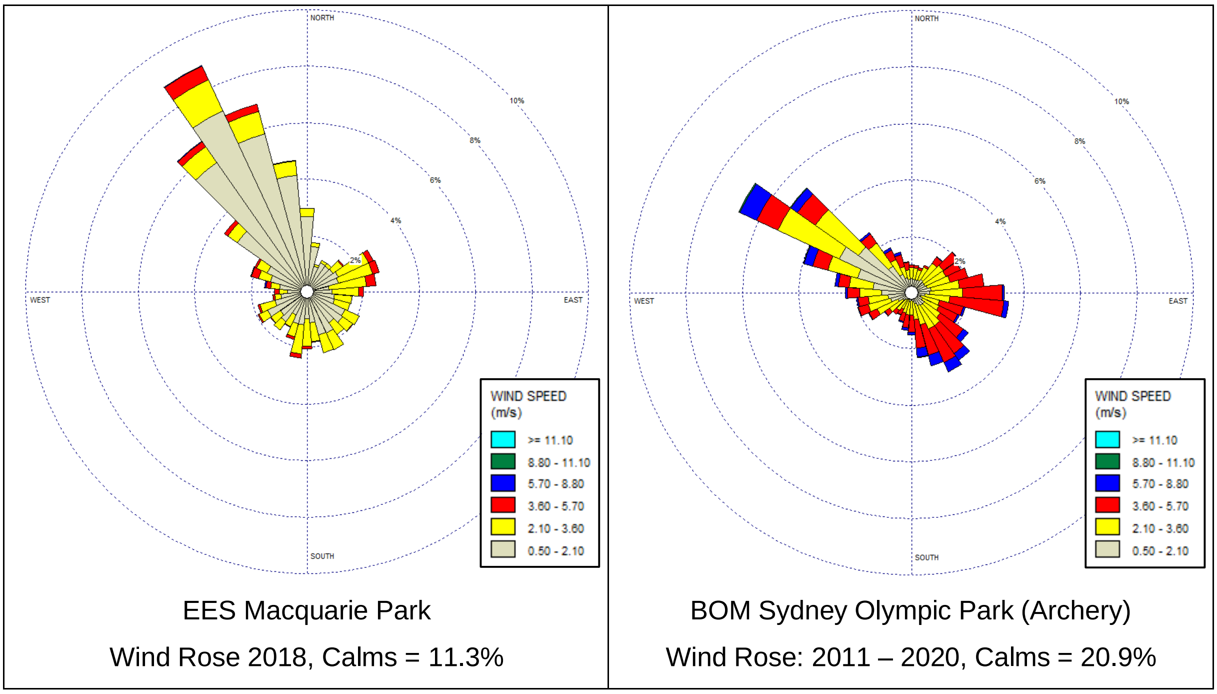


Figure 6 Comparison Wind Roses for EES Macquarie Park and the BOM Sydney Olympic park monitoring stations

Wind roses for the EES Macquarie Park and the BOM Sydney Olympic park monitoring stations are shown in **Figure 6**. Several differences were noted between the data sets, which can be summarised as follows:

- The predominant wind direction for the two monitoring stations differed slightly with the EES data having a north west to north north-westerly predominant wind direction as compared to the BOM data which displayed a more NW to WNW direction. This difference is explained by the orientation of the river valleys in which the stations are positioned i.e. Paramatta river is more east-west oriented whereas the Lane Cove river has a more northerly to north westerly orientation which is reflected in the wind direction (as shown in **Figure 7**).

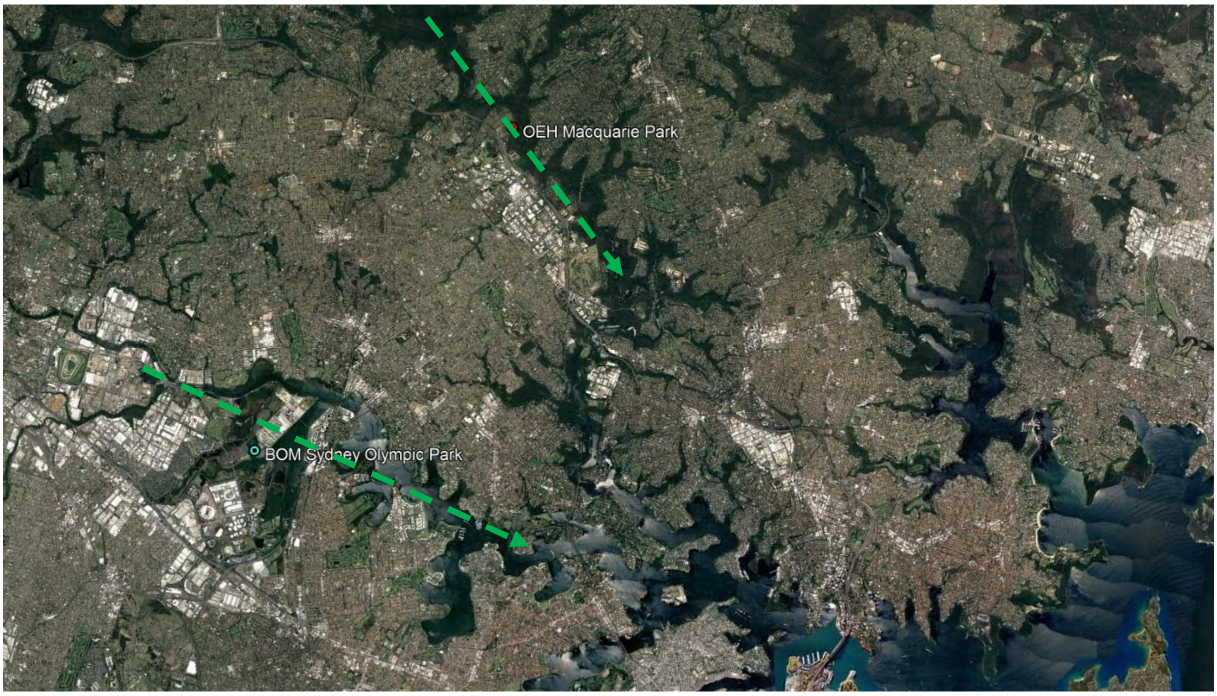


Figure 7 General river valley orientations for the monitored meteorology.

Winds monitored at the BOM station were generally stronger than the EES winds with a higher calm percentage noted by the EES station. The terrain and land use surrounding the two stations is thought to be reason for this difference, with the land around the BOM station being generally flatter than the land around the EES station with much more open space around the BOM station likely leading to stronger winds overall. There is a much higher predominance of forested areas around the EES station which would be expected to lead to generally lower wind speeds and hence higher proportion of calms.

Despite the differences noted between the two data sets, the general shape of the winds exhibited by both data sets are similar enough to demonstrate that the Macquarie Park meteorological station are likely to be reasonably representative of conditions surrounding the Macquarie Park area. The meteorology defined by Macquarie Park is considered to provide a reasonable picture of meteorology around the Macquarie Park region and the differences to the long-term monitoring data at Sydney Olympic Park are considered acceptable and not indicative of large differences invalidating the Macquarie Park data.

A summary of the long-term data recorded at BOM Sydney Olympic Park (from 2011 – 2020) has been extracted and is discussed below. Additional analysis has been provided in **Appendix B**. Note that as there is only eight years of data available at this location, the data presented has been calculated from the measured data provided to AECOM by BOM and is not available as summaries on the BOM website.

The warmest temperatures occur between December and March, with the maximum temperatures occurring in January and the coldest temperatures are recorded in the winter months, with the lowest average minimum temperature occurring in July.

The highest average rainfall is recorded in March, with May, July and September being the driest months. Humidity in the area ranges from 0.25 – 100%, averaging 74%. Average wind speeds range from 0 – 39.2 kilometres per hour and are typically higher at 3 pm compared to 9 am. Winds are predominantly from the northwest at 9 am, with less frequent winds from the east and south-east. Winds are predominantly from the east at 3 pm, with less frequent winds observed from the south to south-east.

5.2 Existing Air Quality

The pollutants of prime interest in NSW are ozone, NO_2 and particulates, with regional levels of certain pollutants approaching or exceeding the national standards prescribed in the National Environment Protection Measure for Ambient Air Quality (NEPM). When operating, the Data Centre emergency generators are expected to generate elevated levels of NO_2 and particulates (along with small quantities of VOC, CO and PAH). Nitrogen Dioxide, Carbon Monoxide and particulates need to be considered cumulatively with existing background concentration, necessitating an analysis of the background air pollutant concentrations.

Background air pollution is characterised through ambient monitoring undertaken by EES at locations throughout the Sydney basin. As outline above, the closest monitoring station to the Data Centre is the Macquarie Park monitoring station situated at the Macquarie University Sporting Fields approximately 1.8 km to the north northwest of the Data Centre building. This station measures a range of pollutants relevant to this study including:

- Oxides of Nitrogen (including Nitrogen Dioxide);
- Carbon monoxide;
- Ozone;
- PM_{10} particulate matter
- $PM_{2.5}$ particulate matter

Data covering the last three calendar years for the Macquarie Park monitoring station have been extracted from the EES online data portal and haven been summarised in **Table 10**. Data trends for the extracted period have also been shown in **Figure 8** to **Figure 12**.

Table 10 Macquarie Park Ambient Monitoring Data Summary

Pollutant	Averaging Period	Concentration (µg/m³)		
		2017	2018	2019
Nitrogen Dioxide	1 Hour Max	69.6	56.4	48.9
	Annual Average	9.9	10.5	10.1
Ozone	1 Hour Max	178.4	170.5	239.1
	4 Hour Max	155.3	157.8	179.8
Carbon Monoxide	1 Hour Max	805.0	5060.0	6785.0
	8 Hour Max	591.4	2694.3	4010.6
PM_{10}[1]	Annual Average	15.1	17.4	20.0
$PM_{2.5}$	24 Hour Maximum	24.1	58.4	152.0
	24 Hr Criteria Exceedances	0	4	19
	Annual Average	6.3	7.0	9.3

[1] PM_{10} Data only included for use in construction impact assessment

Monitoring data from the Macquarie Park EES station show that nitrogen dioxide and carbon monoxide levels in the ambient environment are well below both current criteria and future criteria, with the maximum short term NO_2 concentration consisting of only 28% of the existing criteria and 42% of the lowest expected future criteria (expected post 2025 criteria). CO concentrations reached a maximum of 23% of the 1-hour average CO criterion for the 2019 monitoring year. This value was attributed to the 2019-20 bushfire season which exhibited a much higher than maximum CO concentration for 2017 and 2018, which was 1,035µg/m³ or 3% of the 1-hour average CO criterion.

General seasonal trends in pollutant concentration were observed for both NO_2 and CO, with higher concentrations of both pollutants noted during winter and lower concentrations noted in summer. No significant change to the NO_2 concentrations were noted for the bushfire period of 2019, whereas CO concentrations spiked to a much higher concentration during the 2019 bushfire periods and during a hazard reduction burn carried out in August 2018. These seasonal trends and event concentrations follow the expected patterns and as such the NO_2 and CO data is considered reasonable for use in the assessment for cumulative impact assessment.

Particulate concentrations show that levels of dust in the ambient environment around Macquarie Park are elevated with exceedances of short-term PM_{10} and $PM_{2.5}$ criteria noted in both 2018 and 2019. These exceedances are attributed to unusual events like bushfires (particularly in 2019) and dust storms which occurred in both 2018 and 2019. Particulate concentrations during unusual events should not be used as indicators of long term peak particulate concentrations and compliance with EPA criteria.

Seasonal trends were not as obvious for particulate matter as they were for NO_2 and CO.

As exceedances were noted to occur in 2018 for both PM_{10} and $PM_{2.5}$, simple cumulative calculations (predicted particulate concentrations from a model added to background peak concentrations) cannot be used, as exceedances would be predicted for all time periods due to elevated background concentrations. To account for the elevated background concentrations within the dataset, the cumulative assessment for particulates has been undertaken contemporaneously using methods outlined in Sections 5.1, 8.1.1 and 11.2 of the Approved Methods for Modelling.

The cumulative assessment below was undertaken using contemporaneous meteorology corresponding to the measured ambient pollutant concentrations. 2018 was the selected year for meteorology and therefore in accordance with the contemporaneous assessment methodology, ambient pollution concentrations were also sourced for the 2018 calendar year. 2018 is considered acceptable from an ambient pollutant concentration perspective due to the only other full calendar year of data available, 2019 data, being heavily affected by the bushfires in October to December creating an unrepresentative period where background concentrations were very high.

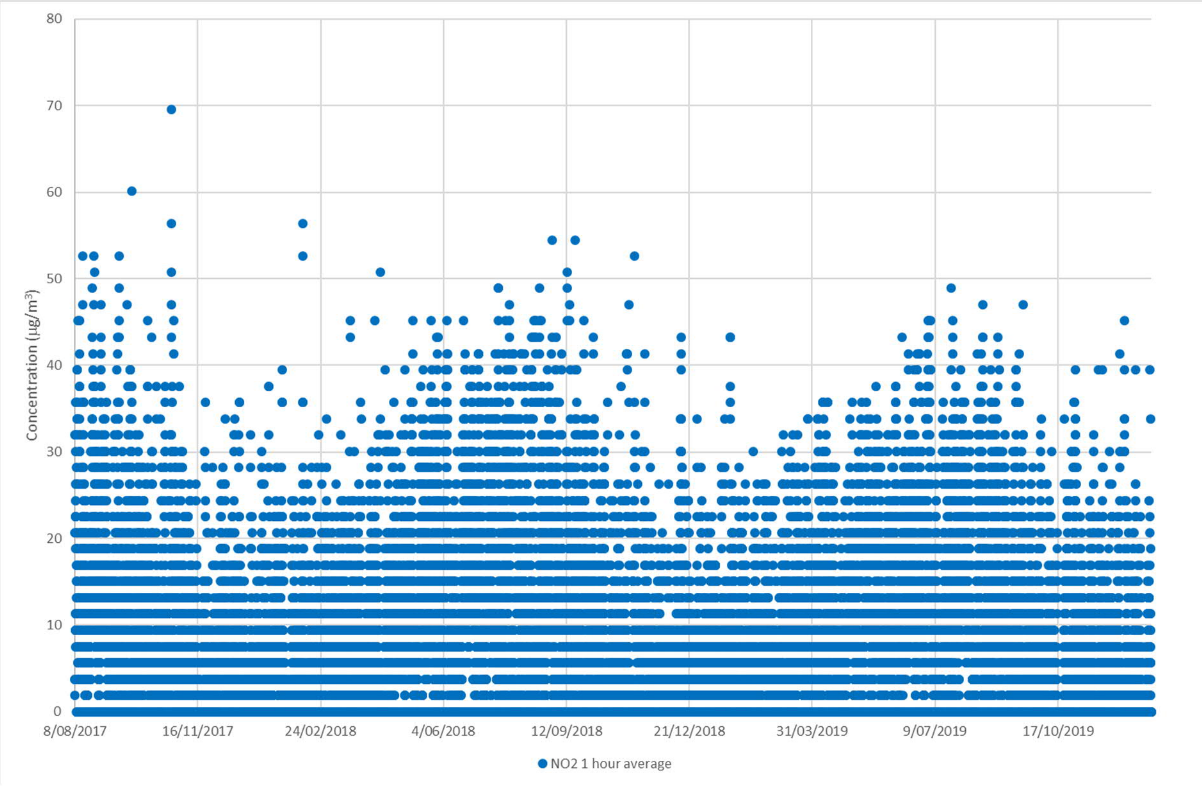


Figure 8 Background NO_2 Concentrations

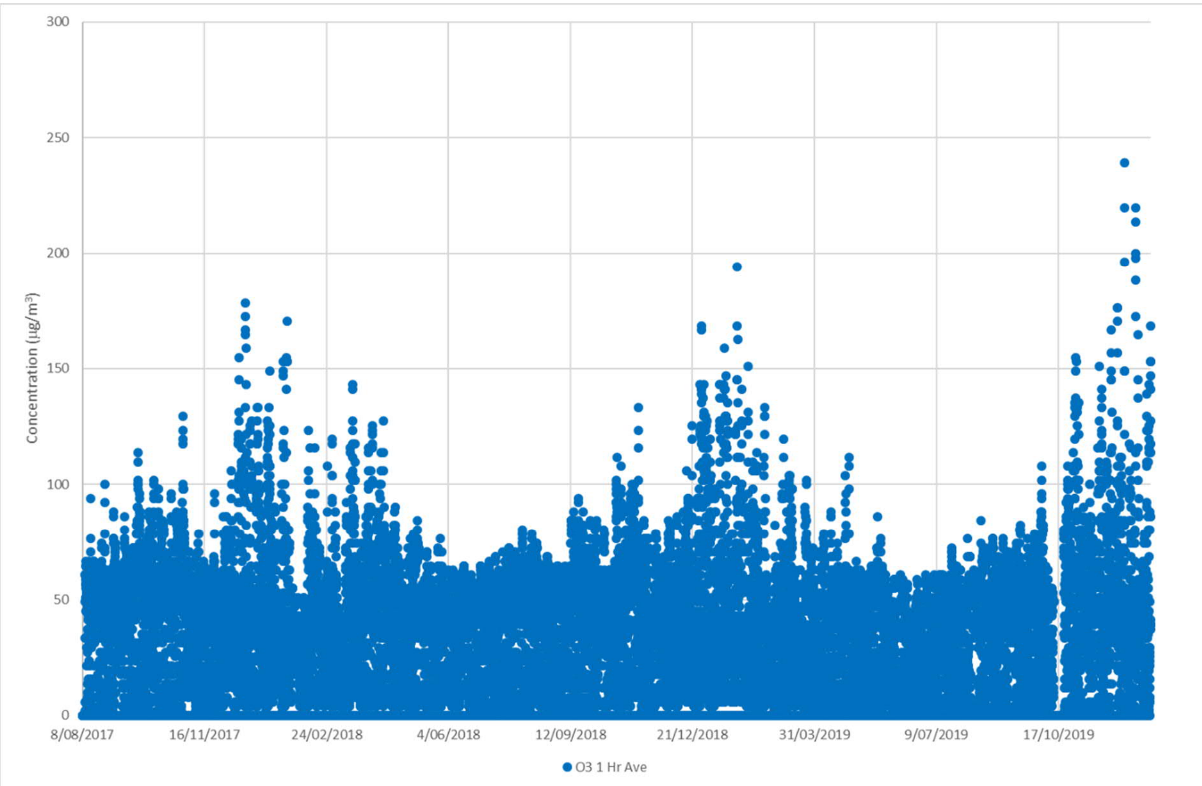


Figure 9 Background Ozone Concentrations

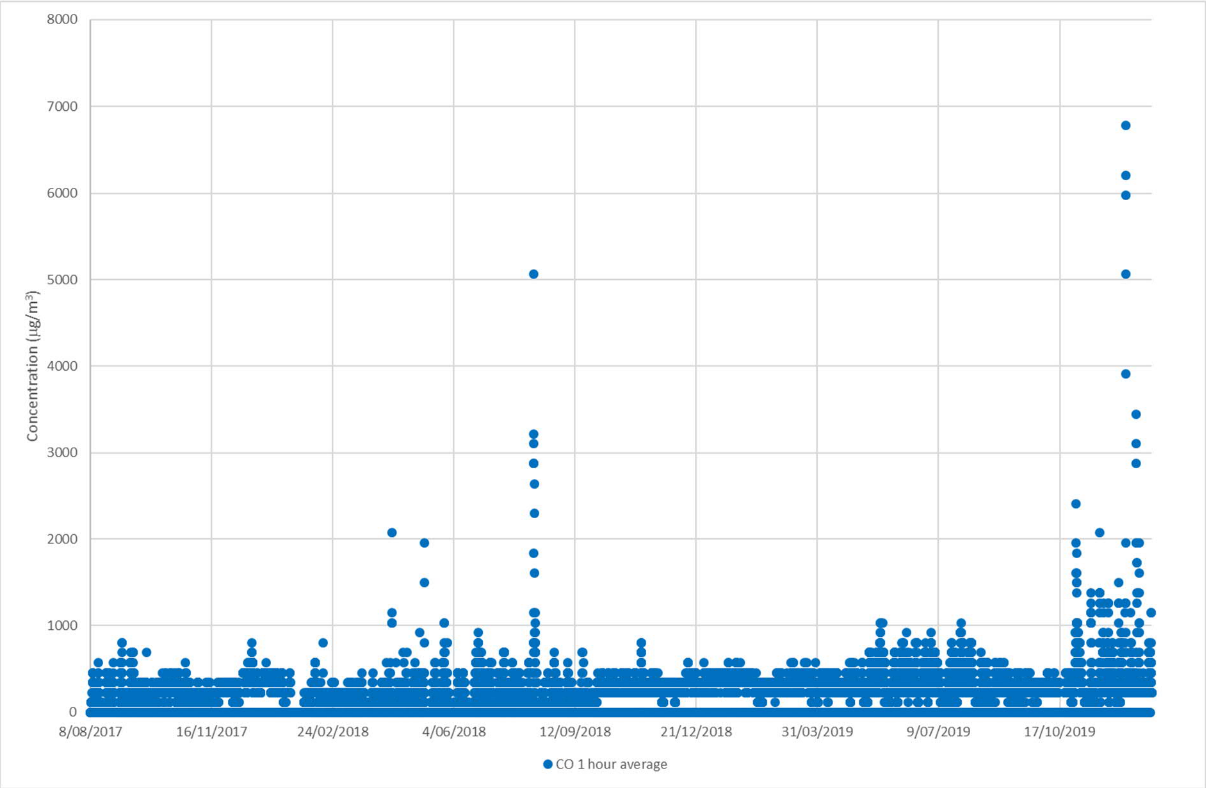


Figure 10 Background CO Concentrations

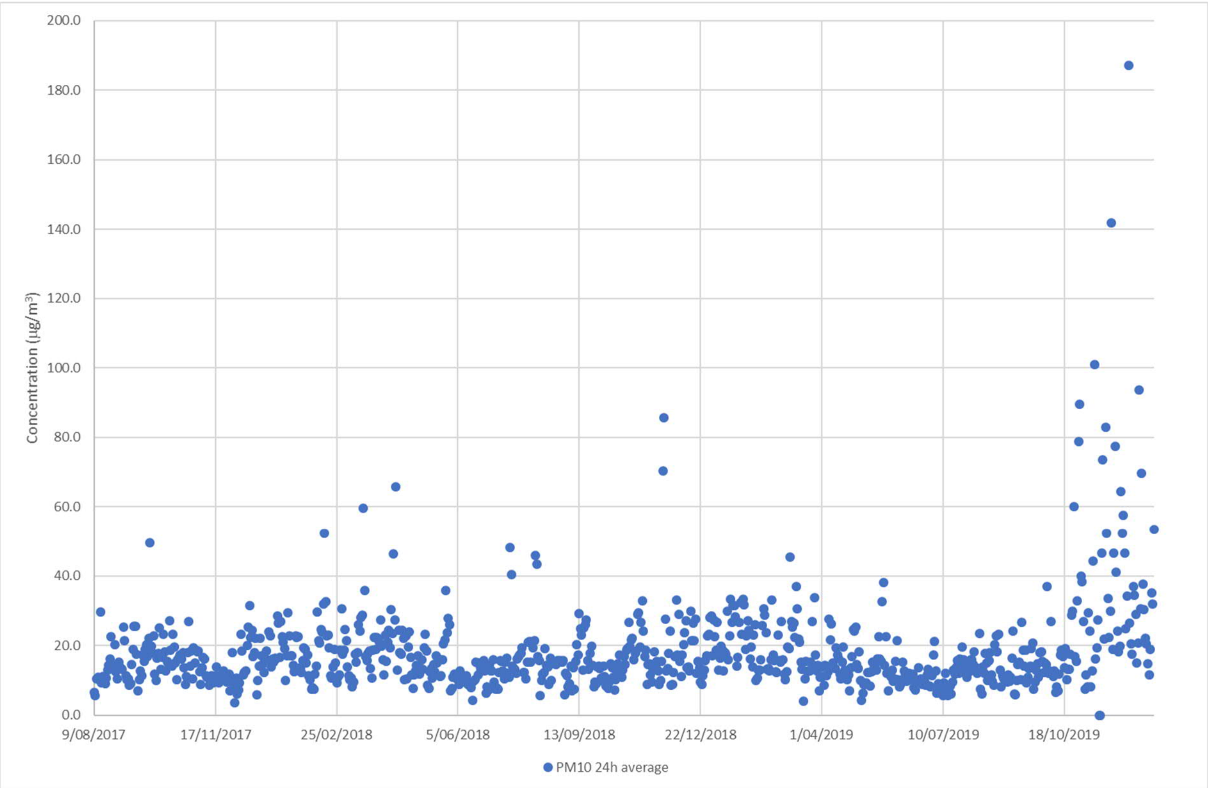


Figure 11 Background PM_{10} concentrations

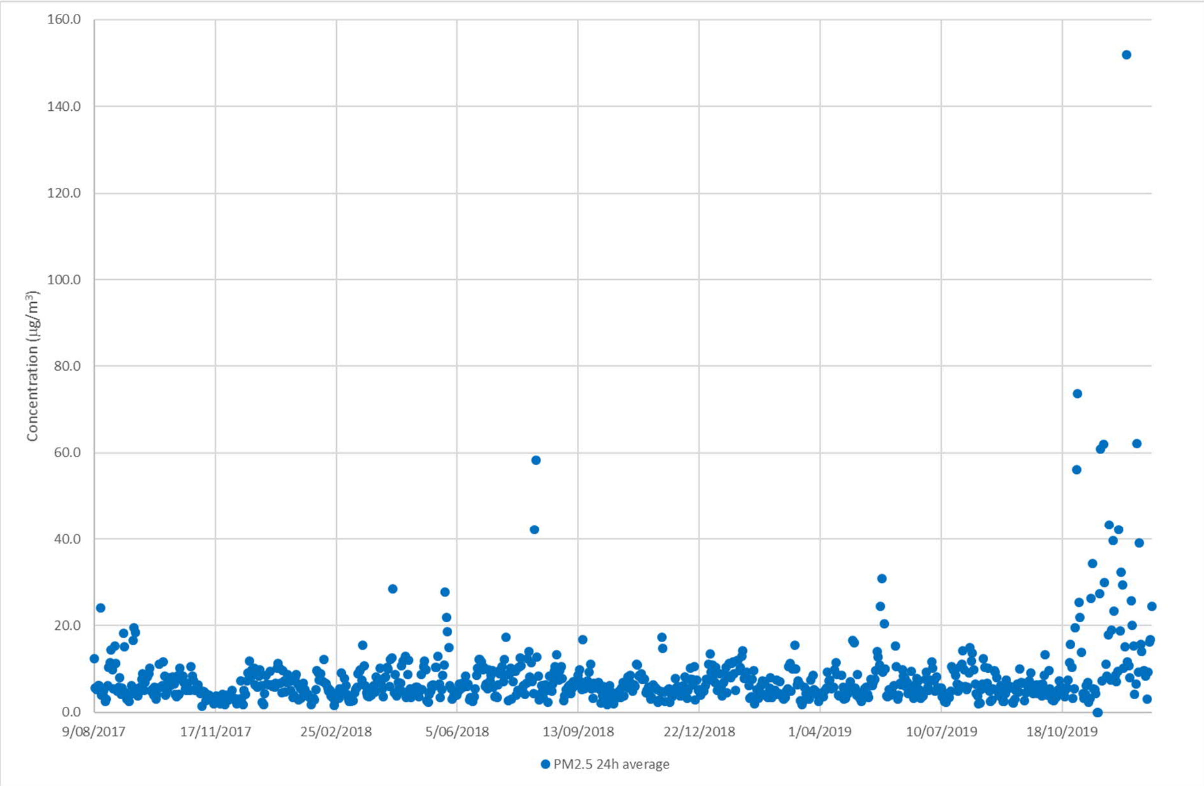


Figure 12 Background $PM_{2.5}$ concentrations

5.3 Terrain and Land Use

The Data Centre site is located at approximately 54 m elevation on a flat area on the edge of the Lane Cove River Valley, which runs from the south-east of the Macquarie Park area to the north northwest of the Macquarie Park commercial area. The area is generally flat dominated by plateaus interspersed with narrow river valleys.

The surrounding region is heavily developed. in all directions with. Within 500 m, the land use is best described as large-scale commercial activities with a range of large warehouses and office developments. There are high-rise residential developments within the commercial area to the west of the Data Centre and some hotel accommodation and educational facilities interspersed amongst the commercial facilities to the east and south of the Data Centre. Approximately 500 m from the Data Centre location the predominant land uses low-density housing.

Forest land and parkland of the Lane Cove River corridor surrounds the commercial area to the north of the Data Centre site, with pockets of low density residential interspersed amongst the green spaces.

6.0 Dispersion Modelling Scenarios

Dispersion modelling scenarios define how the emissions from a site are combined for use in a dispersion model. Information on physical source dimensions, pollutant emission rates and variable operational modes are combined to try and ensure the scenarios represent a realistic picture of the overall emissions from a facility.

The SEAR's outlined in **Section 1.1** include the requirement to provide "*scenarios which assess construction works, realistic operations, back-up generator testing and a justified worst-case scenario*".

To enable the defining of the modelling scenarios, the operation of the emergency generators was considered. As discussed above, the operation of all 18 generators was not considered to be likely to occur either regularly or for a protracted time period and as such has not been considered in the development of the modelling scenarios as the realistic worst-case scenario.

The combination of different maintenance operational modes in important to the development of the expected realistic worst-case operation of the emergency generators. Given the nature of the expected generator maintenance, the "realistic operations" and "backup generator testing" scenarios required by the SEARs are likely to have the same operational characteristics and as such have been considered together. The operational modes and assumptions relevant to the development of the scenarios are as follows:

- Unloaded Maintenance Testing (assumed to be the generators operating at 10% of full power). This test would only occur for a maximum of 15 minutes.
- Loaded Maintenance Testing (assumed to be the generators operating at 50% of full power). This test would only occur for a maximum of 1 hour.
- Maximum Load Testing (assumed to be the generators operating at 100% of full power). This test would only occur for a maximum of 15 minutes.
- Due to the maintenance procedures, it is expected that a maximum of three generators would be tested in a single day.
- No testing is to occur during night-time hours (all testing to occur between 7am and 6pm).

Combination of the above operational modes and assumptions has led to the development of two scenarios which have been considered by this assessment and are outlined in **Table 11**. Each scenario assumes all 18 generators are tested per month according to the three different operating modes described above, with both the CAT and the Cummins models considered separately to ensure that compliance has been considered regardless of the generator selected.

Table 11 Modelling Scenarios

Scenario Number	Engine Manufacturer	Scenario Description
1	CAT	The CAT modelling Scenarios included the following: • Each of the 18 generators tested once per month for 15 minutes per generator – assuming 10% load • Each of the 18 generators tested once per month for 1 hour per generator – assuming 50% load • Each of the 18 generators tested once per quarter for 15 minutes per generator – assuming 100% load
2	Cummins	The Cummins modelling Scenarios included the following: • Each of the 18 generators tested once per month for 15 minutes per generator – assuming 10% load • Each of the 18 generators tested once per month for 1 hour per generator – assuming 50% load • Each of the 18 generators tested once per quarter for 15 minutes per generator – assuming 100% load

The results of the dispersion modelling have been focused on the reporting of the expected worst-case results from the above scenarios. This has been achieved as follows:

- Short term predictions have been extracted for the maximum predicted concentrations for any of the modelled hours for any of the testing modes. Emissions were modelled for all daytime hours across a full 12 months of meteorology. This ensured that all possible meteorological conditions have been included in the assessment and that the worst-case results corresponding to the worst-case meteorology were considered.
- Long term, annual average predictions have been based on the assumption that the maximum predicted concentrations for each month occurs at all testing periods. For example, $PM_{2.5}$ hourly predictions were determined for all hours across the year and the highest 1 hour average predicted concentration was used to calculated the worst case 24 hour average concentration (maximum 1 hour average $PM_{2.5}$ concentration for each day of the modelled month was multiplied by three to correspond with three worst case generator test periods and averaged over the 24 hour period). This worst-case 24-hour period was then assumed to occur six times for each month and this procedure was repeated for each month for a full year to enable the calculation of the annual average. This is a conservative approach as it assumes a worst-case hourly emission occurs for all testing that occurs throughout the year.

The above scenarios, while not divided into the discrete scenarios requested in the SEARs, should address the intent of the SEARs and provide an indication of the worst-case operational impacts from the Emergency Generator Testing.

Note that no construction modelling has been undertaken as there is currently insufficient information to enable a detailed understanding of the construction staging or activities. In addition, construction assessment is not commonly modelled due to the transitory nature of the construction activities and the difficulty in defining the activities that may occur together. Instead of modelling the emissions from the construction activities the potential risk associated with the dust emissions from the construction activities have been assessed using the risk assessment methodology outlined in the Institute of Air Quality Management *Guidance on the assessment of dust from demolition and construction [reference]*. This approach is a common approach for construction activity assessment in NSW and is considered appropriate for the scale of this project. Detailed information of the construction dust assessment methodology is provided in **Section 7.0**.

7.0 Construction Assessment Methodology

7.1 Overview

The Data Centre project construction would be expected to generate a small amount of dust and vehicle emissions. Potential impacts from dust generation during construction have been assessed using the UK Institute of Air Quality Management (IAQM), 2014 *Guidance on the assessment of dust from demolition and construction*. This document provides a qualitative risk assessment process for the potential unmitigated impact of dust generated from demolition, earthmoving and construction activities.

The IAQM methodology assesses the risk of impacts associated with demolition and construction without the application of any mitigation measures. The assessment provides a classification of the risk of dust impacts which then allows the identification of appropriate mitigation measures commensurate with the level of risk.

A qualitative discussion on the potential air quality impacts from vehicle emissions has also been presented.

7.2 Construction assessment

The IAQM guidance process is a four-step risk-based assessment of dust emissions associated with demolition, land clearing and earth moving, and construction activities. The IAQM assessment process is described in the following sections.

This assessment is based on estimated construction and demolition volumes and equipment usage for a building of the size of the Data Centre. In addition, the IAQM assessment only considers the Data Centre building itself and not the other three buildings expected to be constructed on the site.

7.2.1 Step 1 – Screening Assessment

Step 1 of the IAQM assessment requires the determination of whether there are any receptors close enough to warrant further assessment. An assessment is required where there is a human receptor within:

- 350 m from the boundary of a site, or
- 50 m from the route used by construction vehicles on public roads up to 500 m from a site entrance.

7.2.2 Step 2 – Dust Risk Assessment

Step 2 in the IAQM is a risk assessment tool designed to appraise the potential for dust impacts due to unmitigated dust emissions. The key components of the risk assessment involve defining:

- dust emission magnitudes (Step 2A),
- the surrounding area’s sensitivity to dust emissions (Step 2B), and
- combining these in a risk matrix (Step 2C) to determine a potential risk rating for dust impacts on surrounding receptors.

Step 2A – Dust Emission Magnitude

Dust emission magnitudes are estimated according to the scale of works being undertaken classified as small, medium or large. The IAQM guidance provides examples of demolition, earthworks, construction and trackout to aid classification (refer **Table 12**).

Table 12 Classification criteria for small, medium and large demolition and construction activities

Activity	Activity Criteria	Small	Medium	Large
Demolition	Total building volume (m^3)	<20,000	20,000–50,000	>50,000
Earthworks	Total site area (m^2)	<2,500	2,500–10,000	>10,000
	Number of heavy earthmoving vehicles active at one time	<5	5-10	>10
	Total material moved (tonnes)	<20,000	20,000–100,000	>100,000
Construction	Total building volume (m^3)	<25,000	25,000–100,000	>100,000
Trackout	Number of heavy vehicle movements per day	<10	10-50	>50

Step 2B – Sensitivity of Surrounding Area

The “sensitivity” component of the risk assessment is determined by defining the surrounding areas sensitivity to dust soiling, human health effects and ecologically important areas. This is described further below.

Sensitivity of the area to dust soiling and human health effects

The IAQM methodology classifies the sensitivity of an area to dust soiling and human health impacts due to particulate matter effects as high, medium, or low. The classification is determined by a matrix for both dust soiling and human health impacts (refer **Table 13** and **Table 14** respectively). Factors used in the matrix tables to determine the sensitivity of an area are as follows:

- receptor sensitivity (for individual receptors in the area):
  - high sensitivity: locations where members of the public are likely to be exposed for eight hours or more in a day. (e.g. private residences, hospitals, schools, or aged care homes)
  - medium sensitivity: places of work where exposure is likely to be eight hours or more in a day
  - low sensitivity: locations where exposure is transient, around one or two hours maximum. (e.g. parks, footpaths, shopping streets, playing fields)
- number of receptors of each sensitivity type in the area
- distance from source
- annual mean PM_{10} concentration (only applicable to the human health impact matrix).

Table 13 Surrounding area sensitivity to dust soiling effects on people and property

Receptor Sensitivity	Number of Receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

The IAQM guidance provides human health sensitivities for a range of annual average PM_{10} concentrations (i.e. >32, 28-32, 24-28 and <24 µg/m^3). It is noted in the IAQM guidance that the human health sensitivities are tied to criteria from different jurisdictions (UK and Scotland). The annual average PM_{10} criteria for Australia differs from the UK and Scotland and as such concentrations corresponding to the risk categories need to be modified to match Australian conditions. The annual average criterion for PM_{10} in NSW is 25µg/m³ (refer **Section 4.0**) and therefore the scaled criteria ranges for NSW are:

- >25 µg/m³
- 22-25 µg/m³
- 19-22 µg/m³
- <19 µg/m³.

The background PM_{10} concentrations in the region surrounding the Project are outlined in **Section 5.2** and fit within the <19 µg/m³ concentration range. Note that 2019 annual average is not used for this assessment as it is heavily influenced by the 2019 bushfire period and is not considered representative of long-term conditions.

Table 14 provides the IAQM guidance sensitivity levels for human health impacts for the ranges outlined above for the annual average PM_{10} concentrations and highlights (in bold outline) the relevant range for NSW.

Table 14 Surrounding area sensitivity to human health impacts for annual average PM_{10} concentrations

Receptor Sensitivity	Annual average PM_{10} Concentration	Number of Receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	>25 µg/m³	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	22-25 µg/m³	>100	High	High	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	19-22 µg/m³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<19 µg/m³	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>25 µg/m³	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	22-25 µg/m³	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	19-22 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<19 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	≥1	Low	Low	Low	Low	Low

The sensitivity for each construction activity defined by the IAQM guidance is assessed for the Data Centre site. This results in a sensitivity rating for the construction footprint along with ratings for portions of the construction footprint for each construction activity. The ratings depend on the sensitivity of the receptors and the distance from the edge of the construction footprint. As shown in **Table 13** and **Table 14** the greater the distance from the construction footprint (the source), the lower the rating. The highest rating achieved is adopted as the final rating for that group of receptors.

It should be noted that this is not a quantitative human health assessment and risks discussed in this context need to be understood in terms of the IAQM guidance. For a group of receptors, a risk rating indicates the risk that group of receptors may experience unmitigated dust concentrations above the NSW criteria, with the associated potential health effects linked to that criterion.

Sensitivity of area to ecological impacts

Ecological impacts from construction activities occur due to deposition of dust on ecological areas. The sensitivity of ecological receptors can be defined by the following:

- High sensitivity ecological receptors
  - locations with international or national designation and the designation features may be affected by dust soiling
  - locations where there is a community of particularly dust sensitive species
- Medium sensitivity ecological receptors
  - locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown
  - locations within a national designation where the features may be affected by dust deposition
- Low sensitivity ecological receptors
  - locations with a local designation where the features may be affected by dust deposition.

The sensitivity of an ecological area to impacts is assessed using the criteria listed in **Table 15**.

Table 15 Sensitivity of an area to ecological impacts

Receptor sensitivity	Distance from source (m)	
	<20	**20–50**
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Given the heavily developed area surrounding to the construction activity, ecological impacts are considered unlikely and have not been considered further by this assessment.

Step 2C – Unmitigated Risks of Impacts

The dust emission magnitude as determined in Step 2A is combined with the sensitivity as determined in Step 2B to determine the risk of dust impacts with no mitigation applied. **Table 16** provides the risk ranking for dust impacts from construction activities for each scale of activity as listed in **Table 12**.

Table 16 Risk of dust impacts (for dust soiling and human health impacts)

Activity	Surrounding area sensitivity	Dust emission magnitude		
		Large	Medium	Small
Demolition	High	High	Medium	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Negligible
Earthworks	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Negligible
Construction	High	High	Medium	Low
	Medium	Medium	Medium	Low
	Low	Low	Low	Negligible
Trackout	High	High	Medium	Low
	Medium	Medium	Low	Negligible
	Low	Low	Low	Negligible

7.2.3 Step 3 – Management Strategies

The outcome of Step 2C is used to determine the level of management that is required to ensure that dust impacts on surrounding sensitive receptors are maintained at an acceptable level. A high or medium-level risk rating suggests that able management measures must be implemented during the Project.

7.2.4 Step 4 – Reassessment

The final step of the IAQM methodology is to determine whether there are significant residual impacts, post mitigation, arising from a proposed development. The IAQM guidance states:

For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be "not significant".

Based on this expectation, as well as experience within Australia, construction activities with targeted mitigation measures can achieve high degrees of dust mitigation which significantly reduce dust impacts to a negligible level.

8.0 Operational Assessment Methodology

The air dispersion model used to assess the emissions from the proposed generator stacks at the Macquarie Park site was prepared in accordance with the NSW EPA's Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Approved Methods). The modelling approach and inputs are described in the following sections.

8.1 Model Selection

As discussed above, the area surrounding the proposed Data Centre is best characterised as a mixture of commercial buildings and high-rise residential towers which are bordered by low-rise residential areas beyond approximately 300 m – 800 m from the Data Centre site. Within the commercial / high rise residential area close to the Data Centre site, there are a large number of buildings which range in height from approximately 5 m to over 40 m in elevation. The buildings create a highly complex urban canyon region complicating the analysis of plume dispersion. In addition, the buildings on the Data Centre site itself are expected to form a significant urban canyon which also has the potential to affect the dispersion of plumes generated from the testing of the Data Centre diesel generators.

Given the potential urban canyons and complex air flows formed around the Data Centre buildings, the use of a complex dispersion model able to predict concentrations in the near field is required. The common models used for complex modelling scenarios (AERMOD and CALPUFF) do not perform well within 100 m, in highly complex terrain or around buildings and therefore an alternative model is proposed. Given its ability to provide dispersion concentrations on micro-scale grids within complex building environments, the GRAL model has been used for this assessment.

GRAL is a Lagrangian Particle model developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria specifically to assess the dispersion of pollutants from roadways and tunnel portals (Oettl et al., 2002; Oettl et al., 2003; Oettl et al., 2005). GRAL has been extensively evaluated against experimental data from five different tunnel portals both in flat and complex terrain, with high and low traffic volumes, namely the Enrei, Hitachi and Ninomiya tunnels in Japan (Oettl et al., 2003), and the Enrentalerbergtunnel in Austria (Oettl et al., 2002). GRAL has also been compared to other models (ADMS, LASAT, MUMO).

AECOM has been in direct contact with GRAZ University and the GRAL developers to discuss the model's evaluation procedures, scientific basis and application in Australia. Through this relationship, the model and its evaluation data have been thoroughly reviewed, providing confidence in the use of the model for projects in Australia.

Of particular note, the GRAL model has algorithms which effectively consider the flow of air over buildings which form complex building wakes which affect the dispersion of plumes. This is a particular advantage over Gaussian plume models in this particular application given the short generator stacks situated on top of the Data Centre building.

It is acknowledged however that the GRAL modelling system is not as well-known as the CALPUFF or AERMOD modelling system in Australia. On this basis, a comparison run for CALPUFF was run to compare the results from the GRAL model (despite the GRAL model being much more suited to this application than CALPUFF). This comparison has been included as **Appendix C**.

8.2 GRAL/GRAMM Modelling Inputs

The GRAMM / GRAL model and the CALMET / CALPUFF requires a range of data inputs that need to be defined prior to running the model. These data can be broadly separated into the following categories:

- Terrain data;
- Land use data;
- Building data;
- Meteorological data;

- Receptor locations; and
- Source emissions data.

The dispersion modelling process adopted for this assessment, including all input data and output data is presented in **Figure 13**. The dispersion modelling inputs used in this assessment have been described in **Section 8.2.1** to **Section 8.2.7.** Dispersion model results have been discussed in **Section 10.0**.

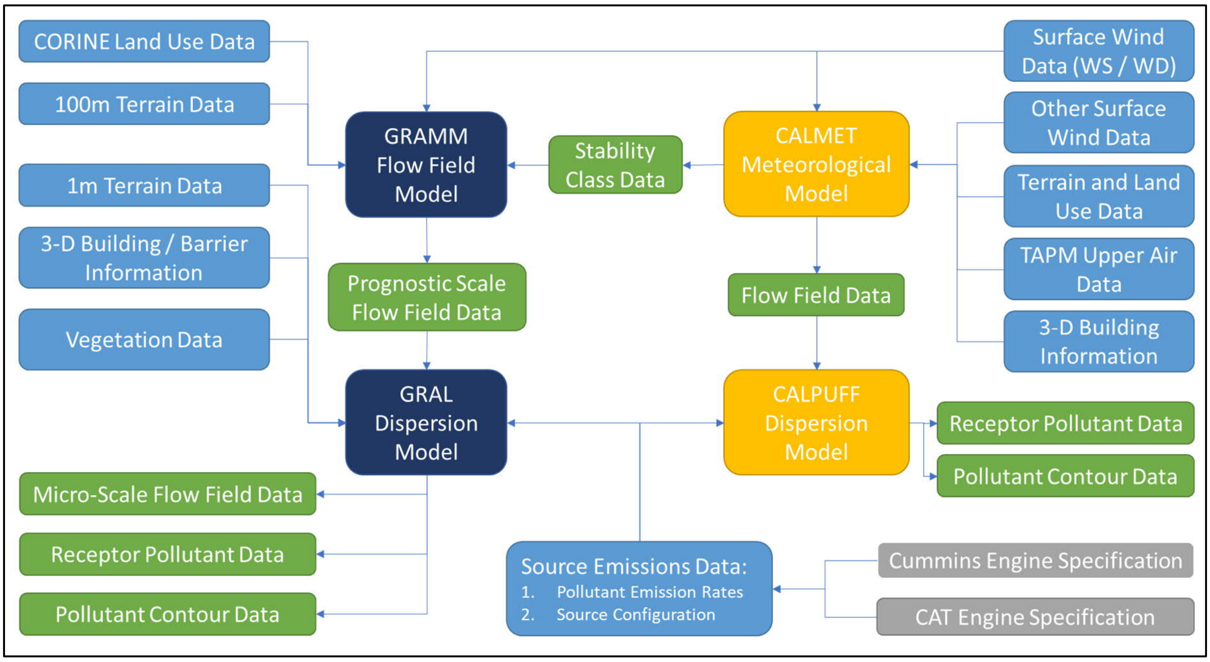


Figure 13 Site Model Program and Input Flow Chart

8.2.1 Terrain Data

Terrain data has been extracted for both the CALMET meteorology development, the GRAMM meteorological data development and the GRAL flow field development. Terrain information for the CALMET model run has be provided in **Appendix D**, with the terrain data used for the GRAMM and GRAL models discussed below.

Terrain data for the modelling assessment was extracted for the GRAMM and GRAL modelling domains from 1 m NSW Government Spatial Services Digital Elevations Models (DEMs) database. For the GRAMM domain the 1 m DEMs were resampled to a 5 m resolution to account for the large size of the GRAMM domain. 5 m resolution data is still considered to be very high-resolution data for the GRAMM domain, which produces a 100 m resolution wind field over the entire GRAMM modelling domain. The terrain data used by the GRAMM model to develop the regional wind fields is displayed in **Figure 14** (along with the GRAL domain and the buildings included in the GRAL modelling run for context).

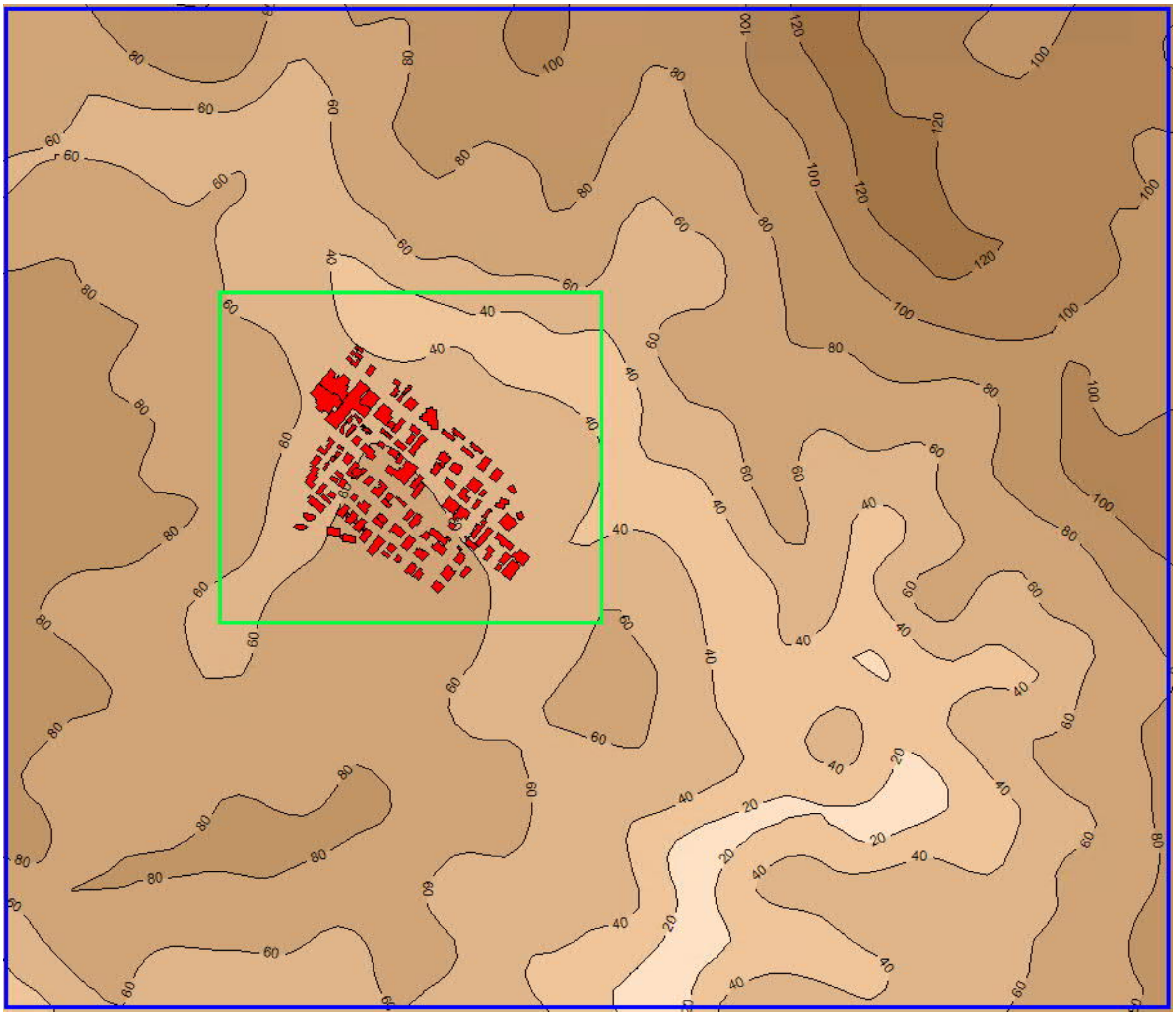


Figure 14 GRAMM Terrain Data Representation

The GRAL model also produces wind fields for the dispersion calculations. GRAL wind fields are based on GRAMM wind fields as an initial guess with the winds flows around the obstacles (buildings, vegetation etc) calculated before calculations are undertaken to calculate the plume dispersion.

A 1 m terrain resolution was used by this study due to the comparably small GRAL modelling domain and the level of detail required to accurately resolve wind flows around very close buildings on a small scale. A plot showing the terrain included in the GRAL modelling has been provided in **Figure 15**, along with the buildings included in the dispersion modelling.

Figure 15 GRAL Terrain Data Representation

Terrain data for the CALMET model comparison has been obtained from the SRTM 30 m Global Terrain Database to establish the overall terrain heights used to generate the meteorology extracted from CALMET for use in the GRAMM model and the CALPUFF model. The terrain for the CALMET domain is discussed in **Appendix D**.

The terrain within the immediate study area within the Macquarie Park commercial area is flat, with terrain influenced by the Lane Cove River, which meanders from the southeast of the modelling domain around the northern edge of the domain. Further to the north of the Lane Cove river, the terrain is dominated by plateaus extending away from the Lane Cove River.

8.2.2 Land Use Data

Changes in land use can affect how air moves across the earth's surface with factors such as surface roughness, soil moisture, albedo, and heat conductivity all influencing wind speed and direction over the modelling domain. A more detailed description of the land use scheme use and the effects of the different settings is provided in the GRAL documentation.

GRAMM model uses the CORINE land use scheme which outlines land uses according to 44 different categories as defined in the GRAMM user manual. Data for use in the modelling was extracted using GIS techniques from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) "Catchment Scale Land Use of Australia", December 2018 version. Cross checks with recent satellite imagery showed a good match with the ABARES data across the Macquarie Park suburb and surrounding areas.

The land use categories which were applicable for the GRAMM domain created for this assessment are provided in **.**

Table 17. Spatial distribution of land use in the GRAMM domain are presented in **Figure 16**.

Table 17 CORINE Land Use Categories – GRAMM Domain

Corine Category Number	Corine Category Description
111	Continuous urban fabric
112	Discontinuous urban fabric
121	Industrial or commercial units
122	Road and rail networks and associated land
141	Green urban areas
313	Mixed forest
321	Natural grasslands
511 - 522	Water courses / bodies / estuaries

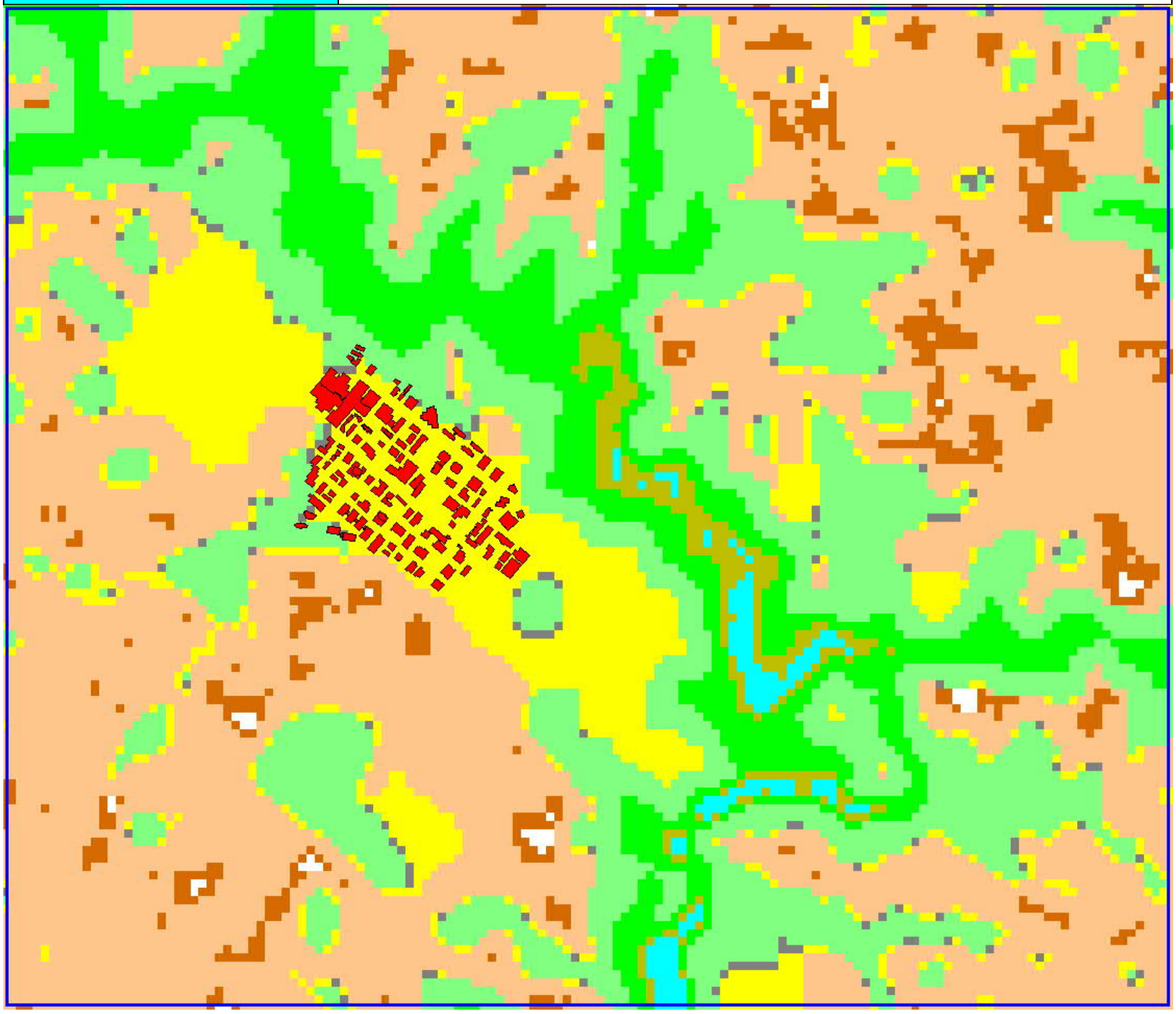


Figure 16 GRAMM Land Use Data Representation – This is a Diagrammatic Representation of data only

8.2.3 Building Data

Building data are critical to the flow of air around the buildings at the Data Centre site and the Macquarie Park commercial area. Buildings need to be considered as part the air quality assessment to ensure the effect of the buildings on the plume dispersion is appropriately considered. GRAL accepts building heights, ground elevation, building vertices, and roof area. These data were obtained from site drawings, aerial photography and observations of buildings in the Macquarie Park suburb. The locations of buildings used in GRAL are presented graphically in **Figure 17**. Note that the single level houses surrounding the commercial area of Macquarie Park were not included in the model. Only large commercial and multi storey residential buildings were model incorporated into the GRAL model.

All Macquarie Park Buildings Viewed from the South

Data Centre Building Viewed from the East

Data Centre Building Viewed from the South

Figure 17 Buildings included in the GRAL domain

8.2.4 Dispersion Meteorology

Meteorological data is vital to a dispersion modelling project in that it defines the direction that the pollution is transported from the source, the degree of mixing occurring and size of the plume that moves away from the source.

GRAL requires a single meteorological data file incorporating the following hourly meteorological data:

a. Wind speed;

b. Wind direction; and

c. Atmospheric stability class.

To generate representative meteorological data for the region, a methodology was adopted that used the CALMET meteorological model to generate a wind field over the Macquarie Park area from which a representative meteorological data file could be extracted for the Data Centre location.

Surface station meteorological data is the primary source of input meteorological data for dispersion models. Ideally surface station data are sourced from stations situated at or close to the subject site to ensure the meteorology is as representative of the subject site as possible. Three surface observation stations were used as input into CALMET, with the EES Macquarie Park Station and the Bureau of Meteorology stations at Sydney Olympic Park 9 km southwest of the site) and Fort Denison / Observatory Hill (10 km southeast of the site) used for the assessment. A wind rose showing the meteorology at the Macquarie Park monitoring location for all hours of the year and the daytime hours (time where Generator Testing is to occur), is shown in **Figure 18**. Given its proximity to the Data Centre site and the analysis undertaken in **Section 5.1**, the Macquarie Park EES station is considered to be the most appropriate station for use in dispersion modelling and has been adopted for use in both CALMET and GRAMM.

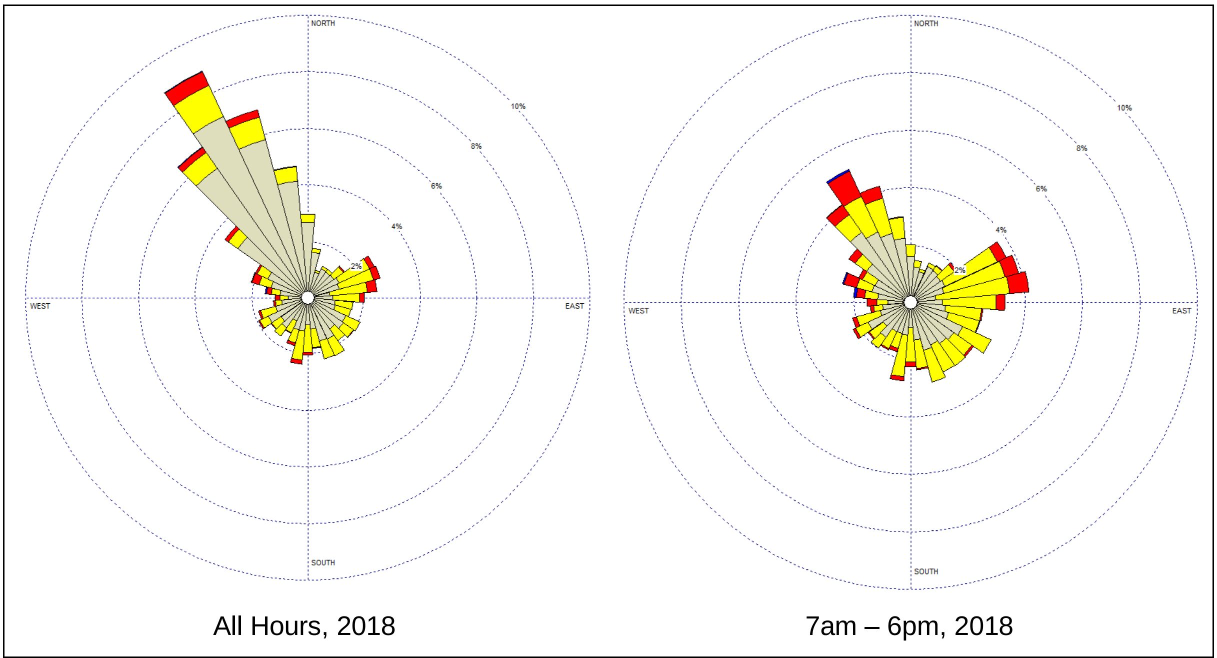


Figure 18 EES Macquarie Park Monitoring Data - 2018

To enable the generation of a region wide, gridded meteorological data file, the surface station data were combined with upper air data from The Air Pollution Model (TAPM) and entered into the CALMET model to generate a wind field across northern Sydney. A more detailed discussion of the CALMET model settings and assumptions is provided in **Appendix D**.

Stability Class data from the CALMET meteorological data file were extracted at the OEH Macquarie Park monitoring location. The wind speed and direction data from the Macquarie Park station were combined with the extracted stability class data to form the input meteorology for the GRAMM model. The GRAMM model was run in accordance with the settings outline in **Section 8.2.6**, producing a series of meteorological wind fields for each hour of the modelling period.

The wind field for the most frequent wind condition experienced for the modelling domain was extracted as an example of the win fields occurring during the year and is shown below in **Figure 19**. The GRAMM wind field showed that the winds across the Macquarie park area were generally consistent and unaffected by terrain or land use with only minor changes across the commercial area surrounding the Data Centre. Immediately to the north of the Macquarie Park commercial area however, the terrain and land use is more visibly influenced by the Lane Cove River which channels the winds down the valleys and gulley's leading into the river valley.

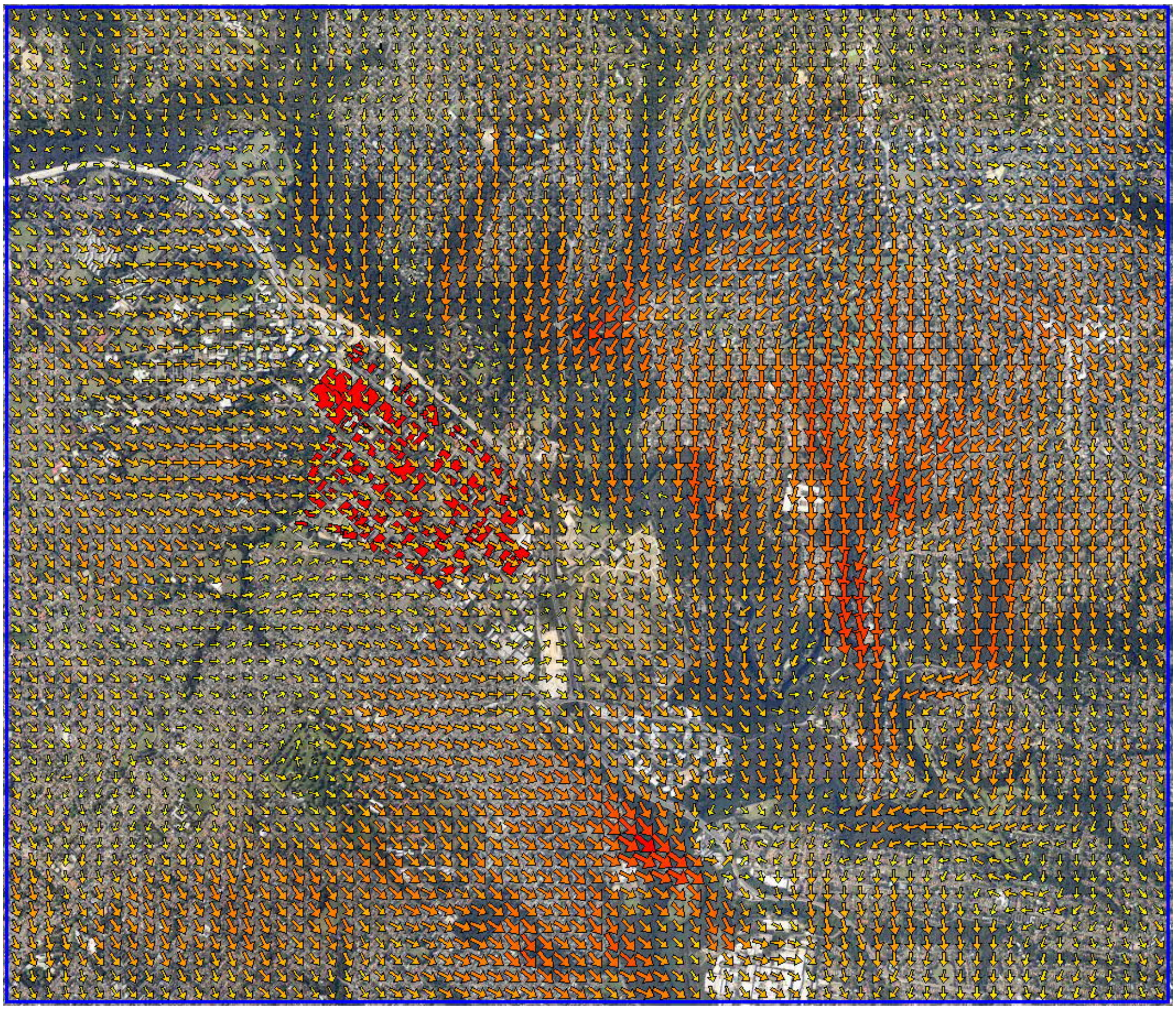


Figure 19 Predominant wind condition extracted from the GRAMM wind field data

8.2.5 Discrete Receptors

The NSW EPA defines sensitive receptors to be "*a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors*" (NSW EPA, 2016).

Historically, sensitive receptors have been positioned at locations where people are expected to live and spend significant periods of time and not at places of work. This historical definition is not considered to present an accurate reflection of the potential impacts that may occur from air pollutant sources present in many areas within NSW and as a result, sensitive receptors have been placed at locations where anyone may work or reside surrounding the proposed Data Centre generators. This includes receptors at elevations higher than the typical ground level receptors, with elevated or "flagpole" receptors added to the receptor list for consideration in the results.

Receptor locations included in the model are presented in **Figure 20**. Receptors were included for nearby commercial buildings along with the closest high-rise residences and single level dwellings along the boundary of the Macquarie Park commercial area. As the impacts from the diesel generators are expected to occur within close proximity to the Data Centre building (due to building wake generated by the building itself), **Figure 21** has been included to show a closer view of the Data Centre with receptor labels included for reference.

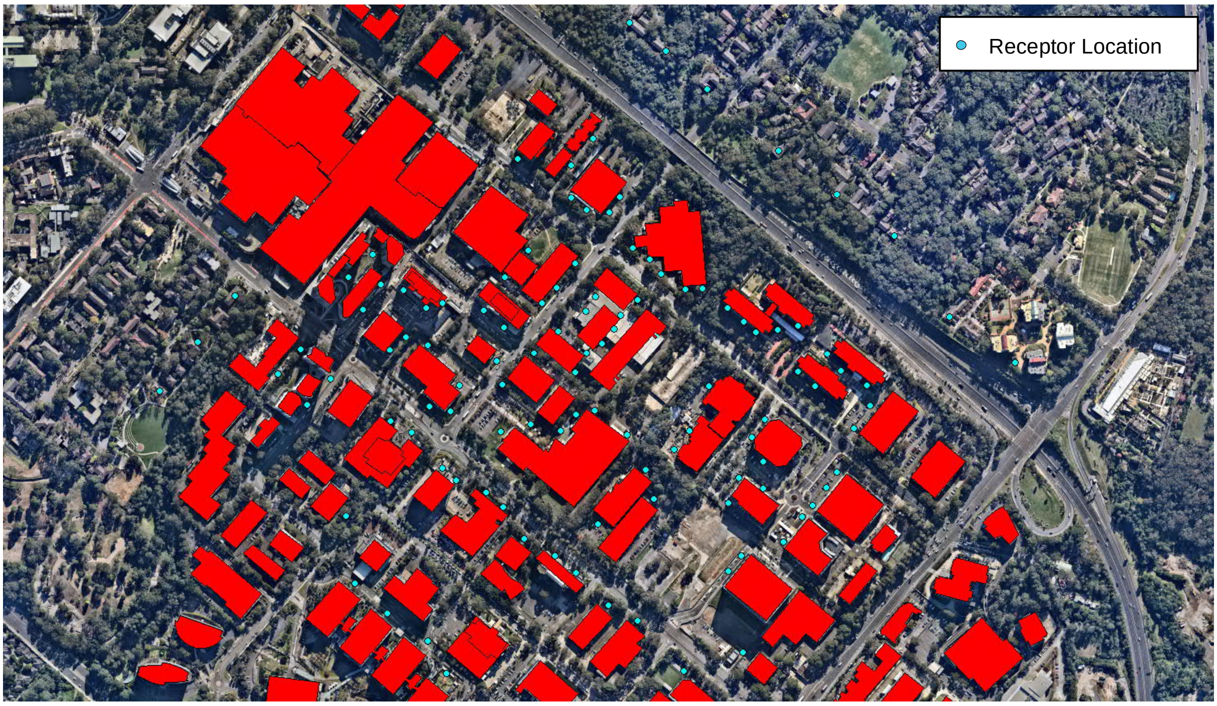


Figure 20 Locations of discrete receptors used in the model

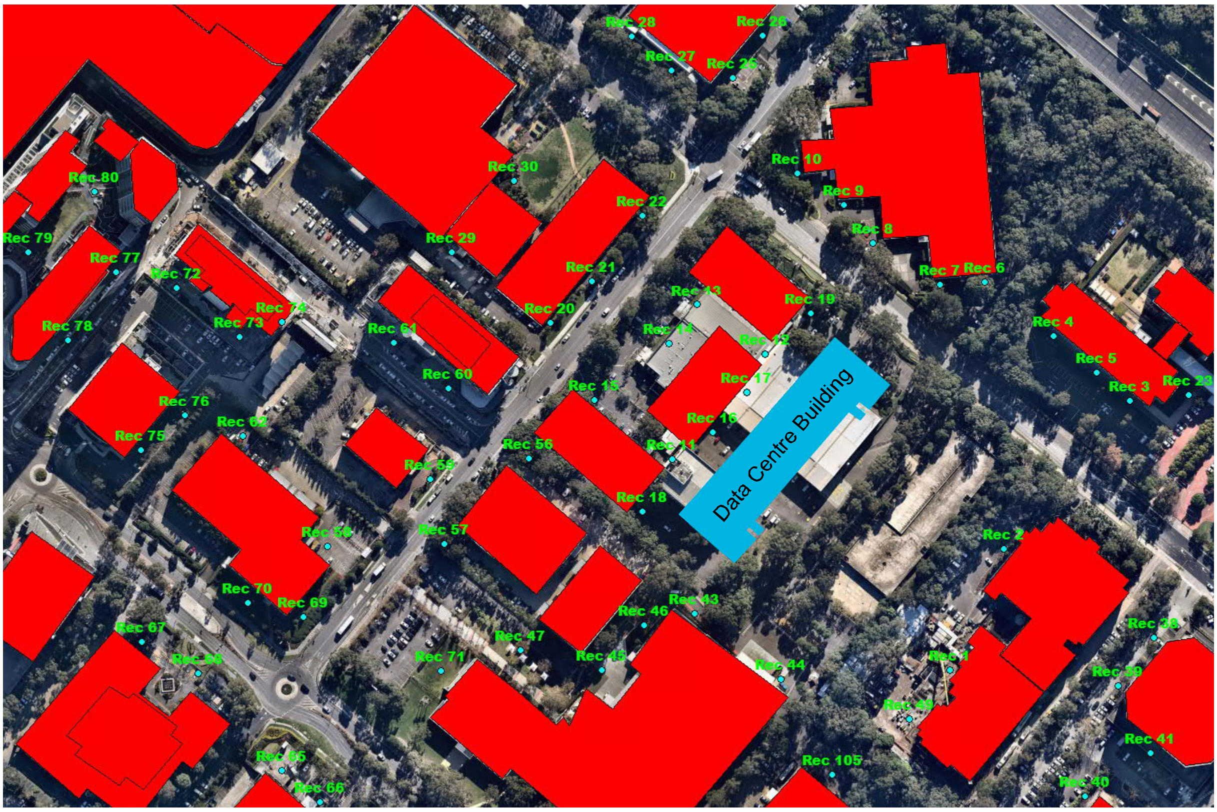


Figure 21 Discrete receptors close to the Data Centre

8.2.6 GRAMM Settings

GRAMM settings were selected based on available data and the settings outlined in the document "Recommendations when using the GRAL / GRAMM modelling system" (Government of Styria, 2017). Settings for the GRAMM modelling run are presented in **Table 18**.

Table 18 GRAMM modelling domain parameters

Parameter	Value
Meteorological grid domain	7 km x 6.0 km
Horizontal grid resolution	100 m
Reference grid coordinate (origin)	324000 m, 6257300 m
Vertical thickness of first layer	10 m
Number of vertical layers	15
Vertical stretching factor	1.25
Relative layer height	(Layer 15) 1107 m
Surface meteorology coordinates	325695 m, 6262275 m (data extracted from CALMET)
Simulation length	12 Months
Number of wind speed categories	8
Wind speed categories	0-0.5, 0.5-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6+ m/s
Number of meteorological conditions	755

When GRAMM is run there are several QA checks that need to be performed to ensure that the meteorological modelling performed by GRAMM is consistent with the meteorological inputs and that the model has not become numerically unstable. The settings listed in **Table 18** represent the post QA check settings which were considered acceptable to use for the modelling.

Table 19 GRAMM Quality Assurance

<table>
<tr><th rowspan="2">Land Use Data</th><th rowspan="2">Max Time Step (s)</th><th colspan="2">Relaxation Factors</th><th rowspan="2">No Cells At Boundary</th><th rowspan="2">Horizontal Grid Spacing</th><th rowspan="2">No. Met Conditions Modelled</th><th colspan="2">Number of Warning Messages</th></tr>
<tr><th>1</th><th>2</th><th>FMC</th><th>ISSP</th></tr>
<tr><td>CORINE</td><td>2</td><td>0.02</td><td>0.02</td><td>0</td><td>100</td><td>755</td><td>0</td><td>0</td></tr>
<tr><td colspan="9">FMC represents errors in the model where Final Mass Convergence (FMC) has not occurred possibly resulting in numerical instability
ISSP represent errors in the model where Internal Steady State Parameters were not met</td></tr>
</table>

The GRAMM run was acceptable from a data acceptability perspective with 100% of the wind conditions having no warning messages. Based on an analysis of the QA parameters the meteorological data is acceptable and producing results that can be used in this assessment.

8.2.7 GRAL Settings

GRAL settings were selected based on available data and the settings outlined in the document "Recommendations when using the GRAL / GRAMM modelling system" (Government of Styria, 2017). Settings for the GRAL modelling run are presented in **Table 18**.

Table 20 GRAL model settings

Parameter	Value
Flow field grid domain	2,295 m x 1,990 m
Horizontal grid resolution	5 m
Vertical thickness of first layer	2 m
Number of vertical layers	40
Vertical stretching factor	2-20m AGL – 1.02 20-50m AGL – 1.05 50-150m AGL – 1.10 150-250+m AGL – 1.20
Relative layer height	(Layer 40) 244 m
Particles per second	300
Surface roughness	0.5
Roughness of building walls	0.01m

GRAL computes wind flow fields around obstacles (buildings) for each of the wind conditions modelled by GRAMM. The most frequent wind condition (7.02% of modelled hours) is a light (0.4 m/s) west north westerly (315 degrees). The GRAL flow field for this wind condition at 10 m above ground level is presented above in **Figure 22**. Note how winds flow over buildings that are less than 10 m in height and are blocked by higher buildings.

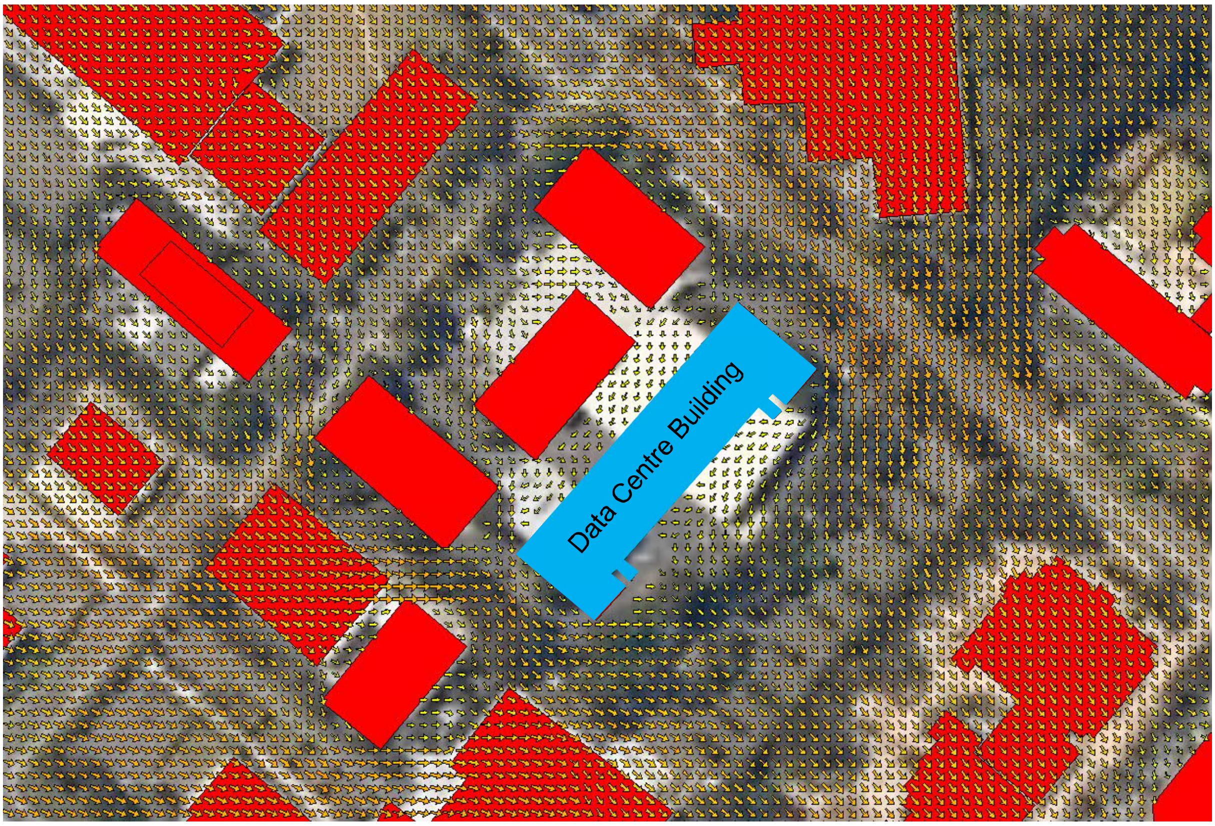


Figure 22 Predominant wind condition extracted from the GRAL flow field data at 10 m above ground level

8.3 Cumulative Assessment Methodology

Assessment of the potential impacts associated with modelled air pollutant concentrations includes a comparison with the NSW EPA criteria defined in **Section 4.0**. The pollutant concentrations need to be compared either in isolation (only due to the emissions from the modelled sources) or cumulatively (assuming the inclusion of background pollutant concentrations. Whether a pollutant needs to be examined in isolation or cumulatively depends on the following:

- Whether the pollutant is listed in Table 7.1 of the NSW EPA Approved Methods for Modelling. The pollutants listed in that table are required to be assessed cumulatively at the "*nearest existing or likely future off-site sensitive receptor*" and must include an analysis of both the incremental impact (in isolation form the background) and the cumulative impact. The impact must also be assessed using the 100^{th} percentile (maximum) concentration from the modelling; or
- If there is a known source of a pollutant close to the development that may influence the results. If there is no known source of pollution close to the development that may affect the predicted pollutant concentrations, then the pollutant must be assessed in isolation.

  Air toxic pollutants (Table 7.2a and Table 7.2b of the NSW EPA Approved Methods for Modelling) must be assessed "*At and beyond the boundary of the facility*" and the impact assessed either for the 100^{th} or 99.9^{th} percentile concentrations (depending on whether the assessment is a Level 1 or Level 2 impact assessment).

  Odorous air pollutants (Table 7.4a and Table 7.4b of the NSW EPA Approved Methods for Modelling) must be assessed "*At the nearest existing or likely future off-site sensitive receptor*" and the impact assessed either for the 100^{th} or 99.9^{th} percentile concentrations (depending on whether the assessment is a Level 1 or Level 2 impact assessment).

This assessment constitutes a Level 2 impact assessment given the following factors:

- The assessment uses meteorological data close to the proposed Data Centre site which has been correlated against long term meteorological data
- Emissions data are based on manufacturers specifications and are considered a reliable upper limit of expected emissions and engine performance;
- Site specific source characteristics and building data have been used in the assessment.

The cumulative methodologies that can be used for the assessment of air pollutants can be summarised as follows:

- ***Use of Statistical Background Data***. This approach assumes the addition of a predicted concentration at a receptor location with a statistical background concentration. The background statistic is assumed to be the 100^{th} percentile using this approach; or
- ***Use of Contemporaneous Background Data***. Contemporaneous background data assumes the pairing of predicted concentrations at a point in time with the predicted pollutant concentrations at that same point in time. Given the proximity of the background monitoring station to the Data Centre location, the use of contemporaneous data is an acceptable approach for the assessment of selected critical pollutants e.g. NO_X / NO_2 and $PM_{2.5}$.

  Note that although contemporaneous data for CO is available, the CO concentrations are expected to be very low, and as a result the 100^{th} percentile background CO concentration has been used for the 1-hour and 8-hour predictions.

Given the above discussion points, the cumulative assessment requirements for the modelled pollutants, where the pollutants need to be assessed and the reporting statistics required have been provided in **Table 21**.

Table 21 Cumulative Assessment Requirements

Pollutant	Cumulative Requirement	Receptor Assessment Location	Results Statistic	Assessed Background Statistic
NO_2	Yes	Nearest off-site receptor	Contemporaneous	Contemporaneous
CO	Yes	Nearest off-site receptor	100^{th} Percentile	100^{th} Percentile
$PM_{2.5}$	Yes	Nearest off-site receptor	Contemporaneous	Contemporaneous
Acetaldehyde	No	Nearest off-site receptor	99.9^{th} Percentile	No Background
Benzene	No	At and beyond the facility boundary	99.9^{th} Percentile	No Background
Formaldehyde	No	At and beyond the facility boundary	99.9^{th} Percentile	No Background
Toluene	No	Nearest off-site receptor	99.9^{th} Percentile	No Background
Xylene	No	Nearest off-site receptor	99.9^{th} Percentile	No Background
PAH as BaP	No	At and beyond the facility boundary	99.9^{th} Percentile	No Background

8.4 NO_X Conversion Methodology

Nitrogen oxides are produced in most combustion processes and are formed during the oxidation of nitrogen in fuel and nitrogen in the air. During high-temperature processes, a variety of oxides are formed, including nitric oxide (NO) and nitrogen dioxide (NO_2).

One of the challenges of modelling NO_x emissions is how to determine the amount of NO_2 at a receptor given that NO reacts (oxidises) in the atmosphere to form NO_2 over time. Early studies (Hegg *et al*., 1977) showed that the rate of oxidation is controlled by the rate of plume mixing rather than by gas reaction kinetics. Ozone is usually the chemical that is responsible for most of the oxidation, but other reactive atmospheric gases can also oxidise NO. CALPUFF assumes that the pollutants are inert, neutrally buoyant gases; i.e. the model does not account for any chemical transformations or heavy gas effects. As such, the transformation of NO_x to NO_2 needs to be done in the post-processing stage.

NO generally comprises 95% of the volume of NO_X at the point of emission. The remaining NO_X consists of NO_2. The conversion of NO to NO_2 requires ozone to be present in the air, as ozone is critical to photochemical reaction from NO to NO_2. Ultimately over time, however, much of the NO emitted into the atmosphere will be oxidised to NO_2 and then further to other higher oxides of nitrogen.

There are several methodologies outlined in the NSW EPA Approved methods document for the calculation of NO_2 concentrations from predicted NO_X concentrations. The two most common methods are:

1. Assumption of 100% of the NO_X reports as NO_2. This is a highly conservative assumption and should only be used in situations where emissions of NO_X are low; and
2. US EPA Ozone Limiting Method (OLM). The OLM assumes that approximately 10% of the initial NO_X emissions are emitted as NO_2. If the ozone (O_3) concentration is greater than 90% of the predicted NO_X concentrations, all the NO_X is assumed to be converted to NO_2, otherwise NO_2 concentrations are predicted using the equation $NO_2 = \{0.1 * NO_X + 46/48 * O_3\}$. This method assumes instant conversion of NO to NO_2 in the plume, which overestimates concentrations close to the source since conversion usually occurs over periods of hours. This method is described in detail in DEC (2005a).

The USEPA's Ozone Limiting Method (OLM) was used to predict ground-level concentrations of 1-hour NO_2 as part of the Data Centre AQIA. The background O_3 data from the Macquarie Park monitoring station (as discussed in **Section 5.2**) were used to convert the modelled NO_X concentrations into NO2 concentrations in accordance with the EPA approved OLM (Method 2, Level 2 Assessment; NSW EPA, 2016).

9.0 Emissions Inventory

Emissions data for the Diesel generators have been obtained from the generator data sheets provided by the manufacturers. As outlined in **Section 6.0**. there are several different engine settings that have been considered for this assessment. The engine settings that have been included are as follows:

- Full Power – engines at maximum power capacity
- Half Power – engines under load but not at full power
- Idle – engines assumed to be operating at 10% of full power capacity.

Data sheets for two generator sets have been provided for consideration in this assessment. The two generators are the CAT Model 3516E and the Cummins model C3000D5e w/QSK78-G15. Full specification sheets have been provided in **Appendix A**.

As discussed in **Section 2.2**, the stack emissions are centred around two stack bundle locations. In the interest of modelling efficiency, the modelling assumes a single stack represents all stacks either at the northern stack bundle or the southern stack bundle. Model results have been calculated for emission at both the northern and southern stack locations to ensure the different locations are considered in the assessment.

9.1.1 Stack Emission Characteristics

Stack characteristics included in the modelling for each of the selected engines is provided in **Table 22** and **Table 23**.

Table 22 CAT Model 3516E Engine Emissions

Parameter	Units	Full Load	1/2 Load	Idle
Generation Rate	EkW	2400	1200	240
Flowrate	Am^3/min	554.4	287.2	103.6
	Am^3/s	9.24	4.79	1.73
	Nm^3/min	180.00	83.50	43.80
	Nm^3/s	3.00	1.39	0.73
Fuel Usage[1]	L/hr	656.0	351.2	109.7
	kg/hr	545.8	292.2	91.3
Temperature	^oC	494.7	574.5	330.5
	K	767.9	847.7	603.7
Stack Diameter	m	500	500	500
Stack Velocity	m/s	47.1	24.4	8.8
[1] Diesel density of 0.832kg/L				

Table 23 Cummins model C3000D5e w/QSK78-G15Engine Emissions

Parameter	Units	Full Load	1/2 Load	Idle
Generation Rate	EkW	2538	1269	254
Flowrate	Am^3/min	489.3	341.1	122.7
	Am^3/s	8.15	5.69	2.04
	Nm^3/min	179.8	130.4	58.6
	Nm^3/s	3.0	2.17	0.98
Fuel Usage[1]	L/hr	597	345	93
	kg/hr	496.7	287.0	77.4
Temperature	ºC	470	441	299
	K	743.15	714.15	572.15
Stack Diameter	m	500	500	500
Stack Velocity	m/s	41.5	29.0	10.4
[1] Diesel density of 0.832kg/L				

9.1.2 Emission Concentrations

Emission concentrations and emission rates for the pollutants of concern (NO_X, CO, VOC and PM) have been extracted from the generator specifications and the concentrations combined to determine the emission rates for the generators during the different operational modes i.e. 100%, 50% and 10% operational capacity.

It should be noted that the pollutant emission concentrations provided in the generator specifications have been reported at a standard 5% oxygen value (common reporting standard for diesel generators). To determine the actual concentration at stack conditions (to enable mass emission rate calculations), the measured stack oxygen percentage has been used to convert the standard oxygen basis to the stack oxygen basis (which varied for each of the different operational mode).

Emission rates for PAH were calculated based on emission factors sourced from the NPI Emission Estimation Technique Manual (EETM) for Combustion engines (NPI, 2008). Emission rates for each operational mode was calculated based on the NPI EETM PAH emission factors and the expected power generation rate (in kWh). The emission concentration was calculated based on the PAH mass emission rate and the volumetric flow rate corresponding to the particular operational mode. Note that no oxygen corrections were made for the PAH emission concentration calculations

All pollutant emission concentrations and emission rates are shown in **Table 24** and **Table 25** for the CAT and Cummins generators respectively.

Table 24 CAT Model 3516E Engine Emissions

Parameter	Units	Full Load	1/2 Load	Idle
Concentration at Normalised Stack Conditions and Reference O_2[1,3]				
Oxides of Nitrogen (NO_X)	mg/Nm^3	1877.3	1855.3	3786.6
Carbon Monoxide (CO)	mg/Nm^3	309.1	615.4	865.3
Volatile organic Compounds (VOC)	mg/Nm^3	12.7	12.9	119
Particulate Matter (as $PM_{2.5}$)	mg/Nm^3	15.4	33.5	14.2
Stack O_2	%	9.4	7.6	13.1
Concentration at Normalised Stack Conditions and Measured O_2				
NO_X	mg/Nm^3	1361.0	1553.8	1869.6
CO	mg/Nm^3	224.1	515.4	427.2
VOC	mg/Nm^3	9.2	10.8	58.8
$PM_{2.5}$	mg/Nm^3	11.2	28.1	7.0
Emission Rates for PAH				
Polycyclic Aromatic Hydrocarbons (PAH)		0.00000000006 (kg TEQ/kWh)		
Emission Rates	kg/hr	0.00000014	0.000000072	0.000000014
Concentration	mg/Nm^3	0.000013	0.000014	0.000005
Emission Rates (per Generator)				
NO_X	kg/hr	14.70	7.78	4.91
CO	kg/hr	2.42	2.58	1.12
VOC	kg/hr	0.099	0.054	0.154
$PM_{2.5}$	kg/hr	0.121	0.141	0.018

[1] Emissions Data from the "Performance Data - 3516E" Data Sheet from CAT
[2] mg/Nm^3 levels are corrected to 5% O_2

Table 25 Cummins model C3000D5e w/QSK78-G15 Engine Emissions

Parameter	Units	Full Load	1/2 Load	Idle
Concentration at Normalised Stack Conditions and Reference O_2[1,2,3]				
Oxides of Nitrogen (NO_X)	mg/Nm^3	2884	1382	1878
Carbon Monoxide (CO)	mg/Nm^3	268	138	448
Volatile organic Compounds (VOC)	mg/Nm^3	73	105	271
Particulate Matter (as $PM_{2.5}$)	mg/Nm^3	17	21	49
Stack O_2[3]	%	9	9	9
Concentration at Normalised Stack Conditions and Measured O_2				
NO_X	mg/Nm^3	2163.0	1036.5	1408.5
CO	mg/Nm^3	201.0	103.5	336.0
VOC	mg/Nm^3	54.8	78.8	203.3
$PM_{2.5}$	mg/Nm^3	12.8	15.8	36.8
Emission Rates for PAH				
Polycyclic Aromatic Hydrocarbons (PAH)		0.00000000006 (kg TEQ/kWh)		
Emission Rates	kg/hr	0.000000152	0.000000076	0.000000015
Concentration	mg/Nm^3	0.0000141	0.0000097	0.0000043
Emission Rates (per Generator)				
NO_X	kg/hr	23.33	8.11	4.95
CO	kg/hr	2.17	0.81	1.18
VOC	kg/hr	0.591	0.616	0.714
$PM_{2.5}$	kg/hr	0.138	0.123	0.129

[1] Emissions Data from the "Performance Data - 3516E" Data Sheet from CAT
[2] mg/Nm^3 levels are corrected to 5% O_2
[3] Stack Oxygen not available. Assumed to be 9%

9.1.3 Comparison with Clean Air Regulation Concentration Values

As discussed above in **Section 3.2.2**, the Clean Air Regulation stack criteria are generally only applicable to Scheduled Premises and whether a facility constitutes a Scheduled premise is based around several operational criteria, which for this particular development are not triggered.

As outlined in **Section 3.2.2**, there are a small number of general criteria which are included in the regulation which apply to Non-Scheduled Premises. Schedule 6 of the Clean Air Regulation lists small number of limits against which the above generator emissions have been compared. **Table 26** lists the pollutants included in Schedule 6 of the Clean Air Regulation and makes a comparison with the particulate concentrations included above in **Table 24** and **Table 25**.

Note that PAH and NO_X do not have a relevant limit against which to compare their emissions. As such no comparison has been made.

Table 26 Comparison of Emission Concentrations with Schedule 6 of the Clean Air Regulation

Pollutants	Clean Air Regulation Criteria[1]	Operational Scenarios	Engine Type	Total Particulate Concentration
Solid Particles	100 mg/m^3	100% Capacity	CAT 3516E	15.4
		50% Capacity		33.5
		10% Capacity		14.2
		100% Capacity	Cummins C3000D5e w/QSK78-G15	17.0
		50% Capacity		21.0
		10% Capacity		49.0

[1] Given the Data Centre facility is a new facility, it is designated as a Group C facility.

10.0 Results

10.1 Construction Assessment

The exact quantities for excavation and the number of on-site vehicles etc are not yet known for this project. However to allow an estimate of the likely dust impacts from construction, a best estimate based on experience at of the locations and the size of the proposed construction have been used to define the magnitude of impacts outlined in **Section 10.1.2**.

10.1.1 Stage 1 Screening Assessment

An initial screening assessment was undertaken to identify whether there were any human receptors within 350 m of the boundary or within 50 m of the route used by construction vehicles. A 350 m screening line was drawn from the Data Centre site boundary which is shown in **Figure 23**. This line shows that there are several residential receptors within the 350 m line and as such the Stage 2 assessment was triggered.

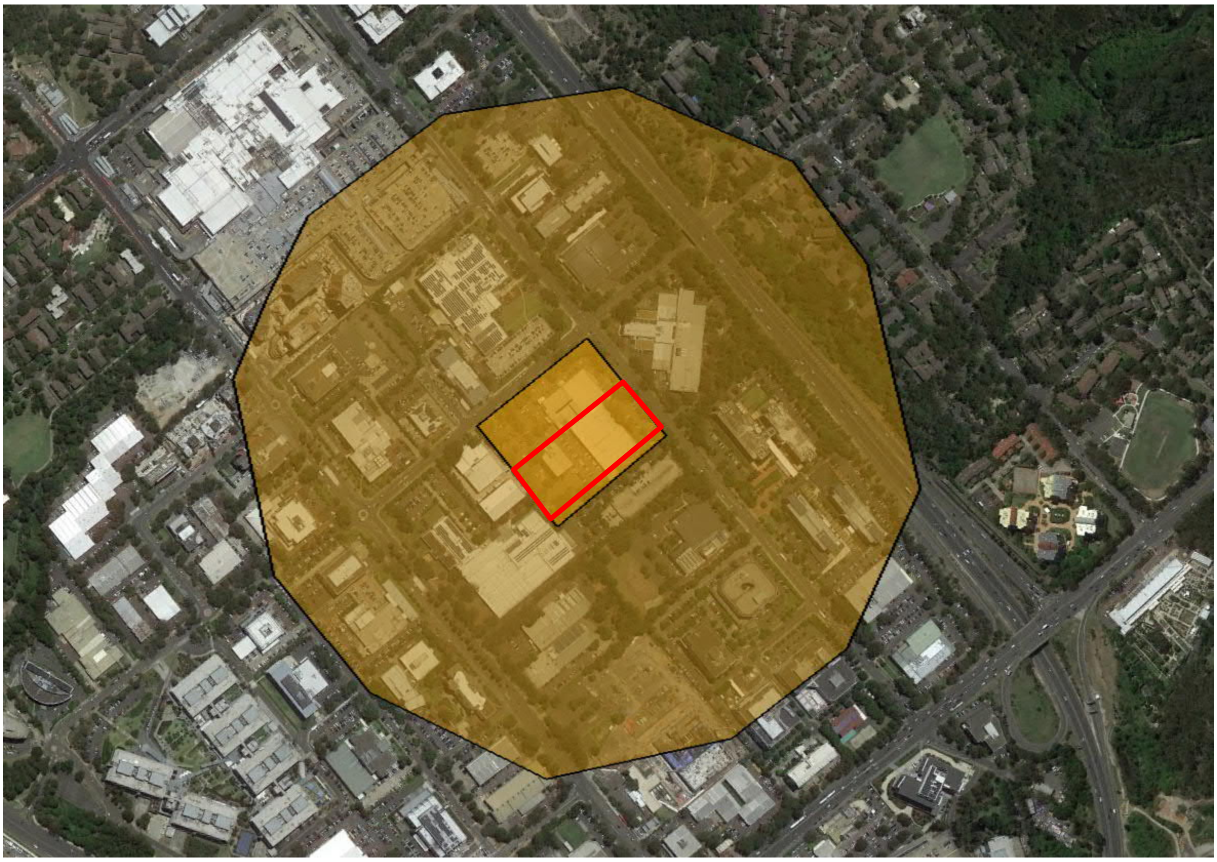


Figure 23 350m Receptor Screening Line

10.1.2 Stage 2 Assessment

The Stage 2 assessment considers the Data Centre construction footprint as shown as a red box in **Figure 23**. The construction activity magnitudes and dust sensitivities for the different construction activities are provided in **Table 27** and are based on the following assumptions:

- Demolition volume was estimated to be in the range of between 20,000 and 50,000 m^3 of construction material.
- Earthworks volume for the construction site was estimated to be between 52,000 m^3 and 60,000 m^3 with approximately 49,000 m^3 to 57,000 m^3 to be exported from the site.
- Total construction site area was estimated to be 14,500 m^2.
- Between 5-10 heavy vehicles are expected to be active at any one time.

- Construction activities for the Data Centre building alone was estimated to be over 100,000 m^3 of building volume.
- Trackout for the site was estimated to consist of from 10 – 50 heavy duty vehicle loads per day during the construction period.

There are a small number of high sensitivity residential and medium sensitivity commercial buildings within 350 m from the construction site boundary. The high sensitivity receptors however were located greater than 100 m from the construction site and the medium sensitivity receptors less than 20 m from the construction footprint resulting in a dust soiling sensitivity rating of medium.

Given the background PM_{10} concentration of 17.4 $\mu g/m^3$ and the distance to high and medium sensitivity receptors, the sensitivity to human health effects for annual average PM_{10} was rated as low.

The potential risks for the overall project were found to be “Medium” to “Low” for construction activities.

Table 27 Summary of unmitigated risk assessment for Data Centre construction activities

Activity	Step 2A: Potential for dust emissions	Step 2B: Sensitivity of area		Step 2C: Risk of unmitigated dust impacts	
		Dust soiling	Human health	Dust soiling	Human health
Demolition	Medium	Medium	Low	Medium	Low
Earthworks	Large	Medium	Low	Medium	Low
Construction	Large	Medium	Low	Medium	Low
Trackout	Medium	Medium	Low	Low	Low

Given the unmitigated risk rating of low to medium, standard mitigation measures designed to minimise the generation of dust on construction sites are recommended.

10.1.3 Non-Construction Source Emissions

The source of non-construction dust emissions during the Project construction phase would be due to the combustion of diesel fuel by heavy vehicles, mobile construction equipment and stationary equipment such as diesel generators. Emissions are expected to depend on the nature of the emissions source i.e. size of the equipment, usage rates, duration of operation etc. Pollutants emitted by construction vehicles include carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), nitrous oxides (NO_2), sulphur dioxide (SO_2), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

Given the typically transitory nature of construction site mobile equipment, vehicle numbers and the commonly applied mitigation measures expected to be incorporated into the operation of the equipment, adverse air quality impacts from the operation of construction equipment are not expected. On this basis, no further quantification of the potential impacts has been undertaken.

10.1.4 Construction Mitigation Measures

Emissions of air pollutants from construction activities can be mitigated using a range of physical or operational measures designed to minimise both the generation and transport of pollutants away from source of the emissions. In terms of dust emissions from the Project, the objective of the mitigation measures is to ensure the Project meets a range of air quality performance outcomes. If the outcomes are met, it is expected that the Project would achieve an acceptable level of dust generation for the construction activities and minimise adverse impacts on surrounding receptors (receptors refer to residential premises, hospitals, schools etc).

The air quality performance outcomes for the construction phase of the Project are as follows:

- no visible dust moving across the construction footprint boundary
- no unnecessary vehicle combustion emissions
- no soil trackout onto public roads

- no complaints from receptors in relation to dust emissions.

The performance outcomes would be addressed through the development of a Construction Air Quality Management Plan (CAQMP). A list of mitigation measures which would be implemented as a minimum to achieve the above performance outcomes are provided below in **Table 28**. Note that this list of measures is a minimum requirement for the Project and additional measures may be required to further reduce potential dust emissions.

Table 28 Mitigation Measures

ID	Performance outcome to be achieved	Mitigation measure
AQ1	No visible dust moving off-site No soil trackout onto public roads No complaints from receptors in relation to dust emissions	Daily construction activities should be planned to take into account the expected weather conditions for each workday. Regular dust observations to be undertaken of active excavation or stockpiling areas. Aim is to ensure visible dust is not moving offsite and that any areas needing additional measured be identified early. Records of observations should be compiled to enable the demonstration that dust is being managed in an ongoing manner. Records should include (as a minimum) the following: • observation date and time • area being inspected • level of dust being generated • meteorological conditions when observation occurred • mitigation measures undertaken.
AQ2	No visible dust moving off-site.	Minimise exposed surfaces, such as stockpiles and cleared areas, including partial covering of stockpiles where practicable.
AQ3	No visible dust moving off-site.	Implement dust suppression measures on exposed surfaces, such as watering of exposed soil surfaces, dust mesh, water trucks and sprinklers to minimise dust generation.
AQ4	No visible dust moving off-site.	Implement dust suppression measures, such as watering, water trucks and sprinklers to minimise dust generation during demolition activities.
AQ5	No soil trackout onto public roads.	Establish defined site entry and exit points to minimise tracking of soil on surrounding roads. Use wheel washes or shaker grids where the risk of off-site trackout of dirt is identified.
AQ6	No visible dust moving off-site No soil trackout onto public roads.	Cover heavy vehicles entering and leaving the site to prevent material escaping during transport.
AQ7	No visible dust moving off-site No unnecessary vehicle combustion emissions.	Keep vehicles and construction equipment operating on site well maintained and turned off when not operating (minimise idling on the site).
AQ8	No visible dust moving off-site.	Minimise the handling of spoil when excavating and loading of vehicles.

10.1.5 Determination of Significant Effects

As indicated in the IAQM documentation, "*For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant'*". With the implementation of mitigation measures, the Medium risk indicated above is expected to be reduced to produce a residual effect which is not significant.

The final determination of "not significant" is dependent on the implementation of proper design and implementation of dust mitigation measures. To ensure the measures are adequately implemented, an air quality management plan needs to be developed as part of the construction planning documentation.

10.2 Operational Assessment

The results of the dispersion modelling have been presented through predicted concentrations at sensitive receptors and concentration contours for the worst-case emission hours. The following points should be noted when viewing the results:

- Results presented in **Table 29** show the predicted pollutant concentrations for the operation of the Data Centre facility. The highest pollutant concentrations predicted for either the 15 minute or 1-hour operation of a single generator has been presented.
- Concentrations for the different pollutants have been reported as either the maximum concentration (NO_2, CO and $PM_{2.5}$) or the 99.9th percentile concentration (Acetaldehyde, Benzene, Formaldehyde, Toluene, Xylene and PAH as BaP), as per the requirements in the NSW EPA reporting requirements from the Approved Methods for Modelling.
- The predicted ground level concentrations have been compared against the relevant air quality criteria for the modelled pollutants. Results are expressed as the maximum incremental ground level concentrations predicted at a receptor location (either sensitive receptor or at or beyond the boundary) for comparison with the EPA criteria.
- The results in **Table 29** represents ground level receptor concentrations only. Receptor concentrations for all receptor levels modelled (0.5 m, 5 m, 10 m and 15 m above ground level) have been included as **Appendix E**).

It is also critical to the assessment to understand that as the Data Centre emergency generators do not operate continuously, the calculated statistics for comparison with the NSW EPA criteria need to be carefully calculated to ensure the results are both representative of worst-case conditions, but also are not unrealistically high. A description of the statistics calculated for this project are provided in **Appendix F**.

As with the statistical values outlined above, the plotting of concentration contours is difficult due to the intermittent nature of the emergency generator emissions. To show the expected plume dispersion however, a selection of contours has been presented which represent the worst case 1-hour concentration contours for NO_2 and CO, the worst case single hourly NO_2 concentration along with the $PM_{2.5}$ 24-hour concentration for both the CAT and Cummins generators. Contours for individual VOC species and PAHs have not been presented due to their extremely low predicted concentrations.

Given that the emission rates and predicted concentrations for the emergency generators operating at 50% capacity represent the highest expected emission rates during maintenance operations, the 1-hour maximum concentration contours have been plotted for this generator operational mode only. Plumes from both the northern and southern stack bundles have been presented.

The 24-hour $PM_{2.5}$ contours represent the expected worst-case 24-hour period during the year.

Table 29 Project Predictions

Pollutant	Averaging Time	CAT Engine		Cummins Engine		Criteria	Reference
		Maximum GLC	Cumulative	Maximum GLC	Cumulative		
NO_2	1 Hour Max	185.6	193.1[1]	187.7	195.2[1]	246	NSW EPA
	Annual	5.4	15.9	6.0	16.5	62	NSW EPA
$PM_{2.5}$	24 Hour Max	1.3	58.4[1]	1.2	58.4[1]	25	NSW EPA
	Annual	0.007	7.0	0.006	7.0	8	NSW EPA
CO	1 Hour Max	188	5248	117.8	5,177.8	30,000	NSW EPA
	8 Hour Max	70.5	2765	44.2	2,738.5	10,000	NSW EPA
VOC							
Acetaldehyde	99.9th Percentile	0.00067	-	0.0072	-	42	NSW EPA
Benzene		0.021	-	0.23	-	29	NSW EPA
Formaldehyde		0.0021	-	0.023	-	20	NSW EPA
Toluene		0.0075	-	0.081	-	360	NSW EPA
Xylene		0.0052	-	0.056	-	190	NSW EPA
PAH as BaP	99.9th Percentile	0.0000028	-	0.000030	-	0.4	NSW EPA

[1] Cumulative concentration calculated using contemporaneous background data

Table 30 Project Prediction comparison with changes to NO_2 criteria

Pollutant	Averaging Time	CAT Engine		Cummins Engine		Criteria	Reference
		Maximum GLC	Cumulative	Maximum GLC	Cumulative		
NO_2	1 Hour Max	185.6	193.1	187.7	195.2	185	NEPM 2020-2025
						164	NEPM 2025+

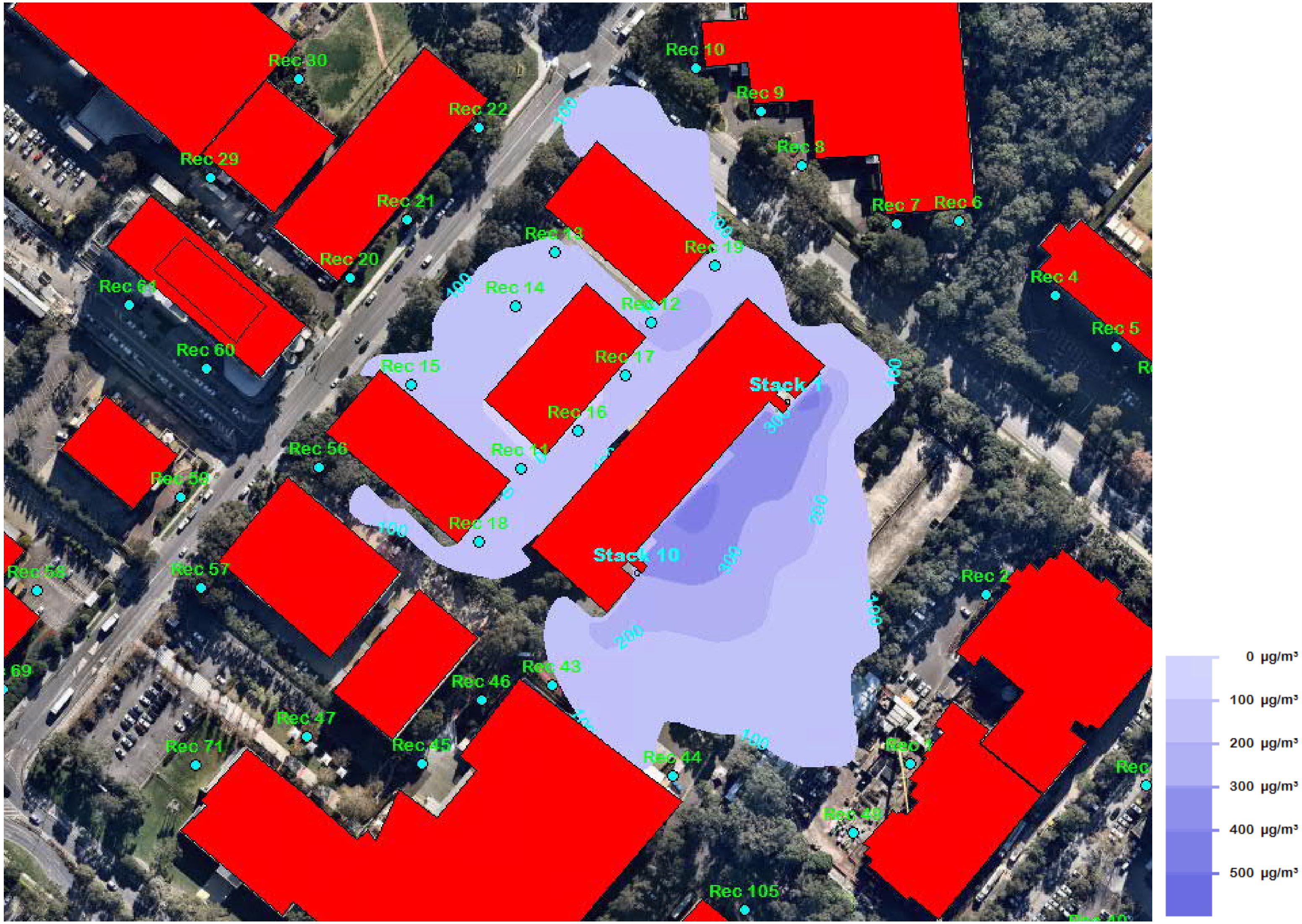


Figure 24 Maximum 1 Hour NO_2 concentration, Stack 1 (North Side of Building), All Hours, CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

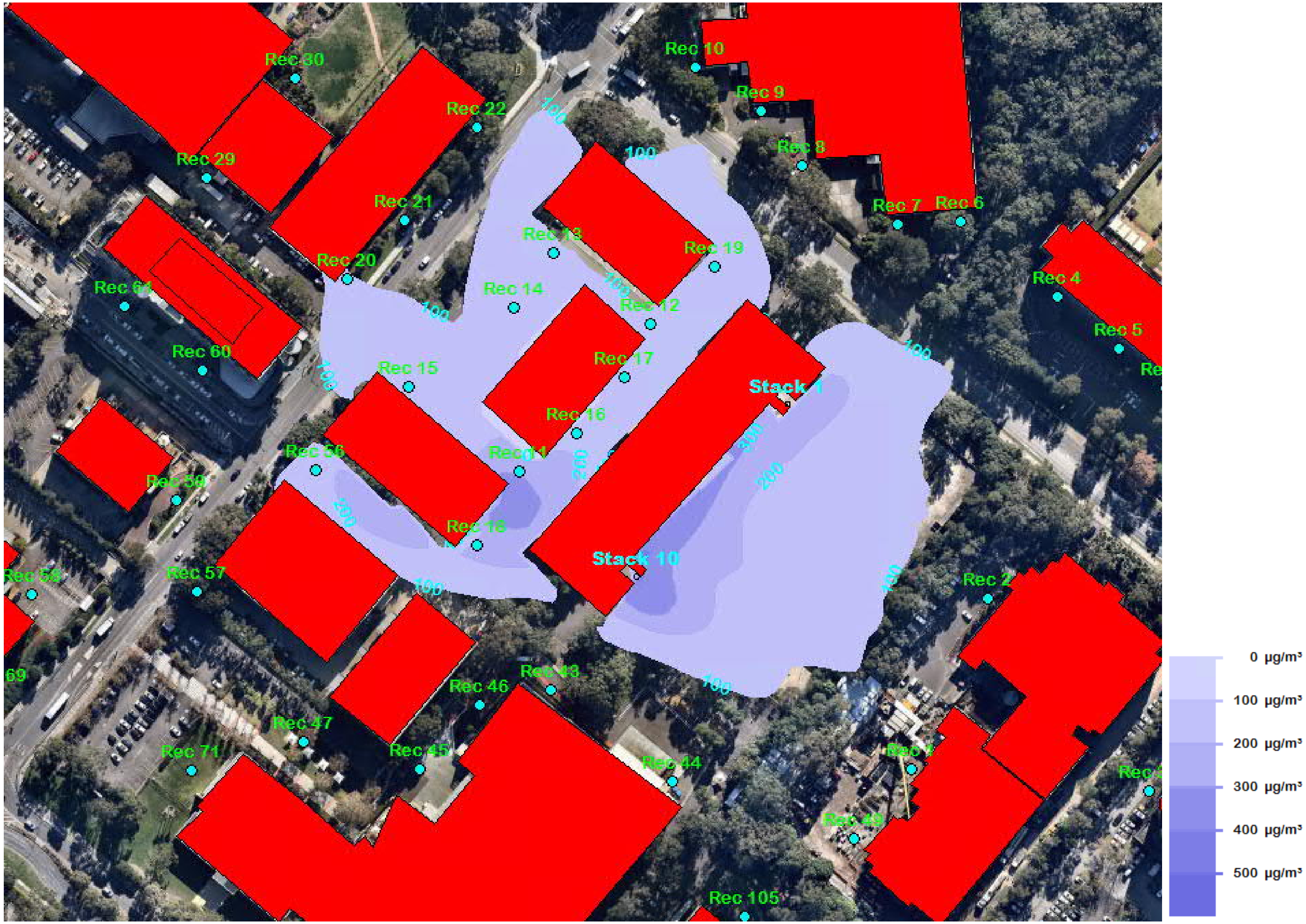


Figure 25 Maximum 1 Hour NO_2 concentration, Stack 10 (South Side of Building), All Hours, CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

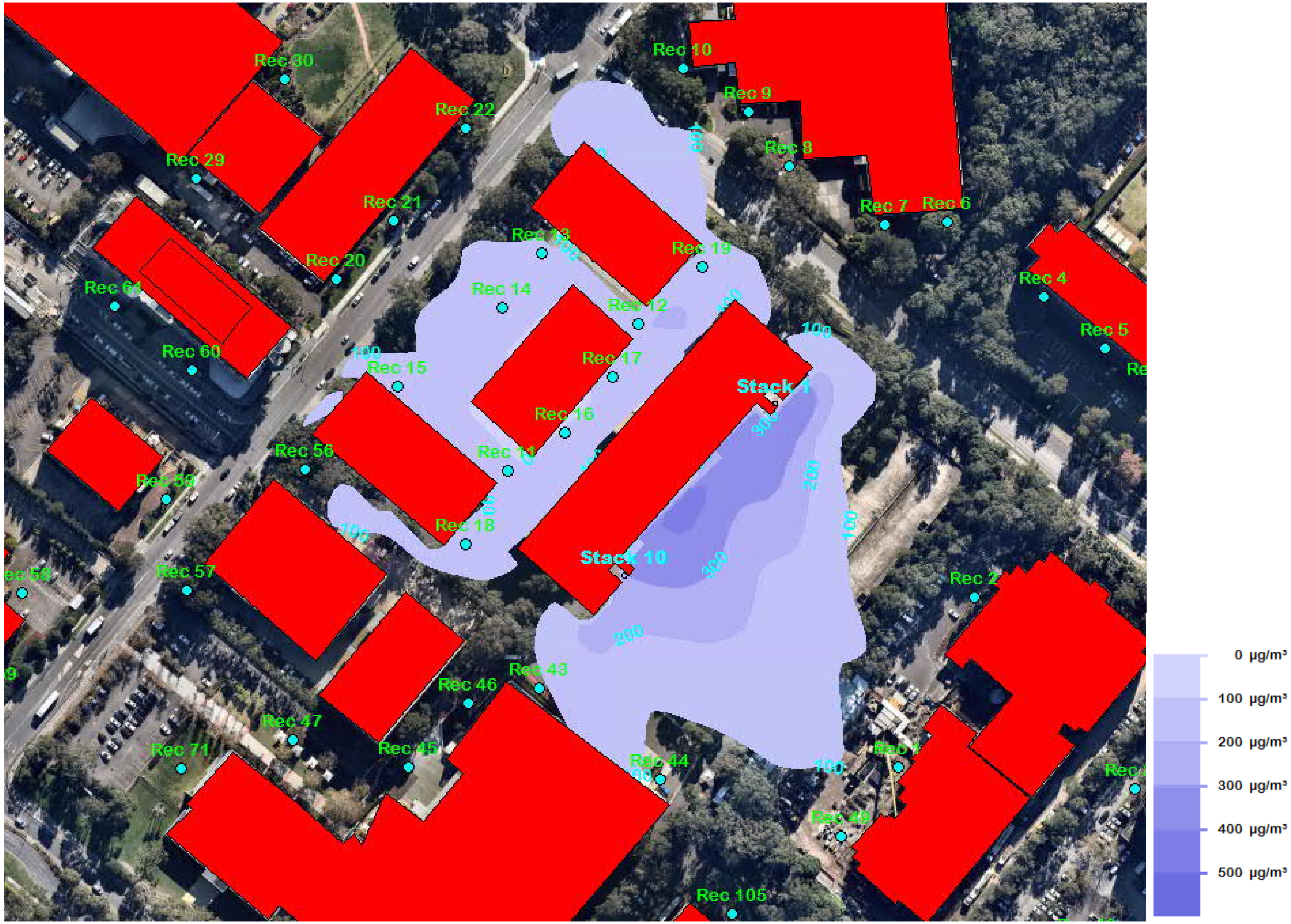


Figure 26 Maximum 1 Hour NO_2 concentration, Stack 1 (North Side of Building), All Hours, Cummins Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

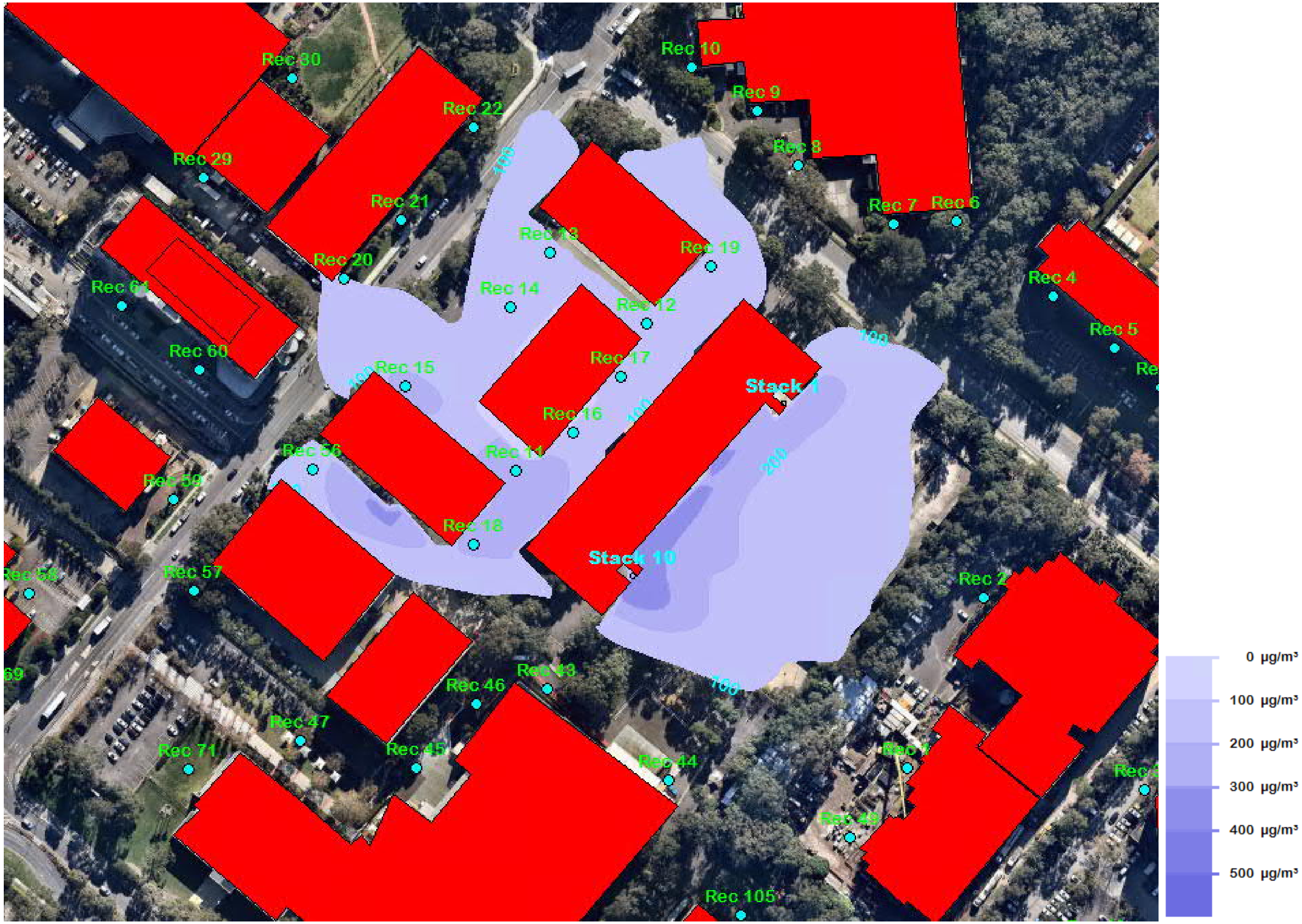


Figure 27 Maximum 1 Hour NO_2 concentration, Stack 10 (South Side of Building), All Hours, Cummins Generator, 50% Capacity for 1-hour operation, [μg/m^3]

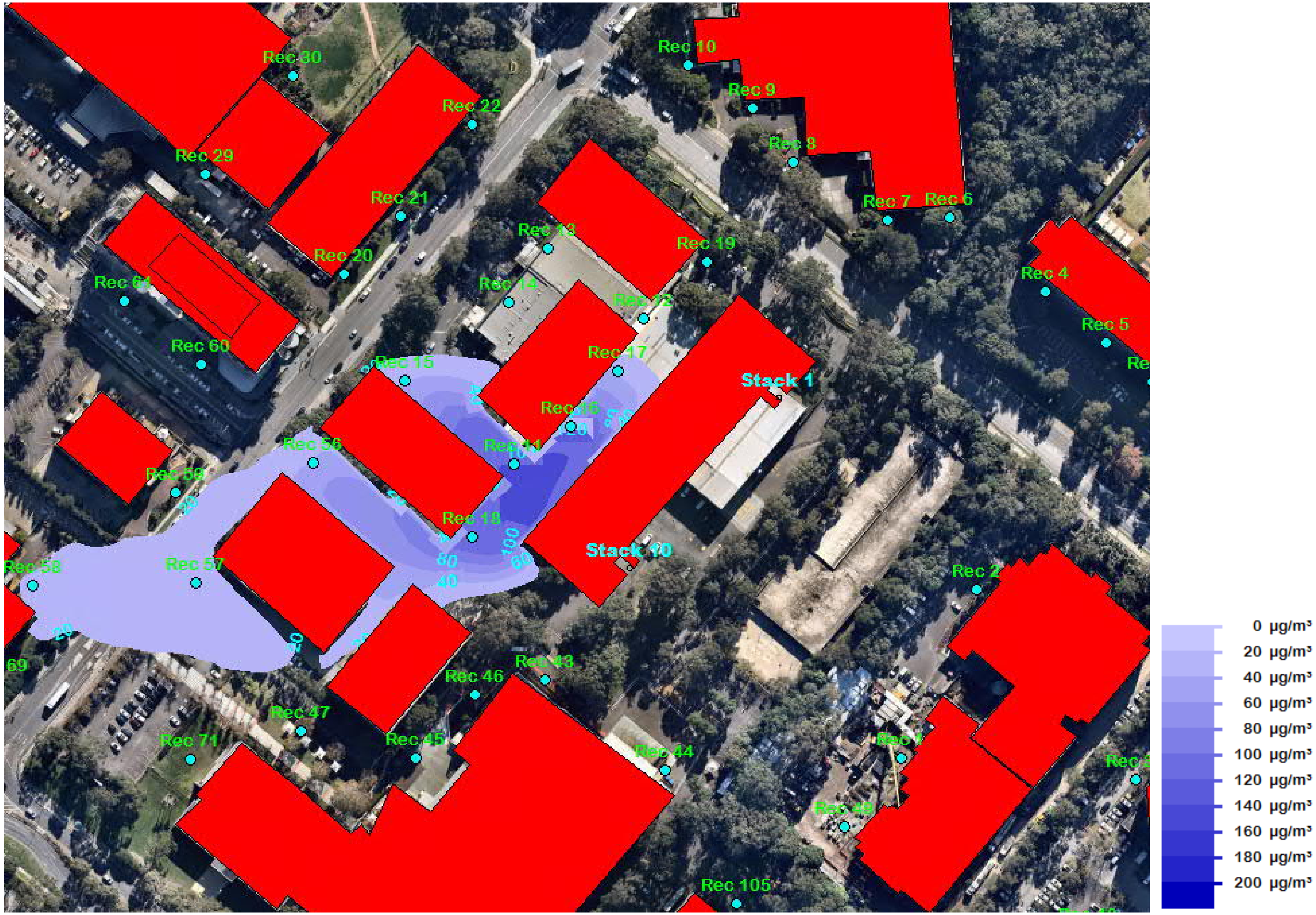


Figure 28 Worst Case Hour NO_2 concentration, Stack 1 (North Side of Building), CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

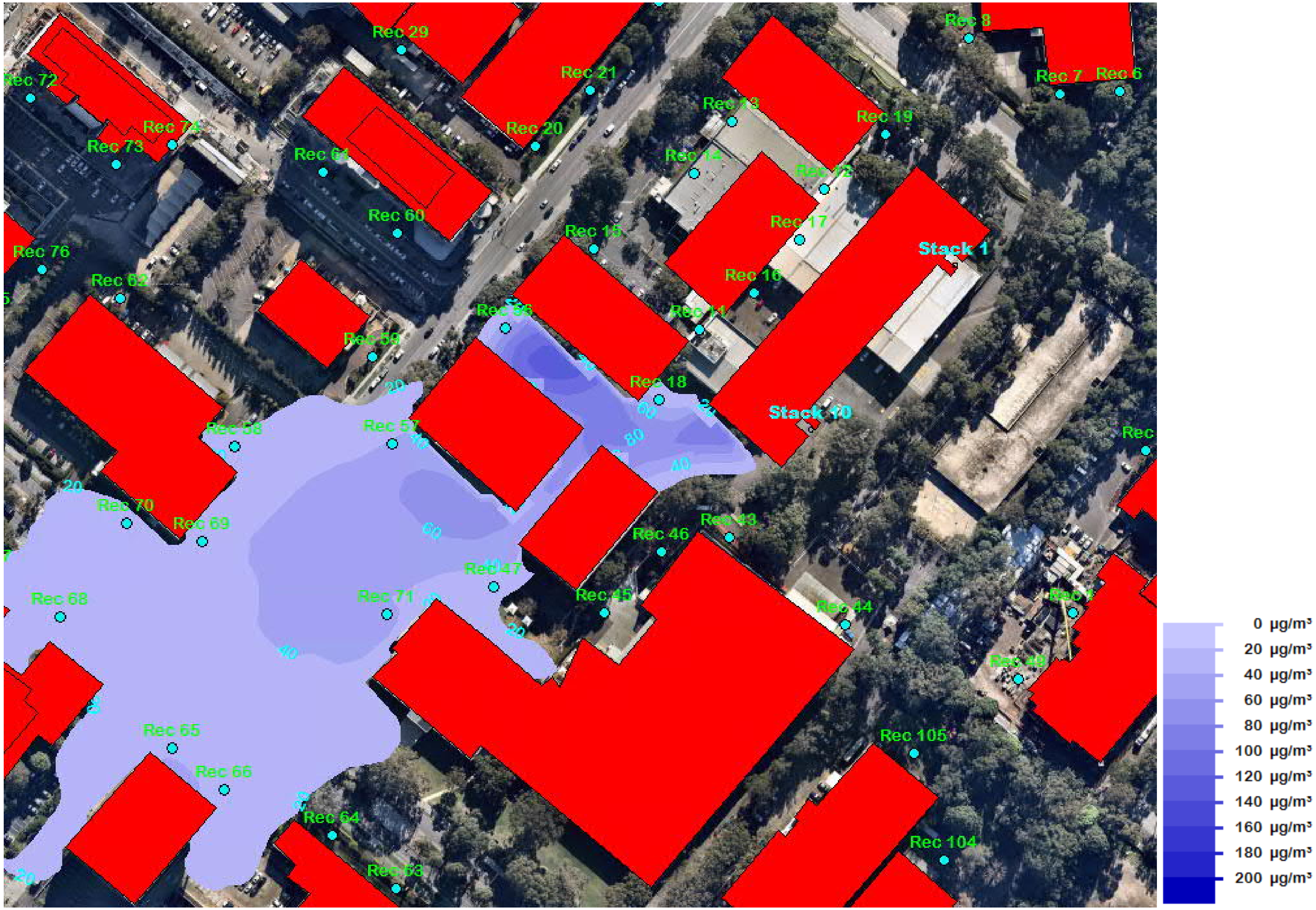


Figure 29 Worst Case Hour NO_2 concentration, Stack 1 (South Side of Building), CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

Figure 30 Worst Case Hour NO_2 concentration, Stack 1 (North Side of Building), CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

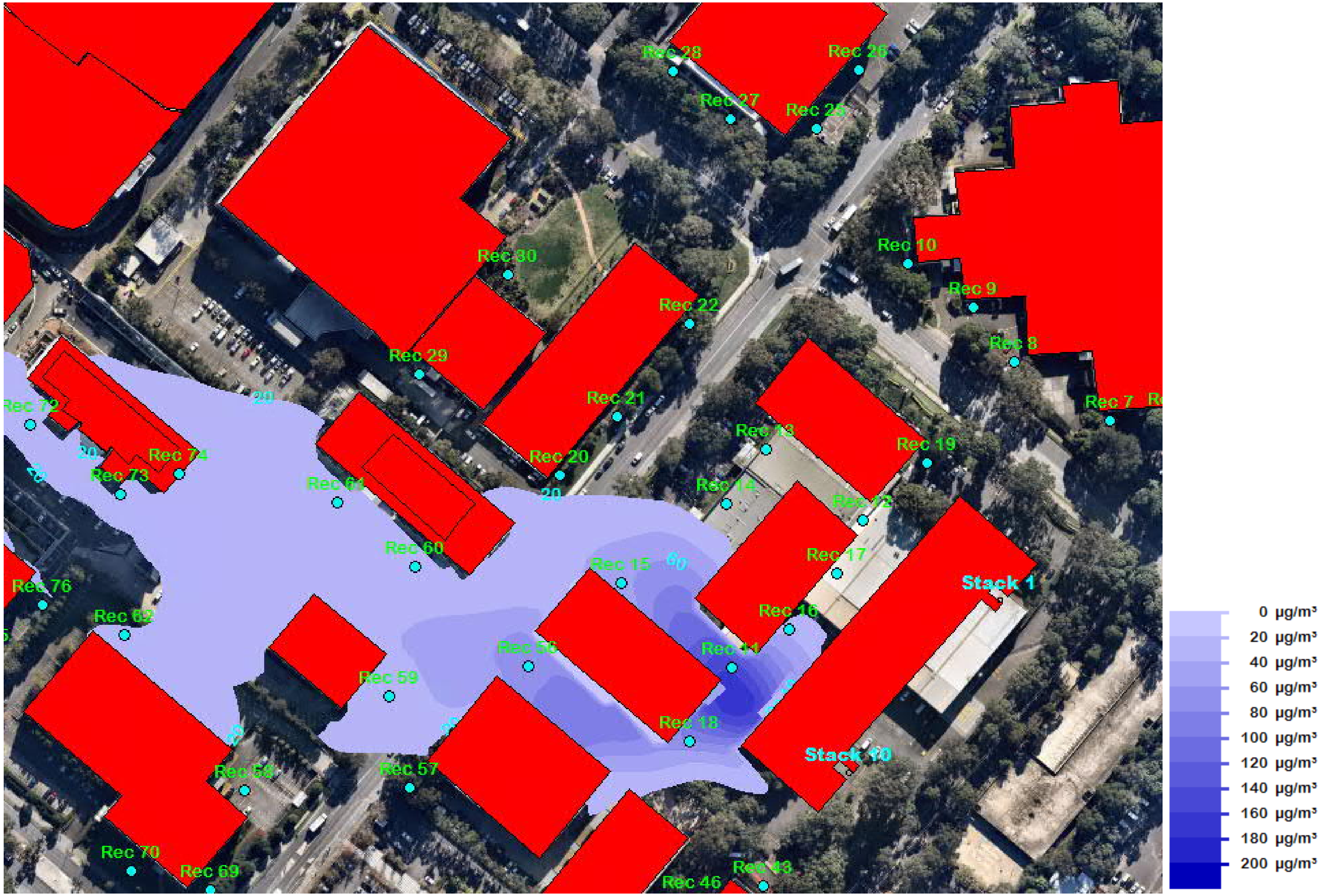


Figure 31 Worst Case Hour NO_2 concentration, Stack 10 (South Side of Building), CAT Generator, 50% Capacity for 1-hour operation, [µg/m³]

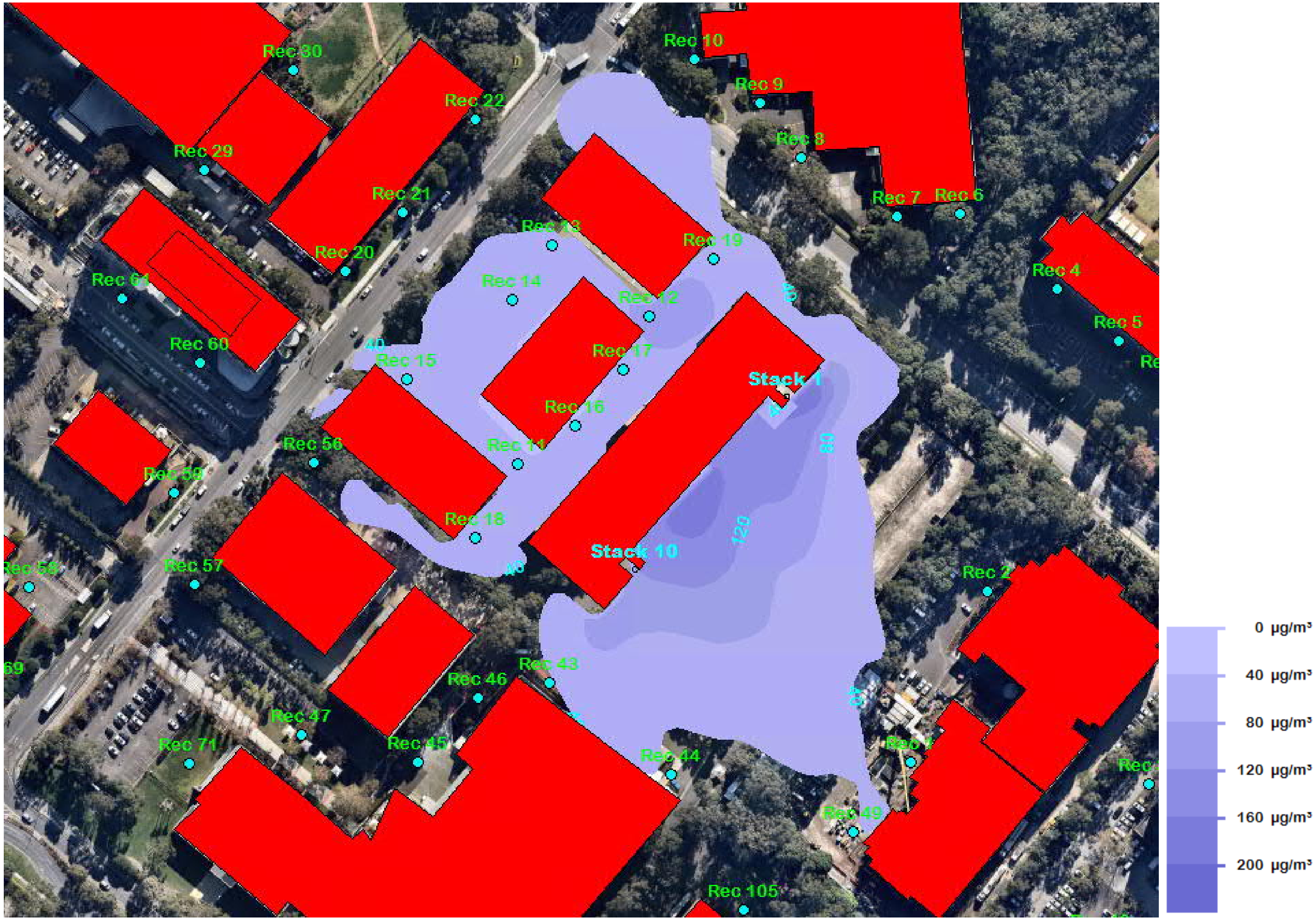


Figure 32 Maximum 1 Hour CO concentration, Stack 1 (North Side of Building), All Hours, CAT Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

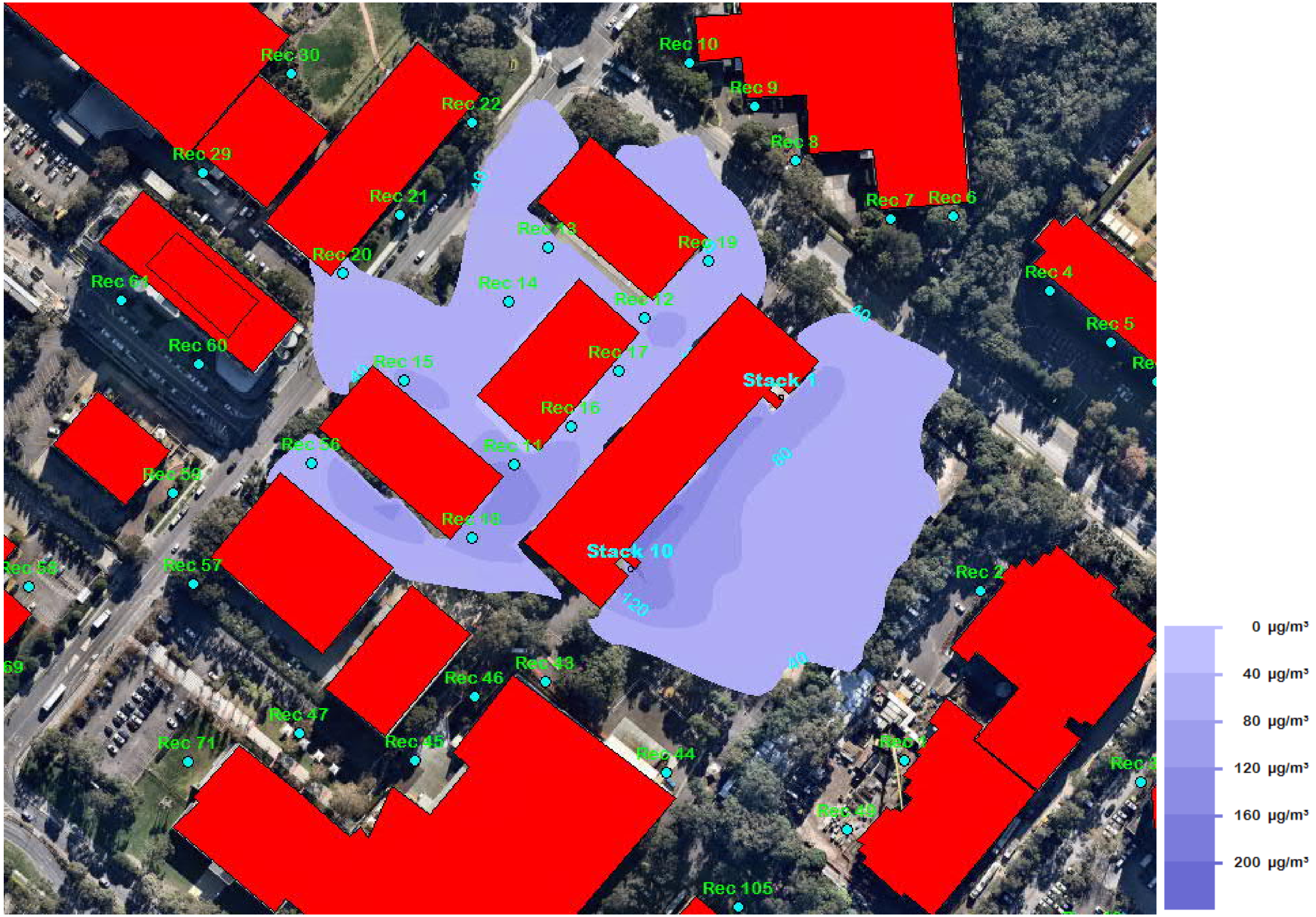


Figure 33 Maximum 1 Hour CO concentration, Stack 10 (South Side of Building), All Hours, CAT Generator, 50% Capacity for 1-hour operation, [µg/m³]

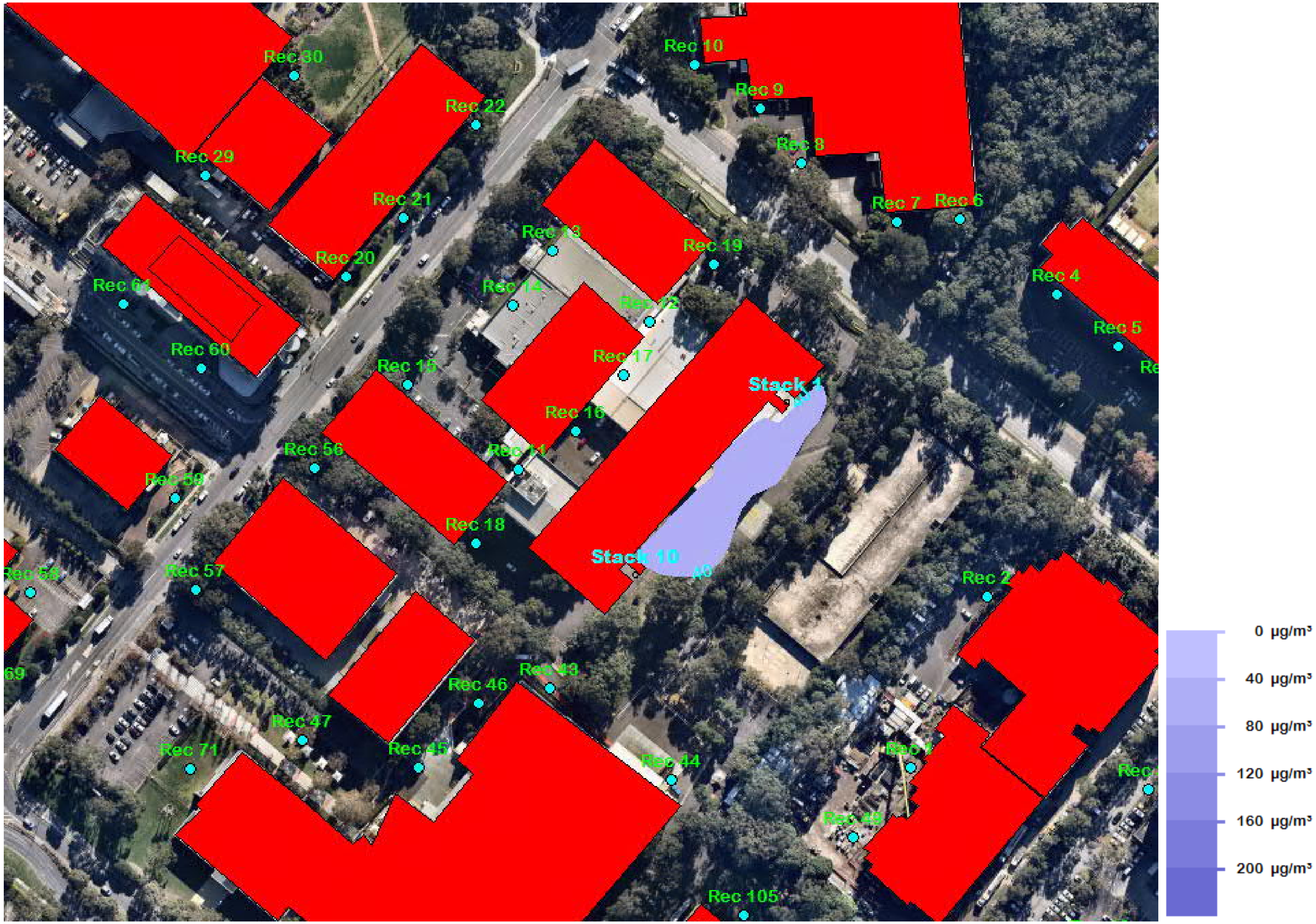


Figure 34 Maximum 1 Hour CO concentration, Stack 1 (North Side of Building), All Hours, Cummins Generator, 50% Capacity for 1-hour operation, [μg/m^3]

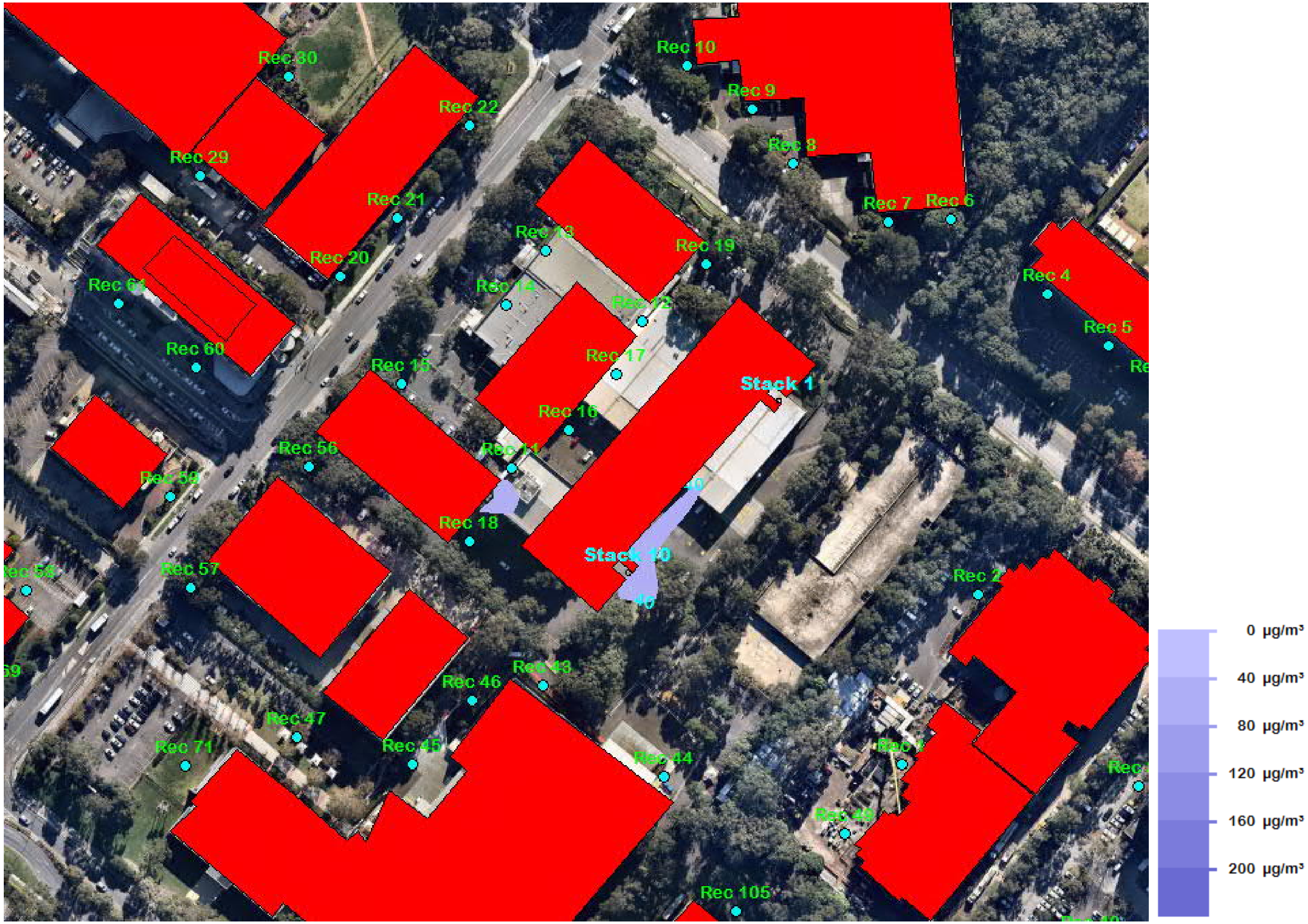


Figure 35 Maximum 1 Hour CO concentration, Stack 10 (South Side of Building), All Hours, Cummins Generator, 50% Capacity for 1-hour operation, [$\mu g/m^3$]

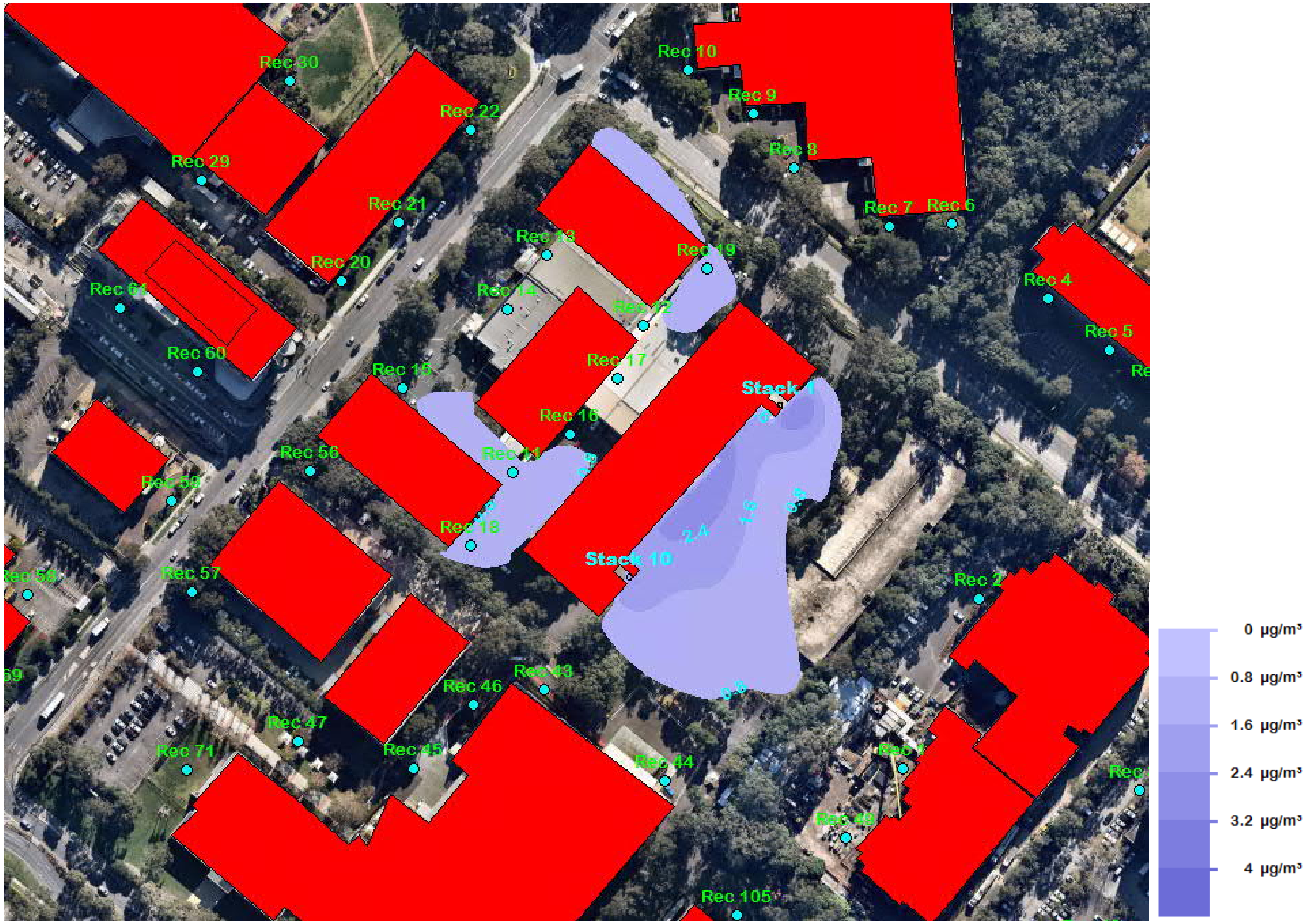


Figure 36 Maximum 24 Hour $PM_{2.5}$ concentration, Stack 1 (North Side of Building), All Hours, CAT Generator, [µg/m^3]

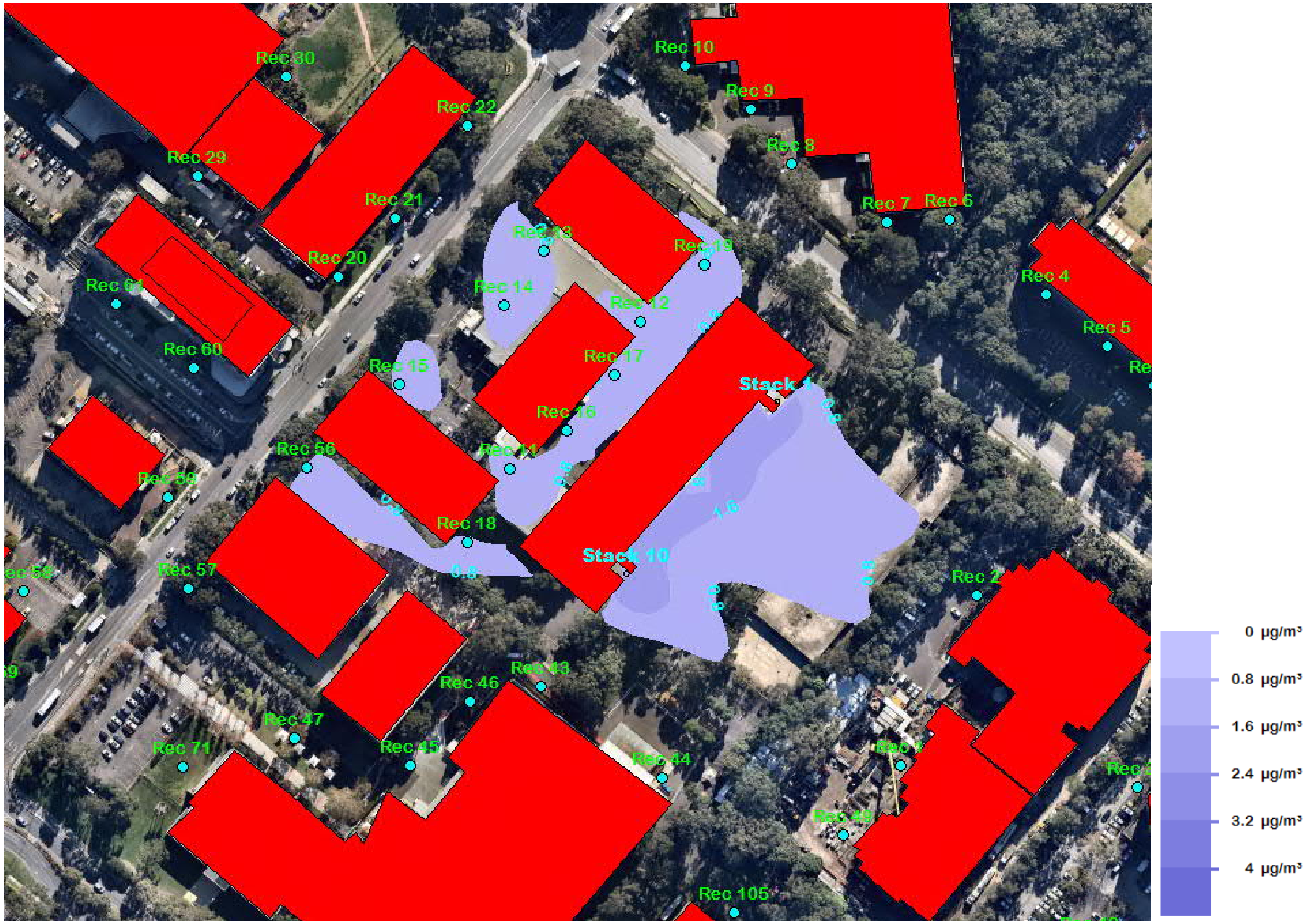


Figure 37 Maximum 24 Hour $PM_{2.5}$ concentration, Stack 10 (South Side of Building), All Hours, CAT Generator, [µg/m^3]

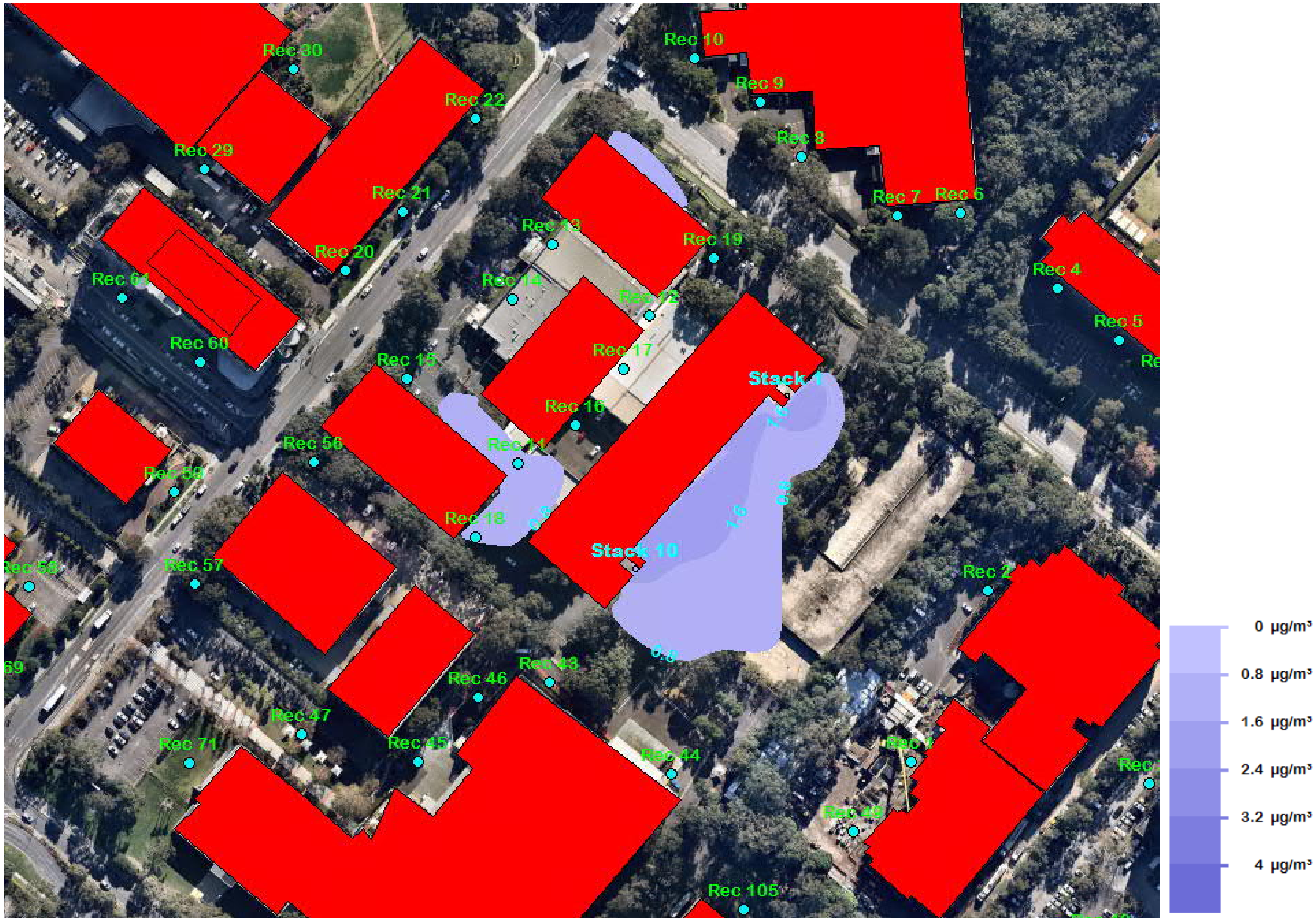


Figure 38 Maximum 24 Hour $PM_{2.5}$ concentration, Stack 1 (North Side of Building), All Hours, Cummins Generator, [$\mu g/m^3$]

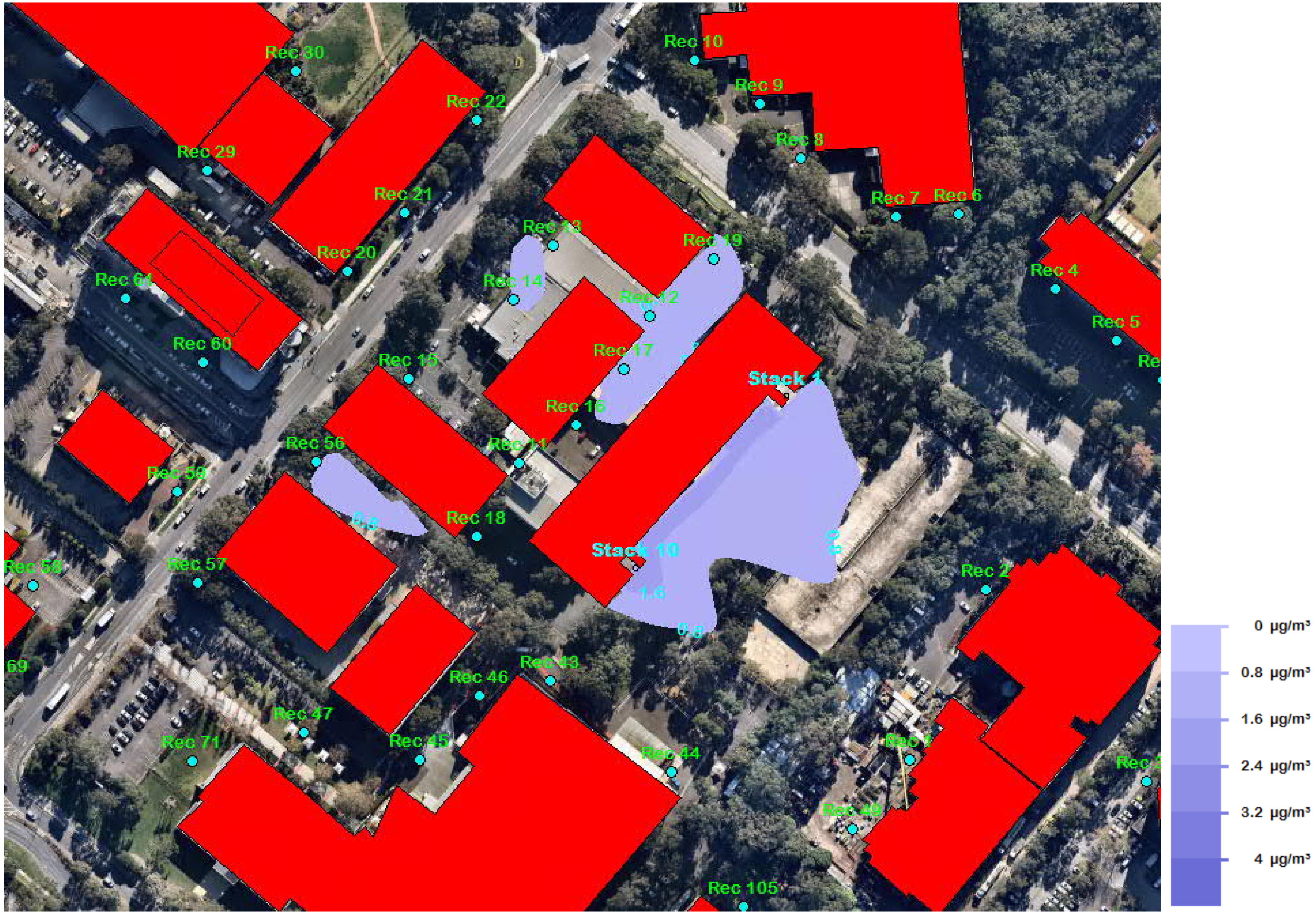


Figure 39 Maximum 24 Hour $PM_{2.5}$ concentration, Stack 10 (South Side of Building), All Hours, Cummins Generator, [µg/m³]

The results presented above show that for both the CAT and the Cummins emergency generators, all pollutants comply with regulatory limits under all modelling conditions and operating modes. NO_2 concentrations were predicted to be elevated close to the NSW EPA criteria (predicted to reach approximately 78% and 79% of the NSW EPA NO_2 criteria for the CAT and the Cummins generators when considered cumulatively). All other pollutants were well below their respective criteria with the exception of $PM_{2.5}$, which exceeded its 24-hour average criteria due to elevated background concentrations. The relative contribution from the generators for $PM_{2.5}$ was low with a maximum contribution to $PM_{2.5}$ of only 1.2 and 1.3 $\mu g/m^3$ for CAT and Cummins generators respectively. There were no additional exceedances predicted as a result of the operation of the generators due to $PM_{2.5}$ and as such it was not deemed to be of concern. Annual average pollutant concentrations (NO_2 and $PM_{2.5}$) were well below levels of concern and did not add significantly to the background pollutant concentrations.

When the possible future NO_2 criteria are considered, it is considered likely that the NO_2 concentrations would exceed the NO_2 criteria proposed by the NEPM (for both the 2020 and the 2025 1-hour criteria). While these are not criteria adopted by NSW EPA, there is a strong likelihood that they will be adopted by NSW regulators and contingency planning needs to be considered to ensure exceedances do not occur e.g. managing the testing times to ensure testing does not occur under worst case meteorological conditions. Future $PM_{2.5}$ criteria are unlikely to change the conclusions of this report, with the 24-hour criterion dropping to 20 $\mu g/m^3$ and the annual average criteria dropping to 7 $\mu g/m^3$. These levels will present a compliance challenge in the Sydney airshed which already exceeds the current higher criteria and lowering the criteria will exacerbate that situation. Given the low contribution to $PM_{2.5}$ in the airshed, it is considered unlikely that this facility would adversely affect $PM_{2.5}$ levels in the surrounding environment.

11.0 Conclusion

An assessment of the potential air quality impact from the operation of a Data Centre in Macquarie Park was undertaken. This assessment considered the risk of construction dust along with the impacts associated with the use of 18 diesel generators designed to operate in the event of a power outage in the Macquarie Park area.

The IAQM construction dust assessment methodology was used to assess the expected risks associated with the construction of the Data Centre building. This assessment identified an unmitigated risk of medium to low for all aspects of the construction activities. With mitigation measures included in the consideration of construction dust, the risk of impacts is expected to fall to negligible for all activities.

The GRAL dispersion model was used to assess the potential operational impacts due to the regular testing of the emergency generators. Two scenarios were considered which assessed the emissions from two candidate engines with emissions data provided by the manufacturers of the engines. The scenarios considered a range of operational modes including the engines operating at 10%, 50% and 100% capacity for time periods of 15 minutes to 1 hour.

Results of the dispersion modelling showed that for both modelling scenarios, there were no exceedances predicted for any of the modelled pollutants under any of the operating modes of the current NSW EPA limits. If in the future the NSW EPA limits are reduced in line with the changes to the NEPM (planned NEPM revision of NO_2 standards in 2020 and again in 2025), then there may be the potential for short term exceedances of the NO_2 limits. If this is the case, additional works may be needed to reduce the emissions or modify the operational characteristics to prevent the potential for ground level exceedance of the new limit.

12.0 References

DEWHA, 2008, *Emissions Estimation Technique Manual for Combustion Engines*, Version 3.0

EPA (2017): *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

Government of Styria (2017): *Recommendations when using the GRAL/GRAMM modelling system*.

Oettl, D., P. J. Sturm, M. Bacher, G. Pretterhofer, R. A. Almbauer (2002): *A simple model for the dispersion of pollutants from a road tunnel portal.* Atmos. Environ., 36, 2943-2953.

Oettl, D., P. J. Sturm, R. A. Almbauer, S. Okamoto, K, Horiuchi (2003): *Dispersion from road tunnel portals: comparison of two different modelling approaches*. Atmos. Environ., 37, 5165-5175.

Oettl, D., P. J. Sturm, R. A. Almbauer, (2005): *Evaluation of GRAL for the pollutant dispersion from a city street tunnel portal at depressed level.* Environmental Modelling and Software, 20, 499-504.

Laurence, A., December 2019, *Data centers without diesel generators: The groundwork is being laid…*
https://journal.uptimeinstitute.com/data-centers-without-generators-the-groundwork-is-being-laid/

Appendix A

Emergency Generator Engine Specifications

Appendix A Emergency Generator Engine Specifications

PERFORMANCE DATA[EM4775]

Performance Number: EM4775 **Change Level: 04**

SALES MODEL:	3516E
BRAND:	CAT
ENGINE POWER (BKW):	2,649.0
GEN POWER WITH FAN (EKW):	2,400.0
COMPRESSION RATIO:	14
RATING LEVEL:	STANDBY
PUMP QUANTITY:	1
FUEL TYPE:	DIESEL
MANIFOLD TYPE:	DRY
GOVERNOR TYPE:	ADEM5
ELECTRONICS TYPE:	ADEM5
CAMSHAFT TYPE:	STANDARD
IGNITION TYPE:	CI
INJECTOR TYPE:	MEUI-C
FUEL INJECTOR:	5816969
UNIT INJECTOR TIMING (MM):	0.88
REF EXH STACK DIAMETER (MM):	305
MAX OPERATING ALTITUDE (M):	2,000
COMBUSTION:	DIRECT INJECTION
ENGINE SPEED (RPM):	1,500
HERTZ:	50
FAN POWER (KW):	115.0
ASPIRATION:	TA
AFTERCOOLER TYPE:	ATAAC
AFTERCOOLER CIRCUIT TYPE:	JW+OC, ATAAC
INLET MANIFOLD AIR TEMP (C):	47
JACKET WATER TEMP (C):	104
TURBO CONFIGURATION:	PARALLEL
TURBO QUANTITY:	4
TURBOCHARGER MODEL:	TPX44TV23
CERTIFICATION YEAR:	2020
CRANKCASE BLOWBY RATE (M3/HR):	100.5
FUEL RATE (RATED RPM) NO LOAD (L/HR):	56.0
PISTON SPD @ RATED ENG SPD (M/SEC):	10.8

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

General Performance Data

THE INLET MANIFOLD AIR TEMP LISTED IN THE HEADER, AND IN THE GENERAL PERFORMANCE DATA, IS THE AVERAGE INLET MANIFOLD TEMP FRONT TO REAR ON THE ENGINE.

THIS STANDBY RATING IS FOR A STANDBY ONLY ENGINE ARRANGEMENT. RERATING THE ENGINE TO A STANDARD PRIME OR CONTINUOUS RATING IS NOT PERMITTED.

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BKW	KPA	G/BKW-HR	L/HR	KPA	DEG C	DEG C	KPA	DEG C
2,400.0	100	2,649	2,714	210.5	656.0	301.1	46.4	687.3	188.5	494.7
2,160.0	90	2,392	2,451	214.6	603.8	276.2	45.2	676.8	173.7	493.3
1,920.0	80	2,137	2,189	218.1	548.3	243.6	43.9	671.2	151.1	498.1
1,800.0	75	2,010	2,059	220.5	521.4	227.4	43.6	669.2	140.5	501.5
1,680.0	70	1,883	1,930	223.3	494.9	211.0	43.0	668.1	130.2	506.4
1,440.0	60	1,631	1,671	215.3	413.1	131.5	41.8	686.1	82.5	552.4
1,200.0	50	1,378	1,412	216.6	351.2	88.2	41.7	688.5	58.0	574.5
960.0	40	1,126	1,153	220.2	291.6	55.7	41.8	661.5	40.8	565.2
720.0	30	873	894	224.6	230.7	31.0	41.4	604.6	28.3	524.8
600.0	25	747	765	228.6	200.8	20.1	40.6	564.3	23.1	492.4
480.0	20	620	636	233.6	170.5	10.2	39.4	511.0	18.6	448.1
240.0	10	368	377	253.7	109.7	-2.5	36.9	374.7	12.6	330.5

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	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	KPA	DEG C	M3/MIN	M3/MIN	KG/HR	KG/HR	M3/MIN	M3/MIN
2,400.0	100	2,649	320	228.6	204.5	554.4	14,451.0	15,008.6	197.2	180.0
2,160.0	90	2,392	295	216.5	194.3	520.9	13,609.7	14,122.4	185.6	169.7
1,920.0	80	2,137	261	200.5	179.5	480.9	12,493.7	12,959.5	170.3	155.8
1,800.0	75	2,010	244	192.4	172.0	461.0	11,927.0	12,370.6	162.6	148.8
1,680.0	70	1,883	227	184.1	164.2	441.7	11,351.7	11,773.1	154.8	141.7
1,440.0	60	1,631	143	141.5	122.5	345.5	8,364.3	8,715.5	114.3	103.6
1,200.0	50	1,378	97	113.3	99.3	287.2	6,749.3	7,048.8	92.5	83.5
960.0	40	1,126	63	88.5	81.8	234.0	5,553.4	5,801.4	76.2	68.8
720.0	30	873	37	67.8	68.7	186.3	4,654.0	4,850.0	63.8	57.8
600.0	25	747	26	59.0	62.8	163.0	4,253.7	4,424.2	58.2	52.9
480.0	20	620	15	50.8	57.6	140.3	3,895.6	4,040.3	53.1	48.6
240.0	10	368	2	39.4	51.4	103.6	3,478.0	3,571.0	46.9	43.8

PERFORMANCE DATA[EM4775]

May 22, 2020

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXH RECOVERY TO 177C	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BKW	KW	KW	KW	KW	KW	KW	KW	KW	KW
2,400.0	100	2,649	835	165	2,652	1,417	353	755	2,649	6,626	7,059
2,160.0	90	2,392	805	161	2,469	1,327	325	670	2,392	6,100	6,498
1,920.0	80	2,137	751	159	2,291	1,236	295	560	2,137	5,539	5,900
1,800.0	75	2,010	710	158	2,223	1,192	281	507	2,010	5,267	5,611
1,680.0	70	1,883	691	158	2,138	1,153	266	458	1,883	4,999	5,325
1,440.0	60	1,631	648	165	1,760	983	222	241	1,631	4,173	4,445
1,200.0	50	1,378	617	166	1,485	846	189	136	1,378	3,548	3,780
960.0	40	1,126	560	155	1,223	679	157	73.3	1,126	2,945	3,138
720.0	30	873	475	136	963	505	124	34.6	873	2,330	2,482
600.0	25	747	438	124	829	415	108	22.1	747	2,028	2,161
480.0	20	620	406	112	683	323	91.7	12.7	620	1,722	1,834
240.0	10	368	283	88.8	445	158	59.0	2.6	368	1,108	1,181

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1500 RPM

GENSET POWER WITH FAN		EKW	2,400.0	1,800.0	1,200.0	600.0	240.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BKW	2,649	2,010	1,378	747	368
TOTAL NOX (AS NO2)		G/HR	17,311	10,470	9,148	7,133	5,802
TOTAL CO		G/HR	4,291	4,592	4,485	3,055	1,948
TOTAL HC		G/HR	151	131	81	145	237
PART MATTER		G/HR	199.1	231.9	234.8	146.6	29.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,252.7	1,714.9	2,226.4	3,031.6	4,543.9
TOTAL CO	(CORR 5% O2)	MG/NM3	556.3	750.1	1,107.7	1,322.2	1,557.5
TOTAL HC	(CORR 5% O2)	MG/NM3	16.9	18.5	17.1	54.4	158.2
PART MATTER	(CORR 5% O2)	MG/NM3	21.5	31.7	47.0	52.3	19.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,097	835	1,084	1,477	2,213
TOTAL CO	(CORR 5% O2)	PPM	445	600	886	1,058	1,246
TOTAL HC	(CORR 5% O2)	PPM	32	35	32	102	295
TOTAL NOX (AS NO2)		G/HP-HR	4.92	3.91	4.99	7.16	11.80
TOTAL CO		G/HP-HR	1.22	1.72	2.45	3.06	3.96
TOTAL HC		G/HP-HR	0.04	0.05	0.04	0.15	0.48
PART MATTER		G/HP-HR	0.06	0.09	0.13	0.15	0.06
TOTAL NOX (AS NO2)		LB/HR	38.16	23.08	20.17	15.73	12.79
TOTAL CO		LB/HR	9.46	10.12	9.89	6.73	4.29
TOTAL HC		LB/HR	0.33	0.29	0.18	0.32	0.52
PART MATTER		LB/HR	0.44	0.51	0.52	0.32	0.07

RATED SPEED NOMINAL DATA: 1500 RPM

GENSET POWER WITH FAN		EKW	2,400.0	1,800.0	1,200.0	600.0	240.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BKW	2,649	2,010	1,378	747	368
TOTAL NOX (AS NO2)		G/HR	14,426	8,725	7,623	5,944	4,835
TOTAL CO		G/HR	2,384	2,551	2,492	1,697	1,082
TOTAL HC		G/HR	113	98	61	109	178
TOTAL CO2		KG/HR	1,754	1,391	945	541	294
PART MATTER		G/HR	142.2	165.6	167.7	104.7	21.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	1,877.3	1,429.1	1,855.3	2,526.4	3,786.6
TOTAL CO	(CORR 5% O2)	MG/NM3	309.1	416.7	615.4	734.6	865.3
TOTAL HC	(CORR 5% O2)	MG/NM3	12.7	13.9	12.9	40.9	119.0
PART MATTER	(CORR 5% O2)	MG/NM3	15.4	22.7	33.5	37.4	14.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	914	696	904	1,231	1,844
TOTAL CO	(CORR 5% O2)	PPM	247	333	492	588	692
TOTAL HC	(CORR 5% O2)	PPM	24	26	24	76	222
TOTAL NOX (AS NO2)		G/HP-HR	4.10	3.26	4.16	5.96	9.83
TOTAL CO		G/HP-HR	0.68	0.95	1.36	1.70	2.20
TOTAL HC		G/HP-HR	0.03	0.04	0.03	0.11	0.36
PART MATTER		G/HP-HR	0.04	0.06	0.09	0.11	0.04

TOTAL NOX (AS NO2)	LB/HR	31.80	19.24	16.81	13.10	10.66
TOTAL CO	LB/HR	5.26	5.62	5.49	3.74	2.39
TOTAL HC	LB/HR	0.25	0.22	0.13	0.24	0.39
TOTAL CO2	LB/HR	3,867	3,067	2,084	1,192	649
PART MATTER	LB/HR	0.31	0.37	0.37	0.23	0.05
OXYGEN IN EXH	%	9.4	9.8	7.6	8.9	13.1
DRY SMOKE OPACITY	%	1.8	2.4	3.9	3.6	0.3
BOSCH SMOKE NUMBER		0.60	0.81	1.25	1.18	0.28

Regulatory Information

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

A BLANK IN THE ALTITUDE DERATE TABLE SIGNIFIES THAT NO RATING IS AVAILABLE AT THAT SPECIFIED ALTITUDE AND AMBIENT TEMPERATURE.

THE TEMPERATURES LISTED IN THE CHART ARE AMBIENT TEMPERATURES. THE FOLLOWING DERATE CHART WAS CALCULATED ASSUMING A 5 DEG C RISE IN AIR TEMPERATURE BETWEEN THE AIR CLEANER INLET, AND THE TURBOCHARGER INLET.

ALTITUDE CORRECTED POWER CAPABILITY (BKW)

AMBIENT OPERATING TEMP (C)	0	5	10	15	20	25	30	35	40	45	50	55	60	NORMAL
ALTITUDE (M)														
0	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649			2,649
250	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649				2,649
500	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649				2,649
750	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649				2,649
1,000	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,387				2,649
1,250	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649					2,649
1,500	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,649					2,649
1,750	2,649	2,649	2,649	2,649	2,649	2,649	2,649	2,611	2,572					2,649
2,000	2,649	2,649	2,649	2,649	2,610	2,579	2,548	2,458	2,351					2,649
2,250	2,628	2,607	2,574	2,542	2,511	2,481	2,451	2,324	2,100					2,573
2,500	2,541	2,510	2,478	2,448	2,417	2,390	2,362	2,216	1,983					2,483
2,750	2,447	2,417	2,389	2,362	2,334	2,307	2,280	2,118	1,860					2,408
3,000	2,361	2,335	2,307	2,281	2,255	2,227	2,197	2,012	1,758					2,335
3,250	2,280	2,254	2,227	2,203	2,178	2,146	2,107	1,880	1,579					2,263
3,500	2,196	2,171	2,145	2,119	2,091	2,043	1,996	1,777	1,519					2,188
3,750	2,121	2,091	2,059	2,034	2,009	1,956	1,889	1,660	1,516					2,121
4,000	2,041	2,012	1,976	1,944	1,910	1,820	1,728	1,545	1,503					2,049
4,250	1,943	1,911	1,877	1,847	1,816	1,711	1,606	1,537	1,485					1,965
4,500	1,842	1,813	1,784	1,757	1,730	1,629	1,556	1,528	1,462					1,876

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
5643862	GG2101	5709046	PG356	XJ	WYH00001	
5643839	LL2837	5838328	PG296	-	ZNL00001	

Supplementary Data

Type	Classification	Performance Number
ALTITUDE DATA	HIGH RESOLUTION	EM5379

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at

15 deg C (59 deg F), where the density is
850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

Exhaust Emission Data Sheet
C3000 D5e
50 Hz Diesel Generator Set
EPA Emission

Engine Information:

Model:	Cummins Inc. QSK78-G15	Bore:	6.69 in. (170 mm)
Type:	4 Cycle, VEE 18 Cylinder Diesel	Stroke:	7.48 in. (190 mm)
Aspiration:	Turbocharged and Aftercooled	Displacement:	4735 cu. in. (77.6 liters)
Compression Ratio:	15.5:1		
Emission Control Device:	Turbocharged and Aftercooler		

PERFORMANCE DATA	1/4 Standby	1/2 Standby	3/4 Standby	Full Standby	Full Prime	Full Continuous
BHP @ 1500 RPM (50 Hz)	851	1702	2552	3403	3088	2358
Fuel Consumption (Ltr/Hr)	180	345	476	597	550	446
Exhaust Gas Temperature (°C)	403	441	452	470	464	450
Exhaust Gas Flow (CFM)	6863	12046	15042	17278	16449	14355
EXHAUST EMISSION DATA						
HC (Total Unburned Hydrocarbons)	0.43 (162)	0.27 (105)	0.20 (84)	0.16 (73)	0.17 (80)	0.21 (84)
NOx (Oxides of Nitrogen as NO2)	3.82 (1445)	3.53 (1382)	4.59 (1954)	6.36 (2884)	5.52 (2466)	4.35 (1823)
CO (carbon Monoxide)	0..58 (219)	0.35 (138)	0.29 (122)	0.59 (268)	0.45 (203)	0.30 (126)
PM (Particular Matter)	0.13 (44)	0.06 (21)	0.04 (15)	0.04 (17)	0.04 (15)	0.04 (15)
All Values are g/bhp-hr. (mg/Nm3 @5% O2)						

TEST CONDITIONS

Data is representative of steady-state engine speed (± 25 RPM) at designated genset loads. Pressures, temperatures, and emission rates were stabilized.

Fuel Specification:	ASTM D975 No. 2-D diesel fuel with 0.03-0.05% sulfur content (by weight), and 40-48 cetane number.
Fuel Temperature:	99 ± 9 °F (at fuel pump inlet)
Intake Air Temperature:	77 ± 9 °F
Barometric Pressure:	29.6 ± 1 in. Hg
Humidity:	NOx measurement corrected to 75 grains H2O/lb dry air
Reference Standard:	ISO 8178

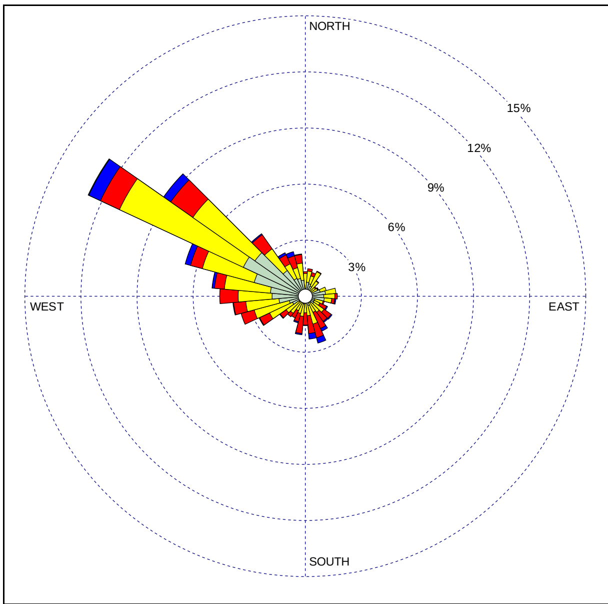
The NOx, HC, CO and PM emission data tabulated here are representative of test data taken from a single engine under the test conditions shown above. Data for the other components are estimated. These data are subjected to instrumentation and engine-to-engine variability. Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures and instrumentation. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.

Appendix B

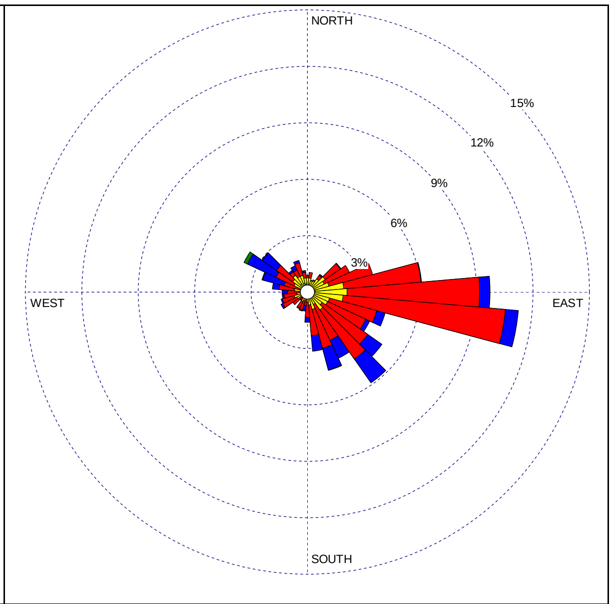
Long Term Meteorology Summary - BOM Olympic Park

Appendix B Long Term Meteorology Summary - BOM Olympic Park

The long-term data averages for the BOM Olympic Park site are shown in **Table 31**. Wind roses for 9am and 3pm time periods are shown in **Figure 40**.



9am Wind Rose



3pm Wind Rose

Figure 40 BOM Olympic Park 9am and 3pm Wind Roses

Table 31 BOM Sydney Olympic Park Summary, 2012-2019

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Temperature														
Mean maximum temperature (°C)	39.1	35.8	33.3	30.8	26.4	21.2	23.7	25.7	30.7	34.4	35.8	38.3	41.2	2012 - 2019
Mean minimum temperature (°C)	14.6	14.5	12.0	9.5	5.1	4.0	2.1	3.0	5.3	8.0	10.2	13.0	1.8	2012 – 2019
Rainfall														
Mean rainfall (mm)	115.6	99.7	156.2	95.7	32.8	152.5	25.2	68.0	41.9	63.1	74.3	69.7	994.7	2012 – 2019
Mean number of days of rain ≥ 1 mm	6.4	8.6	10.9	6.6	4.0	8.3	4.4	4.8	5.0	5.3	6.9	5.8	6.4	2012 – 2019
9 am conditions														
Mean 9am temperature (°C)	24.3	23.1	21.6	19.8	16.2	13.2	12.7	14.1	17.7	19.7	21.7	23.5	19.0	2012 – 2019
Mean 9am relative humidity (%)	68.8	73.4	77.9	73.1	69.4	78.7	70.5	61.9	58.7	61.7	62.0	64.2	68.4	2012 – 2019
Mean 9am wind speed (km/h)	9.2	8.6	7.6	7.9	9.1	8.5	9.7	10.9	10.7	10.0	10.1	9.4	9.3	2012 – 2019
3 pm conditions														
Mean 3pm temperature (°C)	27.3	26.2	25.3	22.7	20.2	16.9	17.5	18.0	20.7	24.2	24.2	26.4	22.5	2012 – 2019
Mean 3pm relative humidity (%)	58.2	60.5	61.3	59.9	53.1	63.0	50.0	47.7	48.2	49.9	54.5	54.8	55.1	2012 – 2019
Mean 3pm wind speed (km/h)	17.1	17.0	15.1	13.3	11.4	9.9	11.8	14.5	16.4	16.4	17.7	16.9	14.8	2012 - 2019

Appendix C

CALPUFF GRAL Model Comparison

Appendix C CALPUFF GRAL Model Comparison

The GRAMM/GRAL dispersion model is still relatively new in its use for regulatory modelling purposes in Australia. The CALPUFF dispersion model has been used for years in a regulatory setting and its functionality is very well known. To provide more confidence the GRAL outputs, a CALPUFF model mimicking the inputs of the GRAL model was also developed to provide a cross check of the GRAL results (despite the CALPUFF models inability to consider fine scale wind flows). The setup of the CALPUFF model and a comparison with the GRAL modelling results is described in this appendix.

Meteorology

As described in the main body of the report, meteorological inputs for GRAMM were developed in CALMET. A full analysis of the CALMET data is provided in **Appendix D**. The same CALMET data was used for the CALPUFF modelling.

Receptors

The same receptors (in terms of eastings, northings and elevation) used in the GRAL model were used in the CALPUFF model. Refer **Section 8.2.5** for details on the receptors.

Buildings and Building Downwash

Buildings used in the GRAL model were exported into Excel and then imported into the CALPUFF model. The location and building heights are identical to those used in GRAL. Building downwash effects were included in CALPUFF via the BPIP-PRIME algorithm. A 3-dimensional view of the buildings are presented in **Figure 41**.

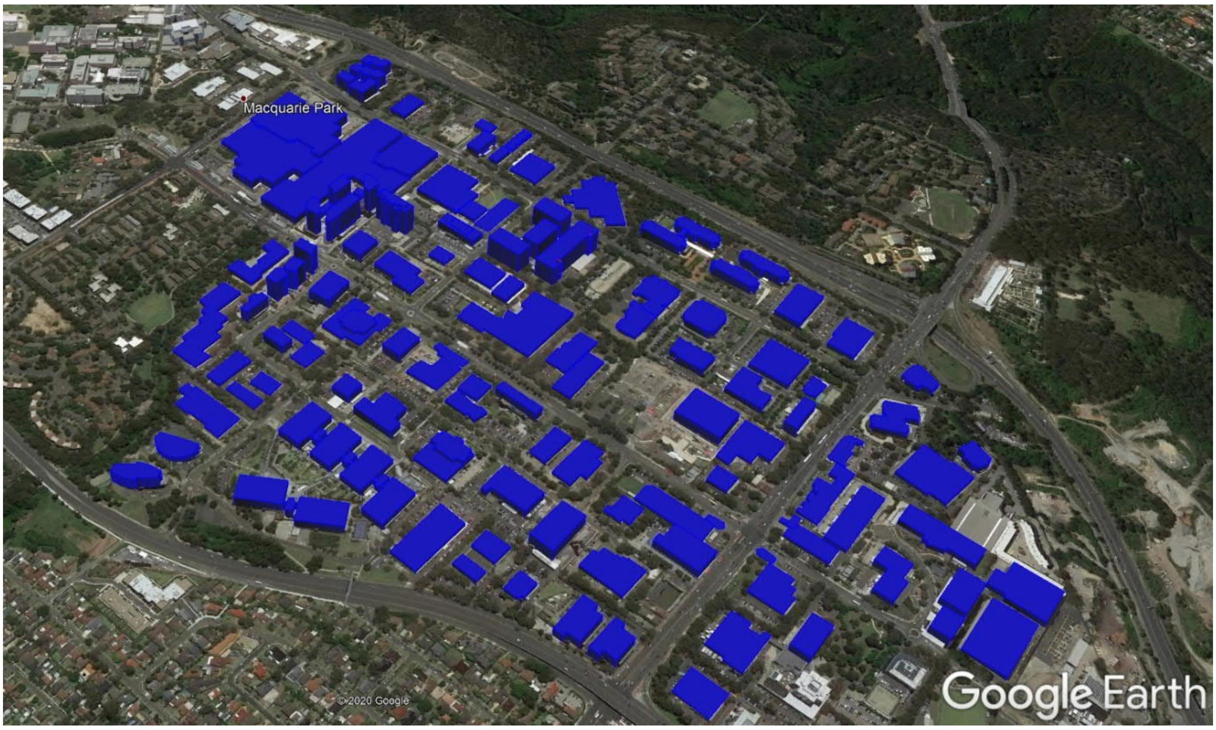


Figure 41 Buildings used in the CALPUFF model

CALPUFF Model Settings

Settings adopted for the CALPUFF model are presented in **Table 32**.

Table 32 CALPUFF model settings

Parameter	Setting
CALPUFF version	7.2.1
Receptors	Refer **Section 8.2.5** for discrete receptor locations.
Calculation type	Concentration
Chemical transformation method	Not modelled
Dispersion Option	Dispersion coefficient. use turbulence computed from micrometeorology
Use PDF method for Sigma-z in the convective BL	On
Puff splitting	No puff splitting
Stack tip downwash	On
Partial plume penetration	On
Partial plume penetration (buoyant)	On
Terrain adjustment method	Partial plume path adjustment
Building wake calculation	PRIME algorithm
Terrain data	SRTM 30 m

Modelled Scenarios

Two scenarios were modelled in CALPUFF to compare against the GRAL model outputs. The two scenarios are described in **Table 33**.

Table 33 Modelling scenarios

Scenario	Description
North Stack 1	A single stack located at the north end of the building operating at 100% load continuously during daytime hours (7am to 6pm) for 12-months of meteorology. Corresponds to inputs for Scenario 1 in the main report.
South Stack 1	A single stack located at the north end of the building operating at 100% load continuously during daytime hours (7am to 6pm) for 12-months of meteorology. Corresponds to inputs for Scenario 1 in the main report.

The location of the two stacks that were modelled are presented in **Figure 42**.

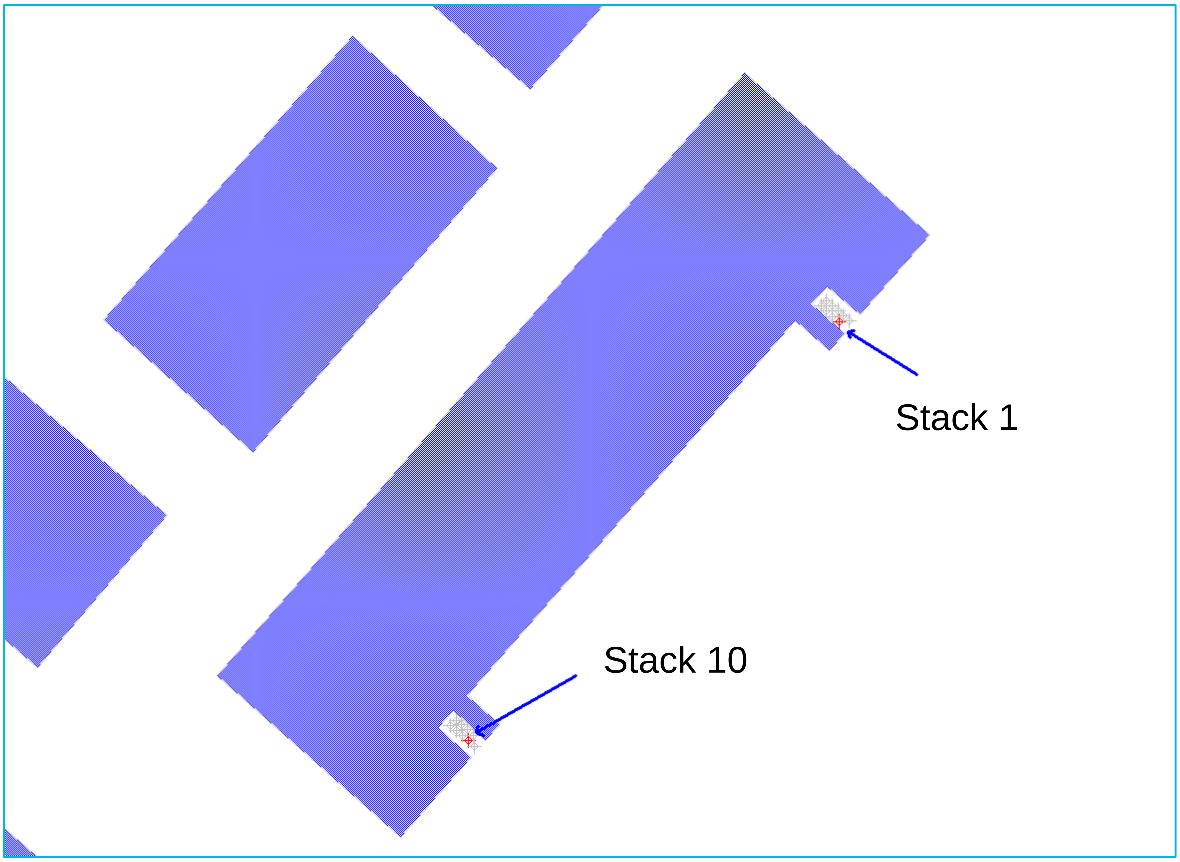


Figure 42 Location of the two modelled stacks

Emissions Inventory

Emission rates for both scenarios were identical to those for the CAT engines modelled with GRAL (refer **Table 24**) and are presented in **Table 34** in both kilograms per hour (GRAL) and grams per second (CALPUFF).

Table 34 Modelled emission rates for CALPUFF – CAT engines

Pollutant	Emission Rate (kg/hr)	Emission rate (g/s)
NO_X	14.70	4.08
CO	2.42	0.67
VOC	0.099	0.028
$PM_{2.5}$	0.121	0.033

Results

Result of the dispersion modelling have been presented in terms of the ground level concentrations at the sensitive receptors surrounding the Data Centre. Results have been presented in **Table 35** and **Figure 43** and **Figure 44**.

Table 35 Modelling results - Maximum 1-hour NO_2 Concentrations (ug/m^3) - OLM method

Receptor	Nth Stk 1		Sth Stk 1		Receptor	Nth Stk 1		Sth Stk 1	
	C'Puff	GRAL	C'Puff	GRAL		C'Puff	GRAL	C'Puff	GRAL
1	80.1	80.9	71.8	97.8	36	38.1	45.4	31.6	66.7
2	71.3	111.0	70.9	121.2	37	31.9	40.3	28.9	62.2
3	59.4	40.6	58.4	74.9	38	61.1	71.8	41.4	109.6
4	65.9	57.2	97.5	81.7	39	61.6	80.9	52.0	118.3
5	64.2	37.3	62.2	77.7	40	57.3	57.5	60.1	85.4
6	61.2	41.1	102.1	68.0	41	60.8	72.2	51.4	92.3
7	64.2	43.6	100.5	79.3	42	54.9	77.7	50.6	86.6
8	58.8	79.6	77.3	83.6	43	102.1	62.2	109.9	81.4
9	63.1	63.0	72.2	73.5	44	105.4	106.2	77.4	113.0
10	65.3	76.4	80.9	113.0	45	99.9	54.4	86.1	71.7
11	86.9	191.5	86.9	202.6	46	92.9	51.8	87.4	83.1
12	63.5	146.2	85.8	181.6	47	131.1	44.3	90.7	52.8
13	89.4	155.9	119.6	167.6	48	53.3	60.5	52.1	83.8
14	87.6	154.2	119.5	165.4	49	98.8	96.5	71.0	104.5
15	114.8	177.5	96.8	186.4	50	48.6	67.3	60.9	92.0
16	74.5	102.9	83.7	169.3	51	39.4	41.4	31.0	76.1
17	70.7	141.5	92.7	182.4	52	39.8	44.4	34.5	70.1
18	105.1	187.9	89.4	196.9	53	41.4	51.4	37.5	69.8
19	62.8	133.9	85.4	168.1	54	42.1	65.8	38.6	81.4
20	116.4	126.0	107.4	143.1	55	45.7	49.3	40.4	64.4
21	104.2	114.2	123.5	142.6	56	125.5	97.9	89.0	110.0
22	93.2	66.7	121.2	77.9	57	126.8	61.7	90.7	79.0
23	55.9	97.2	41.1	117.2	58	66.0	70.0	54.1	81.9
24	46.9	112.0	37.2	134.1	59	131.4	49.4	88.0	75.7
25	67.0	79.9	67.5	108.6	60	128.9	95.8	75.0	118.8
26	64.2	79.7	54.0	84.7	61	138.0	102.9	78.8	93.9
27	73.4	76.6	62.7	88.2	62	56.5	64.0	48.9	96.9
28	62.0	63.6	53.4	74.3	63	49.6	51.6	56.7	62.8
29	122.1	82.1	94.8	95.7	64	48.4	65.6	56.3	70.5
65	66.6	54.0	48.7	66.2	90	32.5	50.6	34.0	66.2
66	64.8	48.2	47.1	73.8	91	31.1	25.1	26.9	40.2
67	68.3	31.3	37.2	38.5	92	25.4	61.1	22.3	44.4
68	69.8	45.4	40.9	57.4	93	24.5	32.8	25.5	43.6
69	69.0	78.5	53.6	82.3	94	27.0	30.0	34.6	47.5
70	69.5	54.2	44.3	70.5	95	30.0	30.7	32.9	35.9

Receptor	Nth Stk 1		Sth Stk 1		Receptor	Nth Stk 1		Sth Stk 1	
	C'Puff	GRAL	C'Puff	GRAL		C'Puff	GRAL	C'Puff	GRAL
71	83.9	62.9	74.1	76.6	96	33.5	32.3	35.4	52.0
72	46.9	88.4	51.3	115.1	97	31.6	32.3	39.9	50.7
73	53.9	60.5	54.8	73.9	98	32.6	25.1	40.2	40.2
74	56.9	113.7	55.8	117.0	99	29.1	46.1	35.7	61.8
75	46.4	53.1	39.0	65.5	100	31.7	33.5	41.4	42.3
76	49.9	50.7	45.8	69.2	101	22.0	31.8	34.2	46.9
77	43.4	87.9	47.2	88.4	102	44.7	62.7	47.6	82.9
78	43.7	87.5	42.7	105.1	103	47.0	66.7	47.6	88.3
79	39.2	67.9	42.4	93.3	104	50.9	87.6	58.6	105.0
80	40.4	74.8	49.7	104.1	105	101.5	102.0	72.6	105.6
81	58.9	46.2	50.7	82.0	106	75.7	58.9	40.5	79.9
82	58.6	52.3	50.3	67.9	107	72.1	66.9	47.2	83.6
83	44.8	44.9	46.4	58.6	108	57.5	46.5	38.8	70.5
84	50.6	54.8	51.4	68.6	109	46.9	38.9	48.7	52.0
85	51.1	58.2	52.8	61.3	110	32.8	33.1	41.2	45.3
86	56.5	85.9	51.9	88.4	111	40.9	41.3	40.8	52.5
87	44.0	37.9	35.0	65.6	112	54.0	50.6	40.7	67.7
88	52.9	64.8	34.2	64.9	113	36.3	41.0	33.4	52.9
89	32.8	53.4	34.5	60.1	114	68.0	31.9	41.3	48.0

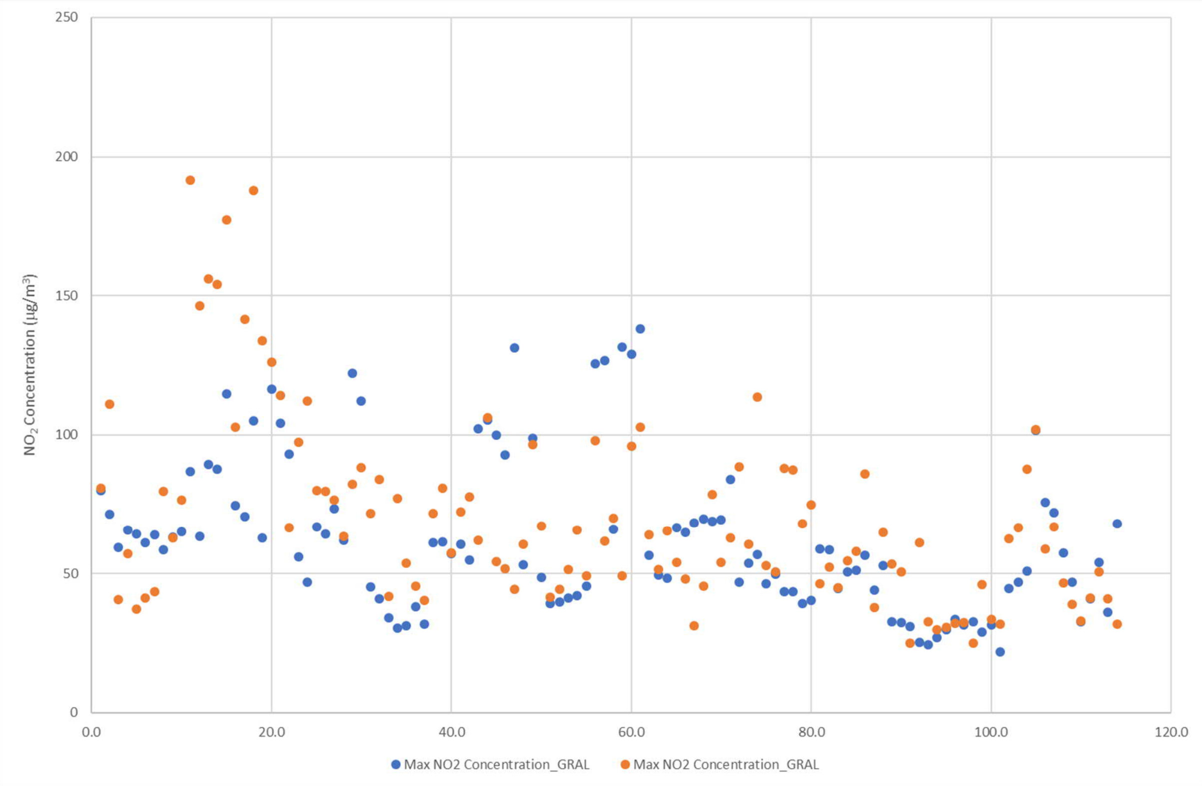


Figure 43 North Stack 1 CALPUFF vs GRAL Comparison (ground level receptors 1-114)

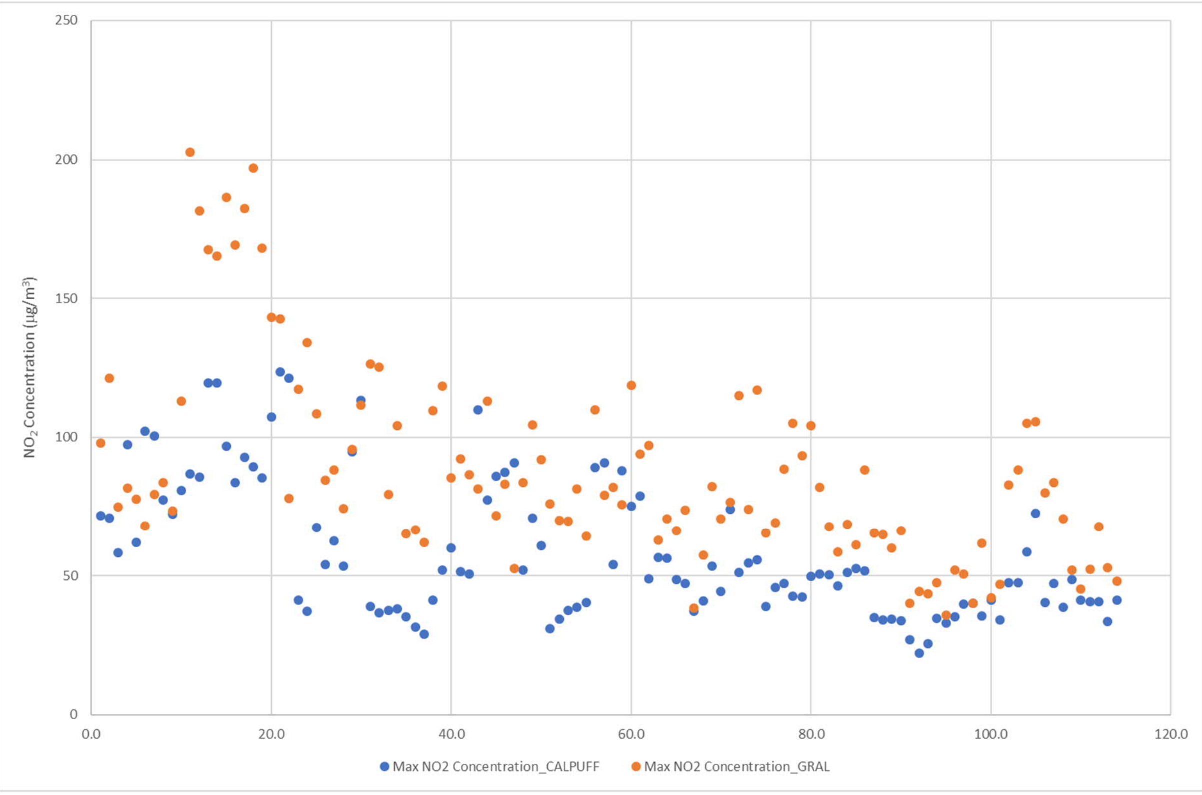


Figure 44 South Stack 1 CALPUFF vs GRAL Comparison (ground level receptors 1-114)

An analysis of the two dispersion models indicates the following:

1. Both dispersion models predict similar concentrations across the modelling domain.
2. There were some receptors that were observed to have higher predicted concentrations for the GRAL model as compared to the CALPUFF model. These receptors had GRAL predicted NO_2 concentrations approximately double the CALPUFF predicted concentrations. When these receptors were identified it was shown that the receptors were those situated very close to the Data Centre building to the west to north. These locations are situated close to tall buildings which had short stacks just above the height of the building and complex wind flows from the buildings themselves. Given GRAL's ability to handle complex wind flows in the micros-scale, the predictions from GRAL are thought to be more reliable than CALPUFF that does not predict wind flows around buildings and considers wake effects through the use of an empirical relationship (BPIP) rather than through direct modelling of the air flow pathways.
3. Receptors beyond approximately 250-300m from the source (generally receptors higher than receptor 60) had results that were lower and predictions for both models were much closer. This was likely due to the lower influence of buildings at higher distances from the source and that the plume is likely to have fully mixed to ground level by this time resulting in ground level plume dispersion.

Based on the results obtained from the dispersion modelling comparison run, the GRAL and CALPUFF result appear to be similar in magnitude with differences in predictions noted for the receptors close to the buildings. The differences are expected to be due to the more advanced dispersion mechanism used by the GRAL model close to the source. Given the above comparison results, the GRAL modelling results are considered more reliable than CALPUFF in this situation and are considered acceptable for the assessment of the Data Centre.

Appendix D

Modelled Meteorological Data

Appendix D Modelled Meteorological Data

The following appendix presents a summary of the following aspects of the modelling:

1. GRAMM Settings for the Meteorological data generation;
2. Analysis of the long term regional meteorological data sourced from the BoM Sydney Olympic Park monitoring station. This data serves as a baseline for the comparison of the meteorological data extracted from the CALMET meteorological model; and
3. Analysis of the meteorological location for which data was extracted for the GRAMM domain has been examined to demonstrate that the data are representative of local conditions.

Meteorological Data Modelling Procedure and Settings

In the absence of site-specific meteorological observations, a meteorological dataset has been prepared using a combination of regional meteorological observations from Bureau of Meteorology (BoM) and NSW Office of Environment and Heritage (OEH) stations, databases of terrain and land use, as well as gridded meteorological data from the CSIRO TAPM prognostic meteorological model. The following sections provide an overview of each of the processes.

TAPM

The Air Pollution Model (TAPM) is a prognostic meteorological and air pollution model developed by CSIRO. The model can be used to predict three-dimensional meteorology, including terrain-induced circulations and is connected to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic-scale meteorological analyses for various regions around the world. TAPM was used in this assessment to generate individual upper air meteorological file for input into the CALMET model.

The initial and lateral boundary conditions for the TAPM simulation use 6-hourly three-dimensional analysis fields from the Global Forecast System. Settings within the TAPM model have been outlined below.

CALMET

CALMET is the meteorological pre-processor for the CALPUFF dispersion model. CALMET has been used in this process to collectively process the gridded TAPM and surface observation data in conjunction with terrain and land use data to produce hourly 3-dimensional gridded arrays of meteorological parameters.

TAPM upper air files have been used within CALMET as an ‘initial guess’ field in which meteorological parameters are initialised prior to the application of a range of diagnostic flow corrections, which are based on physical and empirical algorithms. This process involves resolving blocking, channelling, slope flow and kinematic effects across the CALMET grid, as based on iterative processes. Once this stage is complete, surface observations are incorporated in an objective process, using domain specific weighting values. This approach allows the model to incorporate actual observations, whilst also reflecting variations in micrometeorology at across the modelling.

BoM and OEH Surface Station Meteorological Analysis

The representativeness of the surface observation station nearest the project site is critical to the configuration of the CALMET control files. A station that is nearby and is representative of the project location is given more weight so that its influence extends to the project location. For a station that is nearby and not representative, such as a surface station located in terrain, or a significant distance from the project location, then the surface observation is weighted less (or discounted for use in the model) and will have less influence over the model domain and the nearby project location.

The Macquarie Park project site has five surface observation stations in the general area within about 12 km. The data from the OEH station at Lindfield was not included because it is not considered to be representative of the area due to siting considerations. Tall trees located close to the Lindfield station on the north side likely block winds blowing from that direction. The location of the stations considered for this project has been provided in

Table 36.

Table 36 Sydney Area Surface Station Locations used in the model

Weather Station	Operator	Easting (km UTM)	Northing (km UTM)	Distance from Project Location (km)
Macquarie Park	OEH	325.681	6262.271	1.7
Sydney Olympic Park (air pressure only)	BoM	321.576	6254.605	7.8
Observatory Hill	BoM	333.955	6251.839	11.5
Fort Denison	BoM	335.837	6252.520	12.4

A review of the meteorological data from the BoM Sydney Olympic Park met station for the years 2014 to 2019 was carried out to determine a representative year of data for use in the CALMET modelling. Consideration was given to a range of different parameters, including wind speed & direction, percentage of calms and their comparison to the long-term BoM Sydney Olympic trends. Additionally, an analysis of the Southern Oscillation Index (SOI) was undertaken to ensure the year of meteorological data selected for the model was not adversely impacted by either an El Nino or La Nina event. The data analysis is presented in **Table 37**.

Table 37 Multi-Year Meteorological Data Analysis – Sydney Olympic Park

Sydney Olympic Park BoM data	Calm (%)	Wind Speed (m/s) #	Calm (%)	Wind Speed (m/s) #	Calm (%)	Wind Speed (m/s) #	SOI Avg.
	6:00 AM		3:00 PM		All Hours		
8-year trend	29.2	1.2	1.3	4.1	19.9	2.3	-
2014	24.4	1.2	1.1	4.1	17.3	2.4	-3.0
2015	23.8	1.2	1.6	4.0	20.7	2.3	-11.2
2016	30.1	1.2	1.6	4.0	20.8	2.3	-3.1
2017	32.9	1.1	1.1	4.0	23.0	2.2	2.2
2018	33.4	1.1	0.3	4.3	16.1	2.3	1.0
2019	30.7	1.1	0.8	4.1	16.9	2.2	-7.0

Average wind speed

A comparison of 2014 to 2019 wind speed and calms frequency data by hour of day for the BoM Sydney Olympic Park station is shown in **Figure 45**. This shows that there is not a great difference in average wind speeds and calm frequency from year to year. Night times are characterised by a high frequency of calms and low wind speeds. Daytime conditions show a much lower frequency of calms with higher winds speeds. The chosen year for modelling, 2018, shows slightly higher wind speeds during the day and a higher frequency of calms during the early morning compared with the other years. However, the differences are not great when compared with other years.

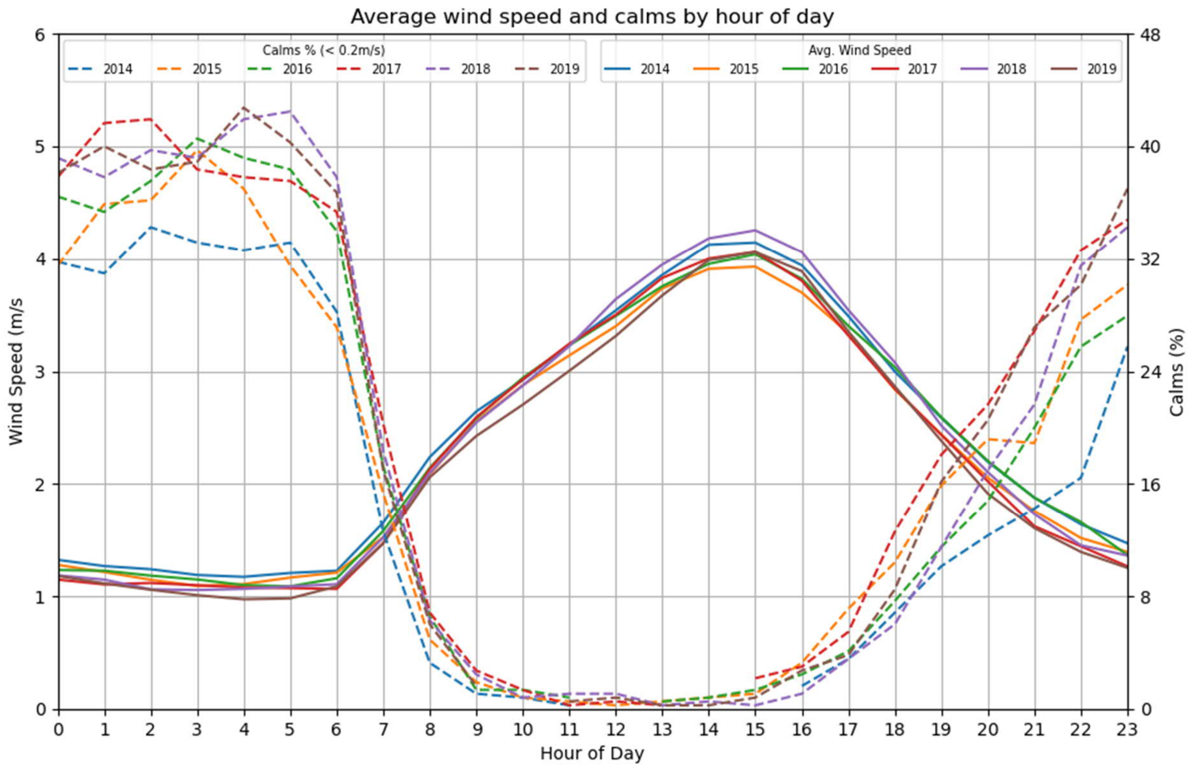


Figure 45 Comparison of 2014 to 2019 average wind speed and calms frequency at BoM Sydney Olympic Park

Based on the data analysed, the year 2018 was chosen as the representative year of meteorology to use in CALMET. The primary reason for this year being selected was the neutral SOI index for the year. An SOI value close to zero (such as in 2018) indicates that meteorological data for that year was not highly impacted by an El Nino/La Nina event, and is likely to indicate a fairly typical year in terms of climate. As shown in **Figure 45**, there is not a lot of difference between each calendar year for daytime wind speeds and frequency of calms. Based on these reasons, the meteorological data for 2018 were considered acceptable for use in the model.

TAPM Configuration

Upper air data for the CALMET model was derived from The Air Pollution Model (TAPM). For the purpose of this assessment, upper air data was extracted the generated TAPM data at four locations for input into the CALMET model. TAPM settings and the locations of the extracted upper air data used in CALMET are provided in **Table 38**.

Table 38 TAPM Settings

Parameter	Setting
TAPM Version	4.0.5
Grid centre coordinates (km UTM)	326.500, 6260.700
Date parameters	2018 01 01 to 2018 12 31
Number of grid points	nx = 25
	ny = 25
Grid spacing	Outer = 30,000 m
	Inner = 1,000 m
Number of grid domains	4
Number of vertical grid levels	nz = 25

Parameter	Setting
Observation file	Not used
Locations of upper air data extracted for CALMET (km UTM)	332.500, 6266.700; 333.500, 6256.700; 318.500, 6255.700; 320.500, 6267.700

The modelling domains generated in the TAPM model provide prognostic data across four nested grids. The first outer grid covers an area of 562,500 km^2 at 30 km resolution. The nested grids step down progressively in dimensions, to the final innermost grid, which covers an area of 625 km^2 at a resolution of 1,000 m. In the vertical direction there are 25 levels (40 layers) from the surface to 100 hPa. The lowest layer is approximately 10m above the ground.

CALMET Configuration

The CALMET meteorological modelling domain has been configured to encompass the region surrounding the Project site, covering nearby sensitive receptors and key terrain features.

Table 39 presents a summary of the domain settings along with key model parameters used within CALMET to generate the meteorological fields. Explanations of these parameters are available in the following guidance document:

- TRC, 2011, 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'.

Table 39 CALMET modelling parameters for the project domain

Parameter	Value
Meteorological grid domain	26 km x 26 km
Meteorological grid resolution	200 metre resolution (130 x 130 grid cells)
Reference grid coordinate (SW corner)	328.000 km E, 6259.000 km S
Cell face heights in vertical grid (m)	0,20,40,80,160,320,640,1200,2000,3000,4000
Simulation length	1 year (2018)
Surface meteorological stations	Macquarie Park (OEH) Sydney Olympic Park (BoM) Sydney Observatory Hill (BoM) (pressure only) Fort Denison (BoM)
Upper air meteorology	4 x TAPM derived up.dat files
CALMET Modelling Mode	Observations mode
Terrain data	Terrain elevations were extracted from NASA Shuttle Radar Topography Mission Version 3 data set (SRTM1 30 metre resolution).
Land use Data	Site-specific creation based on USGS data system
Wind field guess	Compute internally
Seven critical CALMET parameters	TERRAD = 7 km RMAX1 = 2 km R1 = 1 km RMAX2 = 4 km R2 = 1 km IEXTRP = -4 BIAS = -1,-0.5,0,0.5,1,1,1,1,1,1

Land Use

Land use data was been mapped to the modelling domain from the USGS GLCC 1 kilometre land use dataset, which is the most common land use database in Australia.

Terrain

Terrain data presented in **Figure 46** has been interpolated to the modelling grid from the NASA Shuttle Radar Topography Mission Version 3 data set (SRTM1 30 metre resolution). The Project site is marked by a red dot, with the surface stations marked by blue squares and the upper air data locations marked by black triangles.

The Project site is located at about 55 m elevation on a hilltop ridge with a valley running northwest to southeast immediately to the east of the site. The Macquarie Park OEH station (S4) is located just to the northwest in similar terrain. Due to the proximity and similar terrain, wind speed and direction are expected to be fairly similar between the Project site and the OEH station site.

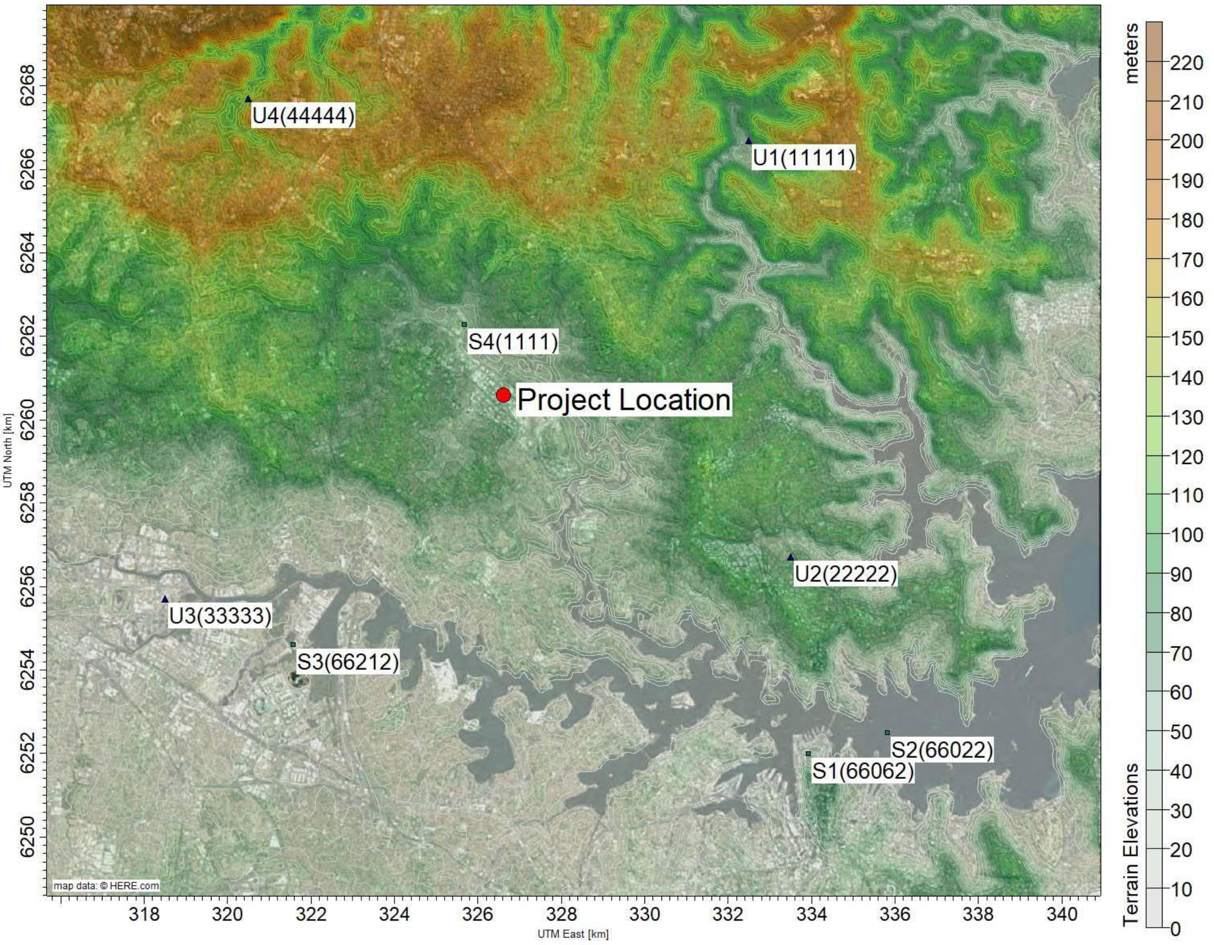


Figure 46 CALMET modelled terrain and location of met stations

CALMET Meteorological Data Review

This section presents a summary of CALMET model predictions at the proposed project location (Site), with reference against observations recorded at the OEH Macquarie Park monitoring station. This OEH station constitutes the closest comparable observations station within the modelling domain. The OEH Macquarie Park station is located approximately 1.7 km northwest from the Site (see **Figure 46** – OEH Macquarie Park is denoted by S4 (1111) in the centre of the figure).

Winds

Wind predictions were extracted from CALMET at the Project site for reference against longer term (2017 to 2020) regional observations at OEH Macquarie Park. The following wind roses present a comparison between the two data sets.

Annual winds for the CALMET data at the Project site are compared against winds at OEH Macquarie Park (2017 to 2020) in **Figure 47**. Average wind speeds are very slightly higher in the CALMET data but are consistent between the two stations. There are differences in the direction of the predominant northwest winds, with the CALMET data showing a slightly more westerly component and the OEH Macquarie Park showing slightly more northerly component. The annual frequency of calms for the CALMET data (3.6 %) is slightly higher than that for OEH Macquarie Park (1.5 %). Generally, a higher frequency of calms in modelling data is more conservative as pollutant dispersion is weak under calm conditions.

Overall, the wind roses show a typical pattern for a location in the Sydney basin.

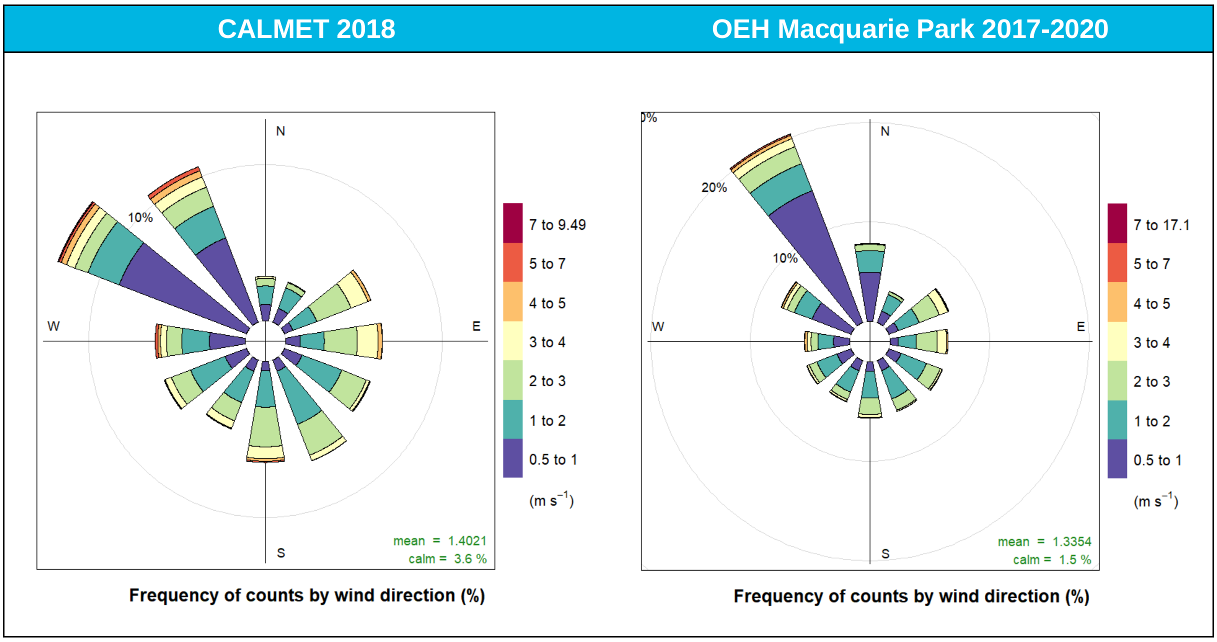


Figure 47 Annual wind roses for CALMET Project site 2018 and OEH Macquarie Park 2017-2020

Seasonal winds for daylight and night-time hours predicted by CALMET at the Project site for 2018 are presented in **Figure 48**. For comparison identical wind roses for OEH Macquarie park for 2017 to 2020 are presented in **Figure 49**.

Daytime winds are quite variable in terms of direction during spring and autumn. Winter daytime winds re dominated by west to northwest winds, while easterly sea breezes dominate daytime conditions during summer.

Night-time winds are dominated by northwest winds during all seasons at both the Project site and OEH Macquarie Park. The frequency of night-time calms is higher in the CALMET data during summer (9.1 %) and lowest in winter (2.8 %). A similar pattern is seen in the OEH data, although the frequencies of calms are lower than in the CALMET data.

Overall, the two data sets are very similar and the wind patterns modelled in CALMET reflect the measurements taken over the 2017 to 2020 period at OEH Macquarie Park.

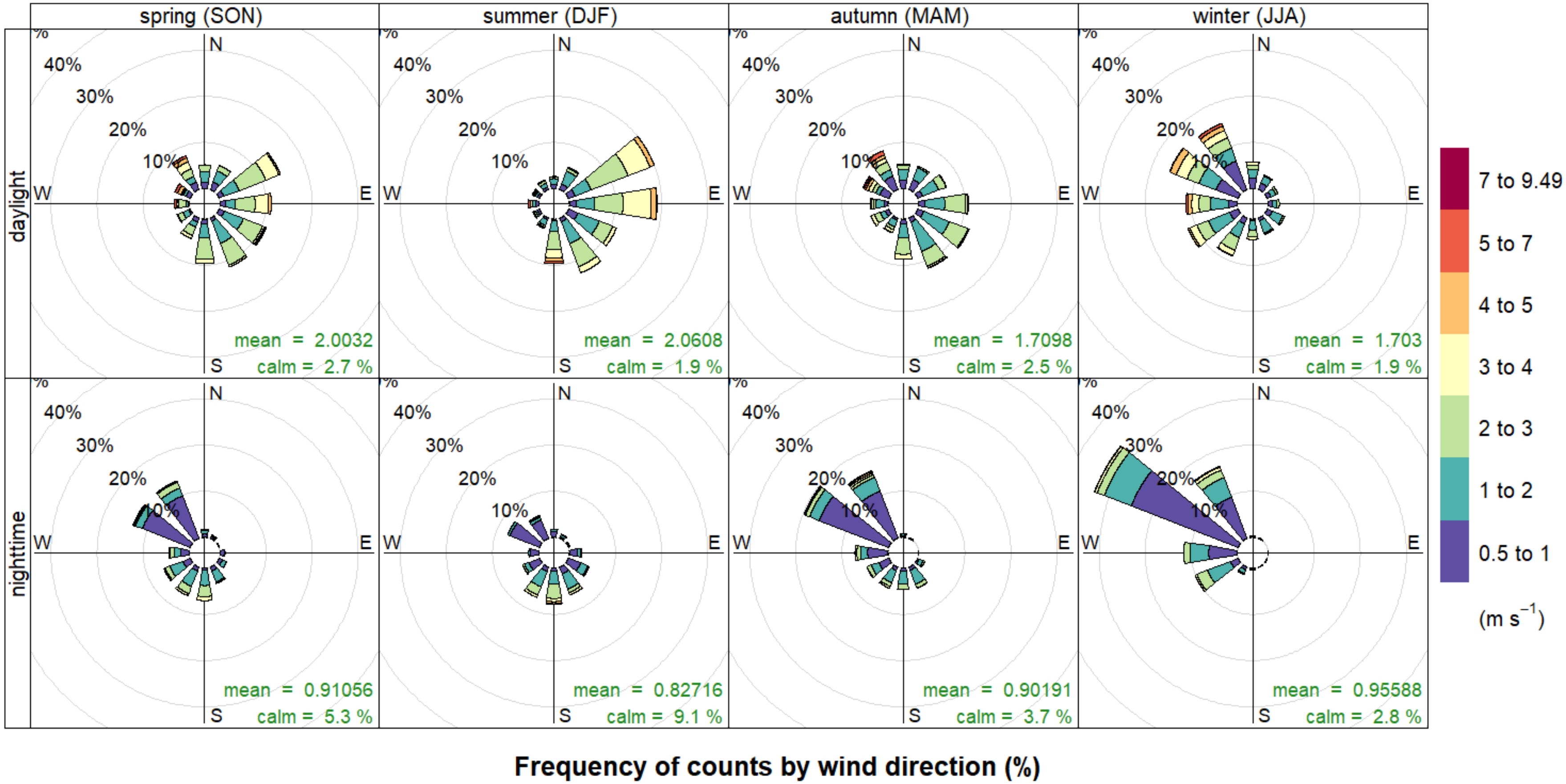


Figure 48 Seasonal wind roses by daylight and night-time hours for CALMET 2018

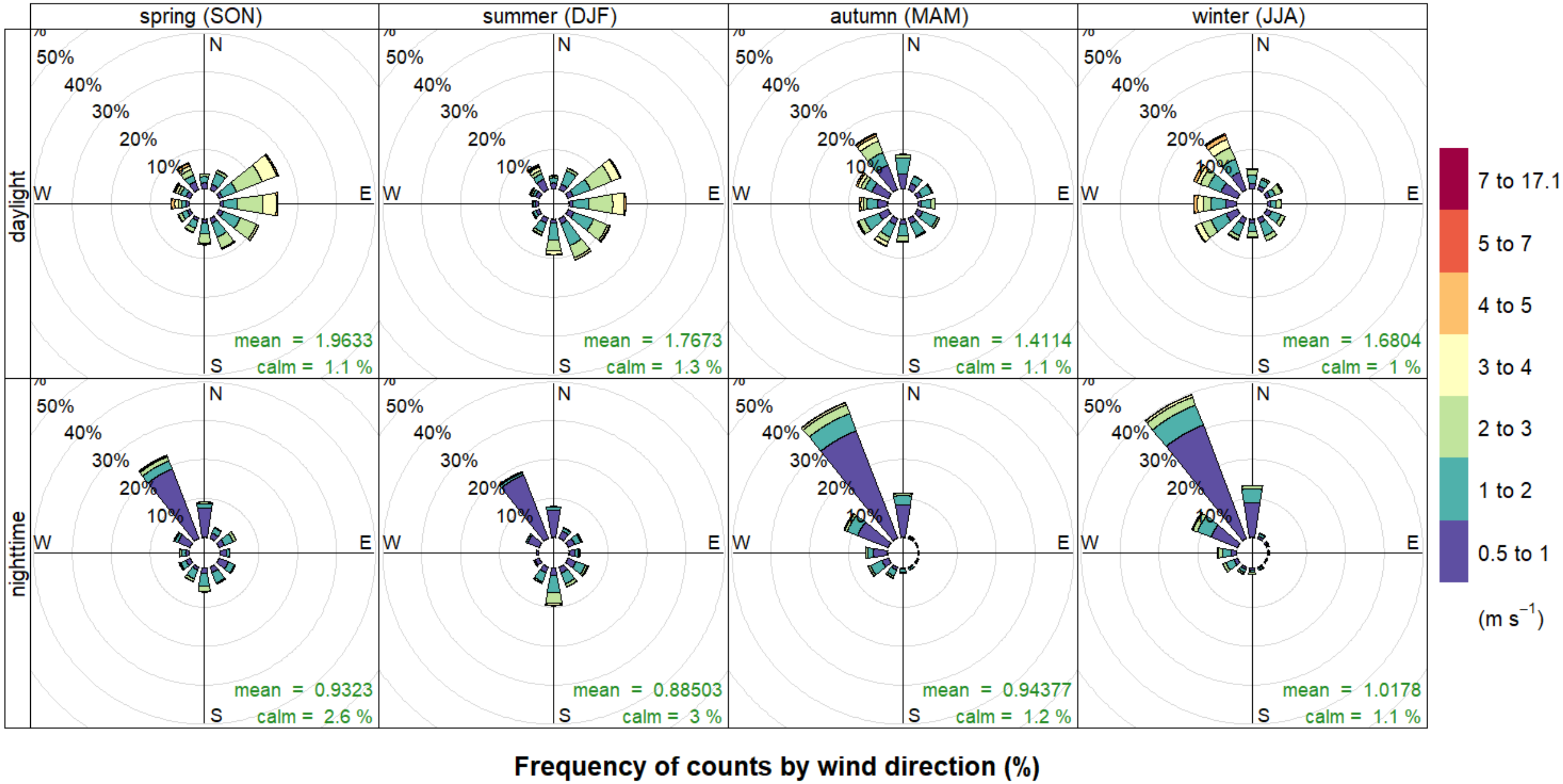


Figure 49 Seasonal wind roses by daylight and night-time hours for OEH Macquarie Park 2017 to 2020

Temperature

Temperature data is estimated within CALMET for each hour of the meteorological data set. A plot of the temperature data predicted by CALMET at ground level at the Project site is presented in **Figure 50**. The results are consistent with expected patterns for the Sydney Basin.

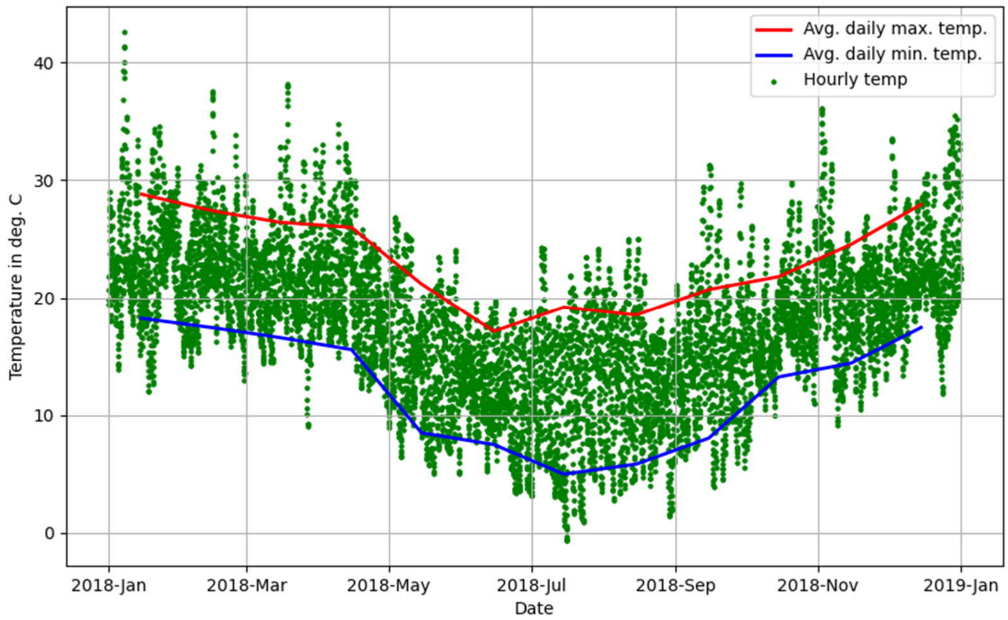


Figure 50 Temperature data for the CALMET 2018

Mixing Height

Mixing height is estimated within CALMET for stable and convective conditions (respectively), with a minimum mixing height of 50 m. **Figure 51** presents mixing height statistics by hour of day across the meteorological dataset, as generated by CALMET at the Project site. These results are consistent with general atmospheric processes that show increased vertical mixing with the progression of the day, as well as lower mixing heights during the night. In addition, peak mixing heights (up to 3000 m) are consistent with typical ranges.

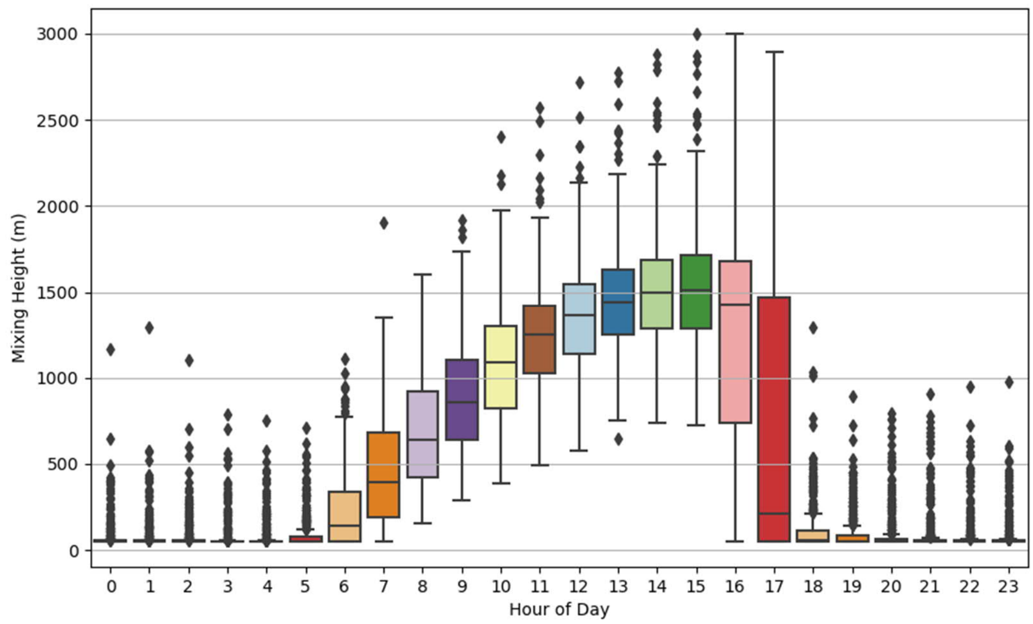


Figure 51 Mixing Height Statistics by Hour of Day for CALMET 2018

Atmospheric Stability

Stability class is used as an indicator of atmospheric turbulence for use in meteorological models. The class of atmospheric stability generally used in these types of assessments is based on the Pasquill-Gifford-Turner (PG) scheme where six categories are used (A to F) which represent atmospheric stability from extremely unstable to moderately stable conditions respectively. The stability class of the atmosphere is based on three main characteristics, these being:

- Static stability (vertical temperature profile/structure)
- Convective turbulence (caused by radiative heating of the ground)
- Mechanical turbulence (caused by surface roughness).

Whilst CALPUFF centrally uses Monin-Obukhov (MO) similarity theory to characterise the stability of the surface layer, conversions are made within the model to calculate the PG class based on Golders method (Golder 1972[1]) as a function of both MO length and surface roughness height.

Figure 52 presents an analysis of stability class frequency against wind speed for the CALMET data and confirm a typical distribution; lower wind speeds are dominated by moderately stable conditions, and high winds speeds are dominated by neutral conditions.

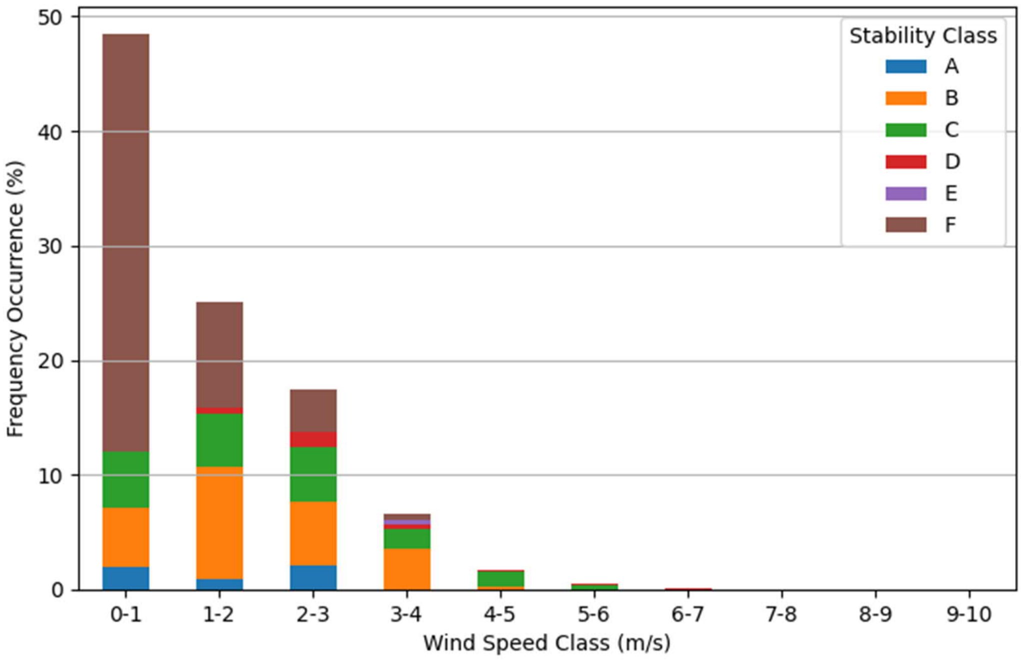


Figure 52 Stability Class Frequency by Wind Speed CALMET 2018

Figure 53 presents an analysis of CALMET stability class data by hour of the day and confirms a typical distribution; night time hours are dominated by moderately stable conditions, day time hours are dominated by slightly and moderately unstable conditions.

[1] Golder, D. 1972, "Relations among stability parameters in the surface layer", Boundary Layer Meteorology, 3, 47-58

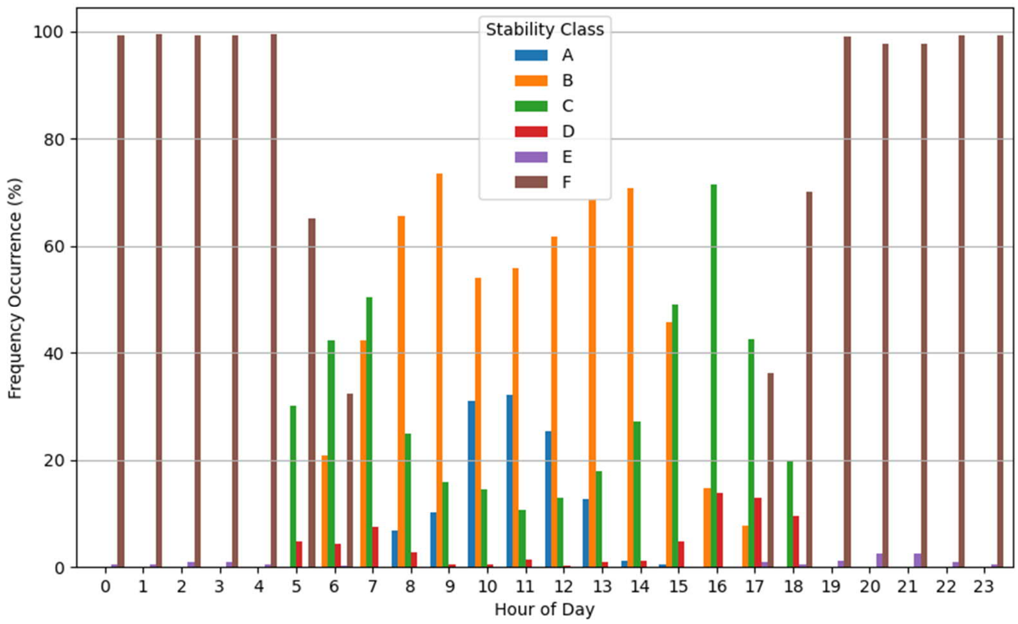


Figure 53 Stability Class by Hour of Day CALMET 2018

Conclusion

A 12-month meteorological dataset has been prepared for the Project site using a combination of local observations and prognostic modelling. Data has been evaluated using hourly observation data. The findings of the data analysis show that the CALMET model is performing well. The predicted meteorology is fit for purpose and acceptable for use in modelling of emissions from the Project site.

Appendix E

All Receptor Model Results (0.5m AGL, 5m AGL, 10m AGLand 15m AGL)

Appendix E All Receptor Model Results (0.5m AGL, 5m AGL, 10m AGL and 15m AGL)

Predicted receptor concentrations extracted from the modelling have been presented below. The receptor elevations modelled were 0.5m, 5m, 10m and 15m above ground level.

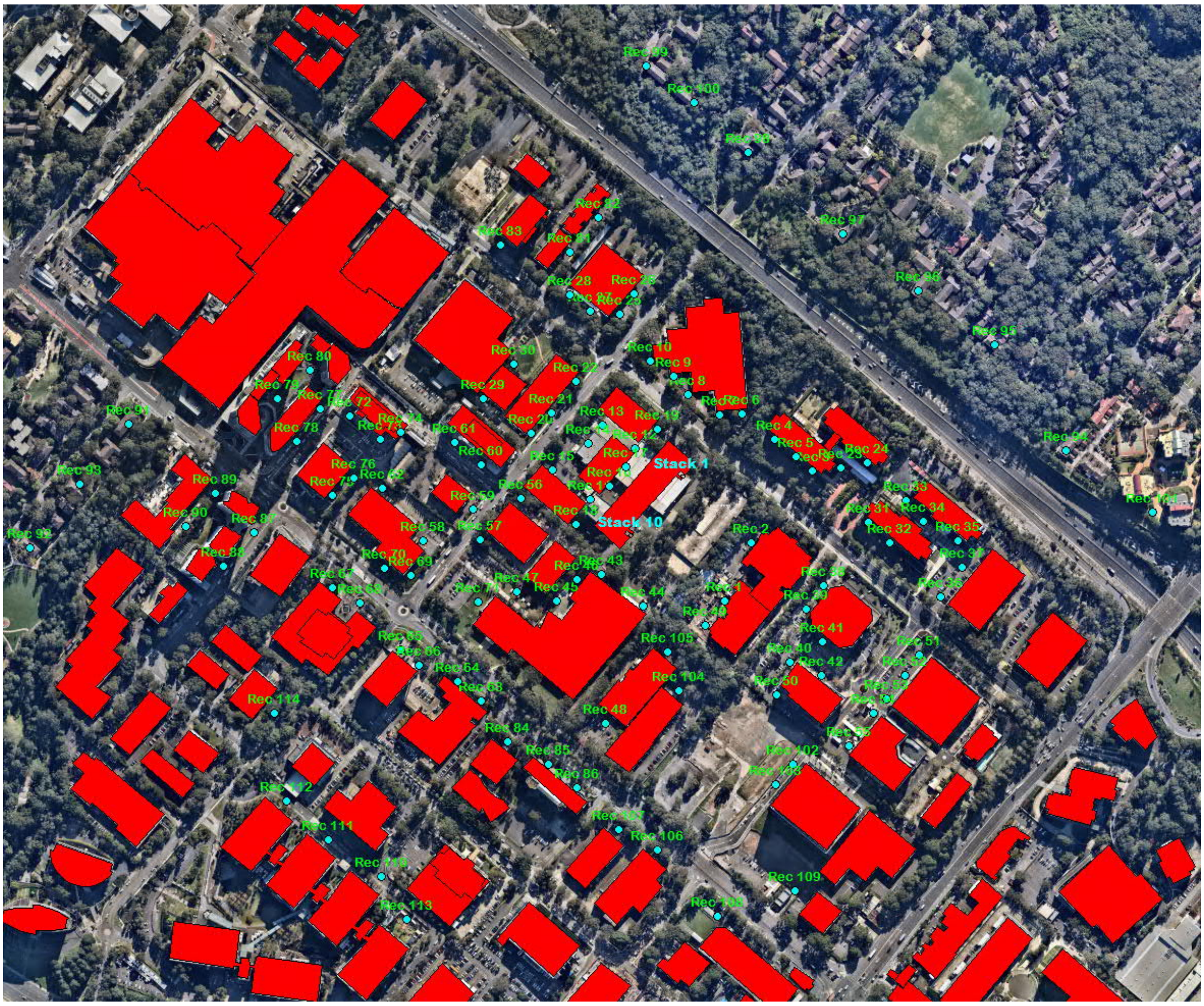


Figure 54 All Receptor Locations

Results are presents as the maximum of the following operational modes:

- 18 generators tested once per month for 15 minutes per generator – assuming 10% load
- 18 generators tested once per month for 1 hour per generator – assuming 50% load
- 18 generators tested once per quarter for 15 minutes per generator – assuming 100% load

Predicted concentration in isolation from background are presented for the following pollutants and averaging periods:

- 1-hour Maximum NO_2 concentration for CAT and Cummins Engines
- 1-hour Maximum CO concentration for CAT and Cummins Engines
- 24 Hour Max $PM_{2.5}$ concentration for CAT and Cummins Engines
- 99.9th Percentile concentration of VOC Species (Acetaldehyde, Benzene, Formaldehyde, Toluene, Xylene, PAH) for CAT and Cummins Engines

Table 40 1 Hour Maximum NO_2 Concentrations – All receptor elevations, all operational modes

Receptor ID	Max 1 Hour NO_2 Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	246							
Maximum	185.6	181.9	170.6	183.6	187.7	184.0	184.0	183.2
1	79.6	69.1	68.8	68.0	73.4	68.7	68.6	70.6
2	98.1	75.2	73.5	78.1	94.1	76.1	73.7	74.5
3	85.6	78.4	79.6	69.3	86.1	82.5	77.5	74.8
4	80.8	77.5	69.1	70.2	80.2	77.7	76.1	71.7
5	78.2	78.7	77.7	75.5	79.3	78.8	78.0	74.0
6	48.5	35.9	53.6	50.1	51.5	32.3	58.0	52.2
7	59.1	44.0	53.2	50.7	58.3	43.9	57.3	49.1
8	77.6	70.5	70.3	67.8	74.3	63.4	64.0	68.3
9	60.8	58.0	63.0	62.7	60.8	58.2	62.8	59.9
10	79.4	65.2	62.6	60.9	79.8	60.1	65.1	61.0
11	185.6	181.9	170.6	183.6	187.7	184.0	184.0	183.2
12	153.7	146.1	142.1	141.7	151.0	143.0	142.1	138.6
13	150.5	140.4	152.8	153.0	148.1	146.4	146.0	154.9
14	148.6	144.3	144.8	146.2	148.3	144.7	146.0	146.3
15	169.6	165.7	155.6	163.0	166.9	163.1	163.6	155.5
16	130.1	114.6	124.4	122.0	121.0	117.2	99.1	98.9
17	156.8	147.4	125.9	126.9	155.5	136.9	126.8	122.9
18	174.1	153.5	154.7	162.6	183.6	166.6	164.4	162.7
19	139.3	132.3	129.7	130.5	136.7	129.3	129.2	127.1
20	142.6	116.6	115.8	111.3	132.8	121.3	118.2	124.4
21	97.6	84.2	90.0	89.9	94.0	86.7	89.8	90.5
22	83.8	86.3	85.2	85.8	74.2	85.7	87.7	84.0
23	75.2	66.1	59.7	65.7	79.0	69.2	64.1	60.6
24	98.4	98.7	98.3	96.9	112.0	97.7	99.9	97.9
25	80.3	57.4	70.2	53.7	79.6	66.7	73.0	64.4
26	62.0	60.9	69.1	50.8	60.7	53.6	64.4	53.1
27	51.1	48.3	53.7	46.6	55.3	45.4	55.5	49.7
28	50.9	44.0	42.9	39.4	65.0	46.8	41.2	41.1
29	72.9	60.9	66.9	72.4	63.4	60.4	75.2	70.0
30	84.9	84.2	81.8	71.4	85.4	80.6	79.8	73.2
31	120.3	85.9	76.0	75.2	110.9	83.9	77.9	69.9
32	104.7	75.1	77.3	64.0	119.2	93.5	85.2	69.5
33	60.9	46.4	42.9	43.4	58.3	48.6	45.2	44.5

Receptor ID	Max 1 Hour NO_2 Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
34	72.0	68.9	66.7	61.2	71.6	68.7	69.1	60.9
35	52.2	44.3	45.6	46.4	60.8	46.5	46.0	45.9
36	46.0	37.4	36.7	38.5	45.3	36.5	39.1	39.3
37	42.0	33.7	31.0	37.4	45.1	34.7	32.8	34.6
38	70.4	59.5	57.6	64.2	68.3	60.9	58.0	66.1
39	93.6	76.0	68.9	72.2	99.3	73.8	69.6	73.5
40	56.2	47.7	53.5	56.3	54.8	55.0	60.6	60.1
41	81.4	64.1	55.2	63.9	87.1	72.2	58.8	69.0
42	71.3	52.3	50.6	52.7	71.5	59.9	47.8	54.5
43	59.3	61.6	71.7	71.7	61.5	62.6	65.3	63.9
44	102.6	95.6	91.5	90.0	104.0	100.5	90.7	84.6
45	41.8	31.1	35.7	50.4	43.8	36.6	37.2	50.3
46	39.5	35.7	40.3	41.7	45.0	33.5	37.8	41.5
47	39.7	39.0	49.9	56.1	45.1	40.4	46.6	54.7
48	51.5	43.4	40.5	41.4	48.8	41.1	39.9	41.0
49	77.0	68.2	66.7	75.4	78.2	69.4	69.6	66.9
50	57.9	41.5	44.4	45.2	59.9	43.3	45.7	42.6
51	37.5	32.7	31.8	34.6	44.8	31.8	33.9	35.3
52	47.1	36.4	36.2	36.7	44.8	39.5	39.8	35.6
53	53.6	42.1	38.9	39.4	49.4	43.5	39.2	40.2
54	54.3	43.9	42.6	42.8	55.5	43.2	43.0	41.9
55	43.4	34.7	36.1	38.2	46.4	35.6	35.7	37.5
56	138.8	136.3	134.2	153.0	145.7	137.0	154.1	173.9
57	90.5	69.6	78.1	79.4	77.5	71.5	74.8	78.2
58	81.3	74.6	66.9	63.0	87.4	71.8	65.8	64.9
59	85.9	74.9	83.2	83.5	91.7	76.9	85.9	86.8
60	68.9	54.0	49.1	67.0	71.7	59.4	57.4	66.6
61	69.3	59.5	46.9	48.3	69.5	57.6	52.6	54.4
62	69.4	53.6	46.1	39.1	73.0	46.8	43.8	38.0
63	53.3	38.9	38.9	42.7	51.2	41.2	39.8	40.0
64	54.3	39.7	41.9	40.7	54.5	44.0	43.2	42.1
65	56.3	49.2	46.0	48.5	53.1	49.5	45.6	46.1
66	55.2	51.1	46.2	43.8	58.1	53.5	52.9	41.8
67	38.2	42.8	43.9	45.3	40.2	45.2	44.9	44.2
68	49.6	46.8	43.3	46.2	51.4	43.4	45.7	41.7
69	89.4	61.0	56.8	53.5	84.0	61.3	65.2	56.1

Receptor ID	Max 1 Hour NO_2 Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
70	65.8	56.1	51.0	51.9	63.5	62.2	53.1	50.4
71	68.5	56.6	55.9	59.6	78.9	59.1	57.7	58.9
72	70.2	57.9	53.5	53.9	67.6	55.7	52.7	52.8
73	59.6	53.3	51.2	44.1	55.5	53.0	46.8	45.3
74	70.2	55.4	50.9	46.2	77.8	55.7	53.5	55.1
75	54.9	40.5	31.1	41.2	57.8	41.4	29.9	40.6
76	48.3	37.6	38.4	33.3	44.7	35.7	37.5	38.5
77	69.3	59.0	57.0	57.7	68.8	65.2	59.1	56.2
78	67.7	52.3	48.1	49.3	71.5	54.1	50.4	52.3
79	60.6	47.4	44.2	40.3	66.0	45.5	42.4	48.1
80	66.9	54.9	48.1	44.5	68.2	55.5	51.3	44.2
81	46.6	33.8	39.1	35.6	42.4	40.5	37.4	39.6
82	51.0	42.0	42.7	44.2	50.2	49.1	40.2	41.2
83	42.4	36.8	32.7	34.3	45.1	35.8	33.8	34.8
84	50.2	37.5	41.1	37.0	52.0	38.8	40.7	36.0
85	44.1	35.0	35.9	35.3	49.3	30.8	31.6	32.4
86	70.9	58.0	48.5	44.4	71.5	53.7	50.4	47.7
87	47.7	38.7	33.8	35.6	51.1	41.9	34.8	33.5
88	64.8	49.9	44.3	33.7	74.8	51.6	42.3	37.3
89	56.1	39.5	34.3	32.5	68.3	34.4	32.1	32.5
90	50.4	39.5	40.9	35.6	52.1	35.3	41.4	33.7
91	30.8	29.1	30.3	27.9	35.7	27.1	26.3	31.2
92	32.0	31.9	27.9	29.6	27.3	23.6	31.2	28.9
93	27.5	31.3	23.2	27.8	26.4	25.9	26.1	28.4
94	31.6	30.9	31.1	30.3	29.0	32.0	34.0	32.6
95	22.7	24.1	23.8	26.5	25.5	23.5	25.8	25.6
96	28.0	28.0	30.3	29.4	29.8	31.3	29.4	27.7
97	29.4	25.6	23.8	26.7	28.3	23.7	25.3	24.9
98	19.4	22.5	25.4	27.5	18.9	21.9	25.6	27.0
99	48.6	25.0	23.0	24.5	39.5	25.8	23.4	22.9
100	22.3	23.7	25.1	27.7	22.6	25.6	26.2	25.5
101	29.8	35.3	33.5	30.5	28.5	34.1	34.5	33.0
102	61.3	44.1	36.5	38.3	54.6	39.9	45.8	38.9
103	47.2	44.1	42.2	39.9	47.1	42.6	42.7	42.2
104	67.5	54.9	52.7	52.9	68.5	62.3	55.1	53.8
105	88.0	70.5	76.1	67.1	83.8	67.0	72.2	64.1

Receptor ID	Max 1 Hour NO_2 Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
106	48.1	38.9	34.6	32.9	45.8	35.3	36.9	32.3
107	45.5	36.5	35.6	34.5	52.4	38.4	35.9	33.1
108	39.7	28.9	31.4	26.8	46.5	28.7	29.4	28.2
109	31.8	25.4	26.5	25.7	31.7	27.3	24.8	25.2
110	28.0	21.4	22.6	22.9	27.9	24.8	24.1	23.1
111	40.2	32.2	27.2	24.9	32.3	33.8	26.3	24.4
112	35.6	28.6	29.9	26.0	38.6	28.9	27.7	31.6
113	29.1	29.3	27.1	24.4	28.8	28.0	26.0	30.8
114	35.3	38.0	31.7	32.7	36.6	33.7	29.4	30.4

Table 41 1 Hour Maximum CO Concentrations – All receptor elevations, all operational modes

Receptor ID	Max 1 Hour CO Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	30,000							
Maximum	188.0	135.6	107.9	90.6	61.7	39.3	31.3	26.3
1	31.9	29.7	28.7	26.2	9.2	8.6	8.5	7.8
2	49.4	35.8	35.7	34.1	13.3	10.7	10.1	10.6
3	33.1	29.9	26.4	24.2	10.2	9.2	8.7	7.6
4	41.7	31.6	31.7	31.0	11.5	9.4	9.3	9.2
5	28.9	30.4	27.1	25.0	8.1	9.2	8.5	7.4
6	16.3	11.9	17.8	16.6	5.1	3.2	5.8	5.2
7	22.1	14.6	17.6	16.8	5.8	4.4	5.7	4.9
8	36.0	26.4	25.5	26.7	8.9	8.0	7.4	8.1
9	37.6	26.4	32.7	27.7	10.0	7.5	9.2	8.4
10	38.8	26.0	30.8	29.3	10.6	8.5	8.4	8.3
11	188.0	135.6	107.9	90.6	61.7	39.3	31.3	25.3
12	117.1	92.0	78.7	77.3	32.6	24.7	23.7	20.2
13	60.5	53.5	59.0	65.0	18.2	16.0	17.8	20.6
14	74.8	61.5	65.0	61.3	22.1	18.7	19.2	19.7
15	131.7	100.9	84.9	80.4	42.3	30.9	25.2	26.3
16	56.8	42.8	41.2	40.5	12.7	11.7	11.0	10.0
17	72.6	60.0	54.9	53.4	23.0	17.5	15.0	14.6
18	132.2	78.1	64.3	63.0	35.9	21.9	20.1	17.4
19	161.3	100.6	80.8	71.6	43.3	27.9	21.1	18.4
20	53.0	38.7	38.4	36.9	14.5	12.1	11.8	12.4
21	35.4	28.1	30.6	30.2	11.3	9.0	9.2	10.1
22	35.9	37.1	33.2	30.4	10.3	10.6	9.3	9.8
23	28.1	23.2	19.8	21.8	9.2	7.2	6.4	6.0
24	45.9	46.9	47.9	45.3	13.6	13.2	15.3	13.9
25	29.7	20.2	23.3	18.5	8.2	6.7	7.3	6.4
26	26.6	21.3	22.9	16.8	8.0	5.4	6.4	5.3
27	20.5	19.7	18.9	17.3	6.9	5.1	5.7	5.2
28	34.4	23.0	21.8	19.0	9.5	6.7	6.5	5.8
29	24.2	20.2	22.5	24.0	6.6	6.1	7.5	7.0
30	32.4	30.1	27.1	24.2	10.3	8.1	8.0	7.3
31	39.9	28.5	25.2	24.9	11.1	8.8	7.8	7.0
32	35.3	29.2	25.6	21.2	11.9	9.3	8.5	6.9
33	20.2	15.4	14.2	14.4	5.8	4.9	4.5	4.4

Receptor ID	Max 1 Hour CO Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
34	27.9	22.9	22.1	20.3	9.3	6.9	7.1	6.1
35	17.3	14.7	15.1	15.4	6.3	4.6	4.6	4.6
36	15.7	12.4	12.2	12.8	4.5	3.6	3.9	3.9
37	13.9	11.2	10.3	12.4	4.5	3.5	3.3	3.5
38	26.3	19.7	19.1	21.3	8.2	6.2	5.9	6.6
39	31.0	25.2	22.9	23.9	9.9	7.4	7.6	7.3
40	18.6	15.8	17.7	18.7	5.5	5.5	6.1	6.0
41	27.1	21.2	18.3	21.2	8.7	7.2	5.9	6.9
42	23.6	17.3	16.8	17.5	7.1	6.0	4.8	5.4
43	19.7	23.5	33.8	30.8	7.0	8.1	9.5	9.3
44	58.5	46.2	39.8	31.3	18.3	14.0	11.7	9.8
45	13.9	15.2	12.1	17.8	4.4	3.7	3.7	5.2
46	16.4	14.1	13.3	13.8	4.5	3.4	3.8	4.1
47	13.2	12.9	16.5	19.3	4.5	4.0	4.7	5.5
48	17.1	14.4	13.4	13.7	4.9	4.1	4.0	4.1
49	46.6	27.7	23.8	25.0	12.9	9.3	7.9	6.8
50	19.2	14.7	14.7	15.0	6.0	4.3	4.6	4.3
51	12.4	10.8	10.6	11.5	4.5	3.2	3.4	3.5
52	15.6	12.1	12.0	12.2	4.5	3.9	4.0	3.6
53	17.8	14.0	12.9	13.1	4.9	4.3	4.1	4.0
54	18.0	14.5	14.1	14.2	5.5	4.3	4.3	4.2
55	14.4	11.5	12.0	12.7	4.6	3.6	3.6	3.7
56	75.5	64.7	59.7	55.3	24.4	21.2	19.4	17.4
57	30.4	23.1	25.9	26.3	9.9	7.1	7.5	8.0
58	34.5	24.7	22.5	20.9	10.7	7.4	6.6	6.5
59	28.5	25.2	29.0	29.3	10.4	8.5	8.9	8.8
60	27.3	17.9	16.3	22.9	8.5	5.9	5.7	6.7
61	24.2	19.7	15.6	16.0	7.5	5.8	5.2	5.4
62	24.7	17.8	15.3	13.0	7.8	4.7	4.4	3.8
63	19.3	12.9	12.9	14.2	6.1	4.1	4.0	4.0
64	18.0	13.2	13.9	13.5	5.4	4.4	4.3	4.2
65	18.7	16.3	15.2	16.1	5.3	4.9	4.6	4.6
66	18.3	16.9	15.3	14.5	5.8	5.3	5.3	4.2
67	12.7	14.2	14.6	15.0	4.0	4.5	4.5	4.4
68	16.4	15.5	14.4	15.3	5.1	4.3	4.6	4.2
69	29.6	20.2	18.8	17.7	10.4	6.1	6.5	5.6

Receptor ID	Max 1 Hour CO Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
70	21.8	18.6	16.9	17.2	6.3	6.2	5.3	5.0
71	22.7	18.8	18.5	19.7	7.9	5.9	5.8	5.9
72	23.3	19.2	17.7	17.9	6.8	5.6	5.3	5.3
73	19.8	17.7	17.0	14.6	5.5	5.3	4.7	4.5
74	34.1	25.6	19.7	19.1	12.1	7.8	6.1	5.8
75	18.2	13.4	10.3	13.6	5.8	4.1	3.0	4.1
76	16.0	12.5	12.7	11.0	4.5	3.6	3.7	3.8
77	37.2	27.1	22.8	19.1	11.3	7.7	7.4	5.9
78	25.5	17.4	16.0	16.4	7.7	5.4	5.0	5.2
79	20.7	15.8	15.0	13.4	6.6	4.5	5.0	4.8
80	22.6	18.2	15.9	14.8	6.8	5.5	5.1	4.4
81	18.2	13.6	17.4	17.3	4.8	4.2	4.3	4.9
82	16.9	13.9	14.2	14.7	6.4	4.9	4.0	4.1
83	19.2	13.3	13.1	12.8	5.5	4.1	3.8	4.0
84	16.8	12.4	13.6	12.3	5.2	3.9	4.1	3.6
85	14.6	11.6	11.9	12.9	4.9	3.2	3.9	4.0
86	23.5	19.6	16.1	14.7	8.3	5.4	5.0	4.8
87	15.8	12.8	11.2	11.8	5.1	4.2	3.5	3.3
88	21.5	16.5	14.7	11.2	8.0	5.1	4.2	3.7
89	18.6	13.1	11.4	10.8	6.8	3.4	3.2	3.2
90	16.7	13.1	13.6	11.8	5.2	3.5	4.1	3.4
91	10.2	9.7	10.0	9.2	3.6	2.7	2.6	3.1
92	10.6	10.6	9.2	9.8	2.7	2.4	3.1	2.9
93	9.1	10.4	7.7	9.2	2.6	2.6	2.6	2.8
94	10.5	10.2	10.3	10.1	2.9	3.2	3.4	3.3
95	7.5	8.0	7.9	8.8	2.5	2.3	2.6	2.6
96	9.3	9.3	10.0	9.7	3.0	3.1	2.9	2.8
97	9.8	8.5	7.9	8.9	2.8	2.4	2.5	2.5
98	6.4	7.5	8.4	9.1	1.9	2.2	2.6	2.7
99	16.1	8.3	7.6	8.1	3.9	2.6	2.3	2.3
100	7.4	7.9	8.3	9.2	2.3	2.6	2.6	2.5
101	9.9	11.7	11.1	10.1	2.8	3.4	3.4	3.3
102	20.3	14.6	12.1	12.7	5.5	4.0	4.6	3.9
103	19.4	15.5	14.0	13.2	6.4	4.3	4.3	4.2
104	36.6	23.7	19.6	17.8	10.0	6.8	5.8	5.4
105	29.2	23.5	25.2	22.2	8.7	6.7	7.2	6.4

Receptor ID	Max 1 Hour CO Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
106	15.9	12.9	11.5	10.9	4.6	3.5	3.7	3.2
107	15.1	12.1	11.8	11.4	5.2	3.8	3.6	3.3
108	13.1	9.6	10.4	8.9	4.6	2.9	2.9	2.8
109	12.2	8.4	8.8	8.5	3.6	2.7	2.5	2.5
110	9.3	7.1	7.5	7.6	2.8	2.5	2.4	2.3
111	13.3	10.7	9.0	8.3	3.2	3.4	2.6	2.4
112	11.8	9.5	9.9	8.6	3.9	2.9	2.8	3.2
113	9.7	9.7	9.0	8.1	2.9	2.8	2.6	3.1
114	11.7	12.6	10.5	10.8	3.7	3.4	2.9	3.0

Table 42 1 Hour Maximum $PM_{2.5}$ Concentrations – All receptor elevations, all operational modes

Receptor ID	Max 24 Hour $PM_{2.5}$ Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	25							
Maximum	1.28	2.06	1.73	1.64	1.17	0.75	0.60	0.50
1	0.22	0.61	0.59	0.54	0.18	0.16	0.16	0.15
2	0.34	0.51	0.48	0.50	0.25	0.23	0.19	0.20
3	0.23	0.27	0.21	0.20	0.19	0.18	0.17	0.14
4	0.28	0.28	0.26	0.23	0.22	0.18	0.18	0.18
5	0.20	0.26	0.22	0.20	0.15	0.18	0.16	0.14
6	0.11	0.18	0.28	0.27	0.10	0.06	0.11	0.10
7	0.15	0.23	0.36	0.34	0.11	0.08	0.11	0.09
8	0.24	0.48	0.48	0.54	0.17	0.15	0.14	0.15
9	0.26	0.54	0.62	0.57	0.19	0.14	0.18	0.16
10	0.26	0.53	0.63	0.60	0.20	0.16	0.16	0.16
11	1.28	1.39	1.28	1.37	1.17	0.75	0.60	0.48
12	0.80	1.88	1.61	1.58	0.62	0.47	0.45	0.38
13	0.41	1.09	1.20	1.33	0.35	0.30	0.34	0.39
14	0.51	1.22	1.33	1.25	0.42	0.36	0.37	0.37
15	0.90	2.06	1.73	1.64	0.80	0.59	0.48	0.50
16	0.39	0.58	0.58	0.61	0.24	0.22	0.21	0.19
17	0.49	1.08	0.96	0.86	0.44	0.33	0.28	0.28
18	0.90	1.15	1.18	1.10	0.68	0.42	0.38	0.33
19	1.10	2.05	1.65	1.46	0.82	0.53	0.40	0.35
20	0.36	0.59	0.63	0.58	0.28	0.23	0.22	0.24
21	0.24	0.57	0.62	0.62	0.21	0.17	0.18	0.19
22	0.24	0.44	0.41	0.42	0.17	0.20	0.18	0.19
23	0.19	0.38	0.39	0.34	0.18	0.14	0.12	0.12
24	0.31	0.65	0.71	0.59	0.26	0.25	0.29	0.26
25	0.20	0.41	0.48	0.38	0.16	0.14	0.14	0.12
26	0.18	0.43	0.47	0.34	0.15	0.14	0.12	0.11
27	0.14	0.33	0.36	0.32	0.13	0.10	0.11	0.10
28	0.23	0.25	0.26	0.23	0.18	0.13	0.12	0.11
29	0.16	0.40	0.42	0.44	0.13	0.12	0.14	0.13
30	0.22	0.47	0.46	0.43	0.20	0.15	0.15	0.14
31	0.27	0.38	0.34	0.24	0.21	0.17	0.15	0.13
32	0.24	0.39	0.33	0.29	0.23	0.18	0.16	0.13
33	0.14	0.19	0.19	0.19	0.11	0.09	0.09	0.08

Receptor ID	Max 24 Hour PM2.5 Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
34	0.19	0.30	0.28	0.26	0.18	0.13	0.14	0.12
35	0.12	0.21	0.21	0.23	0.12	0.09	0.09	0.09
36	0.11	0.21	0.23	0.19	0.09	0.07	0.07	0.07
37	0.09	0.19	0.19	0.20	0.09	0.07	0.06	0.07
38	0.18	0.32	0.34	0.34	0.16	0.12	0.11	0.13
39	0.21	0.39	0.33	0.33	0.19	0.14	0.14	0.14
40	0.13	0.32	0.30	0.32	0.10	0.10	0.12	0.11
41	0.18	0.32	0.30	0.30	0.17	0.14	0.11	0.13
42	0.16	0.32	0.29	0.33	0.14	0.11	0.09	0.10
43	0.13	0.48	0.69	0.63	0.13	0.15	0.18	0.18
44	0.40	0.94	0.81	0.64	0.35	0.27	0.22	0.19
45	0.09	0.31	0.25	0.27	0.08	0.07	0.07	0.10
46	0.11	0.29	0.27	0.28	0.09	0.06	0.07	0.08
47	0.09	0.19	0.22	0.22	0.09	0.08	0.09	0.10
48	0.12	0.29	0.26	0.28	0.09	0.08	0.08	0.08
49	0.32	0.57	0.49	0.51	0.24	0.18	0.15	0.13
50	0.13	0.28	0.26	0.28	0.11	0.08	0.09	0.08
51	0.08	0.19	0.19	0.20	0.09	0.06	0.06	0.07
52	0.11	0.19	0.21	0.19	0.09	0.08	0.08	0.07
53	0.12	0.23	0.21	0.23	0.09	0.08	0.08	0.08
54	0.12	0.27	0.25	0.26	0.11	0.08	0.08	0.08
55	0.10	0.19	0.21	0.22	0.09	0.07	0.07	0.07
56	0.51	0.49	0.50	0.51	0.46	0.40	0.37	0.33
57	0.21	0.31	0.33	0.34	0.19	0.14	0.14	0.15
58	0.23	0.26	0.24	0.22	0.20	0.14	0.12	0.12
59	0.19	0.22	0.24	0.24	0.20	0.16	0.17	0.17
60	0.19	0.37	0.33	0.47	0.16	0.11	0.11	0.13
61	0.16	0.40	0.32	0.33	0.14	0.11	0.10	0.10
62	0.17	0.28	0.25	0.20	0.15	0.09	0.08	0.07
63	0.13	0.20	0.23	0.21	0.12	0.10	0.09	0.08
64	0.12	0.20	0.25	0.18	0.10	0.08	0.08	0.08
65	0.13	0.22	0.20	0.18	0.10	0.09	0.09	0.09
66	0.12	0.24	0.24	0.22	0.11	0.10	0.10	0.08
67	0.09	0.18	0.19	0.17	0.08	0.09	0.09	0.08
68	0.11	0.19	0.18	0.18	0.10	0.08	0.09	0.08
69	0.20	0.22	0.23	0.21	0.20	0.12	0.12	0.11

Receptor ID	Max 24 Hour $PM_{2.5}$ Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
70	0.15	0.21	0.20	0.17	0.12	0.12	0.10	0.10
71	0.15	0.21	0.25	0.24	0.15	0.11	0.11	0.11
72	0.16	0.39	0.36	0.36	0.13	0.11	0.10	0.10
73	0.13	0.36	0.35	0.30	0.11	0.10	0.09	0.09
74	0.23	0.52	0.40	0.39	0.23	0.15	0.12	0.11
75	0.12	0.20	0.18	0.20	0.11	0.08	0.06	0.08
76	0.11	0.25	0.20	0.22	0.08	0.07	0.07	0.07
77	0.25	0.45	0.44	0.39	0.21	0.15	0.14	0.11
78	0.17	0.34	0.33	0.32	0.15	0.10	0.10	0.10
79	0.14	0.32	0.31	0.27	0.13	0.09	0.10	0.09
80	0.15	0.37	0.33	0.30	0.13	0.11	0.10	0.08
81	0.12	0.23	0.26	0.24	0.09	0.08	0.08	0.09
82	0.12	0.28	0.29	0.30	0.12	0.09	0.08	0.08
83	0.13	0.17	0.17	0.16	0.10	0.08	0.07	0.08
84	0.11	0.25	0.22	0.19	0.10	0.07	0.08	0.07
85	0.10	0.21	0.23	0.26	0.09	0.06	0.07	0.08
86	0.16	0.40	0.31	0.29	0.16	0.10	0.10	0.09
87	0.11	0.22	0.19	0.17	0.10	0.08	0.07	0.06
88	0.15	0.19	0.18	0.15	0.15	0.10	0.08	0.07
89	0.13	0.21	0.18	0.16	0.13	0.07	0.06	0.06
90	0.11	0.22	0.19	0.17	0.10	0.07	0.08	0.06
91	0.07	0.13	0.15	0.17	0.07	0.05	0.05	0.06
92	0.07	0.19	0.19	0.20	0.05	0.04	0.06	0.05
93	0.06	0.21	0.14	0.15	0.05	0.05	0.05	0.05
94	0.07	0.16	0.16	0.15	0.06	0.06	0.06	0.06
95	0.05	0.13	0.16	0.17	0.05	0.04	0.05	0.05
96	0.06	0.19	0.17	0.17	0.06	0.06	0.06	0.05
97	0.07	0.17	0.16	0.18	0.05	0.05	0.05	0.05
98	0.04	0.15	0.17	0.19	0.04	0.04	0.05	0.05
99	0.11	0.17	0.16	0.17	0.08	0.05	0.04	0.04
100	0.05	0.16	0.17	0.19	0.04	0.05	0.05	0.05
101	0.07	0.16	0.19	0.19	0.05	0.06	0.07	0.06
102	0.14	0.26	0.23	0.24	0.10	0.08	0.09	0.07
103	0.13	0.32	0.27	0.26	0.12	0.08	0.08	0.08
104	0.25	0.48	0.40	0.36	0.19	0.13	0.11	0.10
105	0.20	0.48	0.51	0.45	0.17	0.13	0.14	0.12

Receptor ID	Max 24 Hour $PM_{2.5}$ Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
106	0.11	0.26	0.23	0.20	0.09	0.07	0.07	0.06
107	0.10	0.21	0.20	0.20	0.10	0.07	0.07	0.06
108	0.09	0.20	0.19	0.18	0.09	0.05	0.06	0.05
109	0.08	0.17	0.18	0.17	0.07	0.05	0.05	0.05
110	0.06	0.14	0.15	0.14	0.05	0.05	0.05	0.04
111	0.09	0.22	0.17	0.16	0.06	0.06	0.05	0.05
112	0.08	0.19	0.20	0.17	0.07	0.05	0.05	0.06
113	0.07	0.17	0.18	0.17	0.05	0.05	0.05	0.06
114	0.08	0.15	0.12	0.15	0.07	0.06	0.06	0.06

Table 43 1 Hour Maximum Acetaldehyde Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile Acetaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	42							
Maximum	0.00066	0.00054	0.00047	0.00052	0.00720	0.00662	0.00662	0.00662
1	0.00017	0.00015	0.00015	0.00014	0.00176	0.00148	0.00153	0.00148
2	0.00024	0.00020	0.00020	0.00019	0.00239	0.00204	0.00207	0.00217
3	0.00019	0.00016	0.00014	0.00013	0.00182	0.00662	0.00662	0.00662
4	0.00017	0.00015	0.00014	0.00014	0.00208	0.00153	0.00164	0.00158
5	0.00014	0.00014	0.00014	0.00013	0.00164	0.00144	0.00136	0.00133
6	0.00008	0.00006	0.00009	0.00009	0.00092	0.00065	0.00100	0.00100
7	0.00010	0.00007	0.00009	0.00009	0.00094	0.00077	0.00092	0.00089
8	0.00014	0.00012	0.00014	0.00015	0.00132	0.00117	0.00130	0.00141
9	0.00020	0.00013	0.00017	0.00016	0.00163	0.00127	0.00158	0.00157
10	0.00022	0.00016	0.00016	0.00017	0.00220	0.00167	0.00163	0.00173
11	0.00060	0.00054	0.00047	0.00052	0.00719	0.00562	0.00533	0.00525
12	0.00061	0.00045	0.00042	0.00039	0.00611	0.00455	0.00406	0.00396
13	0.00037	0.00031	0.00034	0.00036	0.00387	0.00350	0.00349	0.00426
14	0.00039	0.00033	0.00035	0.00036	0.00455	0.00376	0.00393	0.00396
15	0.00059	0.00048	0.00041	0.00037	0.00720	0.00535	0.00452	0.00460
16	0.00029	0.00025	0.00024	0.00026	0.00260	0.00259	0.00231	0.00231
17	0.00046	0.00038	0.00036	0.00035	0.00517	0.00369	0.00359	0.00350
18	0.00055	0.00044	0.00042	0.00042	0.00633	0.00446	0.00482	0.00417
19	0.00066	0.00051	0.00046	0.00047	0.00664	0.00535	0.00485	0.00434
20	0.00024	0.00020	0.00019	0.00020	0.00255	0.00219	0.00220	0.00212
21	0.00020	0.00017	0.00019	0.00019	0.00212	0.00181	0.00199	0.00220
22	0.00015	0.00017	0.00017	0.00019	0.00153	0.00201	0.00210	0.00197
23	0.00015	0.00013	0.00012	0.00012	0.00177	0.00143	0.00141	0.00127
24	0.00025	0.00026	0.00025	0.00022	0.00274	0.00270	0.00274	0.00251
25	0.00016	0.00013	0.00015	0.00012	0.00184	0.00156	0.00164	0.00154
26	0.00015	0.00011	0.00013	0.00011	0.00161	0.00185	0.00152	0.00141
27	0.00011	0.00011	0.00012	0.00010	0.00132	0.00109	0.00133	0.00119

Receptor ID	99.9th Percentile Acetaldehyde Concentration(µg/m^3)							
	CAT Generators				Cummins Generators			
28	0.00011	0.00008	0.00009	0.00008	0.00113	0.00100	0.00097	0.00093
29	0.00014	0.00012	0.00013	0.00014	0.00136	0.00134	0.00146	0.00147
30	0.00016	0.00013	0.00015	0.00013	0.00183	0.00155	0.00156	0.00142
31	0.00023	0.00019	0.00016	0.00015	0.00247	0.00194	0.00174	0.00162
32	0.00020	0.00016	0.00016	0.00014	0.00218	0.00180	0.00188	0.00157
33	0.00012	0.00009	0.00009	0.00009	0.00116	0.00101	0.00096	0.00098
34	0.00015	0.00014	0.00012	0.00011	0.00181	0.00130	0.00120	0.00109
35	0.00011	0.00009	0.00009	0.00009	0.00135	0.00102	0.00097	0.00105
36	0.00010	0.00009	0.00008	0.00008	0.00106	0.00087	0.00087	0.00088
37	0.00010	0.00008	0.00007	0.00007	0.00099	0.00083	0.00077	0.00080
38	0.00015	0.00013	0.00013	0.00014	0.00183	0.00144	0.00133	0.00140
39	0.00019	0.00016	0.00015	0.00016	0.00226	0.00171	0.00162	0.00173
40	0.00011	0.00010	0.00011	0.00011	0.00108	0.00105	0.00110	0.00114
41	0.00016	0.00013	0.00012	0.00013	0.00204	0.00162	0.00130	0.00147
42	0.00015	0.00012	0.00011	0.00011	0.00171	0.00140	0.00114	0.00128
43	0.00010	0.00012	0.00015	0.00016	0.00074	0.00082	0.00113	0.00123
44	0.00038	0.00027	0.00025	0.00020	0.00409	0.00317	0.00256	0.00227
45	0.00010	0.00009	0.00010	0.00011	0.00089	0.00069	0.00081	0.00081
46	0.00010	0.00008	0.00008	0.00010	0.00103	0.00072	0.00081	0.00086
47	0.00010	0.00010	0.00013	0.00013	0.00073	0.00084	0.00109	0.00131
48	0.00010	0.00009	0.00009	0.00009	0.00105	0.00089	0.00084	0.00083
49	0.00019	0.00015	0.00014	0.00014	0.00182	0.00150	0.00139	0.00151
50	0.00011	0.00009	0.00009	0.00009	0.00119	0.00092	0.00088	0.00093
51	0.00008	0.00006	0.00007	0.00007	0.00097	0.00076	0.00081	0.00080
52	0.00009	0.00008	0.00008	0.00008	0.00105	0.00095	0.00086	0.00081
53	0.00010	0.00009	0.00008	0.00009	0.00110	0.00097	0.00094	0.00096
54	0.00011	0.00009	0.00009	0.00009	0.00113	0.00101	0.00099	0.00098
55	0.00010	0.00007	0.00007	0.00007	0.00084	0.00079	0.00072	0.00082
56	0.00041	0.00038	0.00039	0.00035	0.00477	0.00451	0.00439	0.00416
57	0.00020	0.00015	0.00017	0.00017	0.00202	0.00171	0.00172	0.00187

Receptor ID	99.9th Percentile Acetaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
58	0.00019	0.00015	0.00014	0.00014	0.00240	0.00174	0.00153	0.00155
59	0.00019	0.00016	0.00018	0.00018	0.00220	0.00184	0.00205	0.00210
60	0.00014	0.00012	0.00010	0.00013	0.00172	0.00126	0.00137	0.00149
61	0.00012	0.00011	0.00010	0.00011	0.00159	0.00118	0.00119	0.00124
62	0.00014	0.00011	0.00011	0.00011	0.00175	0.00112	0.00105	0.00091
63	0.00011	0.00007	0.00008	0.00009	0.00102	0.00118	0.00120	0.00117
64	0.00012	0.00009	0.00009	0.00009	0.00130	0.00081	0.00085	0.00092
65	0.00012	0.00011	0.00010	0.00011	0.00125	0.00108	0.00105	0.00110
66	0.00012	0.00011	0.00011	0.00010	0.00137	0.00128	0.00127	0.00100
67	0.00008	0.00009	0.00010	0.00010	0.00092	0.00108	0.00107	0.00106
68	0.00011	0.00010	0.00009	0.00010	0.00123	0.00104	0.00109	0.00100
69	0.00020	0.00013	0.00012	0.00013	0.00213	0.00144	0.00156	0.00134
70	0.00013	0.00012	0.00011	0.00011	0.00143	0.00131	0.00127	0.00113
71	0.00015	0.00012	0.00013	0.00013	0.00189	0.00142	0.00138	0.00141
72	0.00014	0.00013	0.00011	0.00012	0.00152	0.00133	0.00126	0.00126
73	0.00009	0.00009	0.00009	0.00010	0.00101	0.00094	0.00098	0.00105
74	0.00015	0.00011	0.00009	0.00010	0.00186	0.00133	0.00128	0.00132
75	0.00009	0.00007	0.00008	0.00009	0.00103	0.00091	0.00071	0.00090
76	0.00010	0.00010	0.00008	0.00009	0.00107	0.00086	0.00090	0.00090
77	0.00013	0.00012	0.00011	0.00012	0.00136	0.00115	0.00125	0.00128
78	0.00014	0.00011	0.00010	0.00011	0.00171	0.00120	0.00111	0.00125
79	0.00013	0.00009	0.00008	0.00007	0.00117	0.00109	0.00083	0.00084
80	0.00014	0.00012	0.00010	0.00009	0.00163	0.00123	0.00110	0.00098
81	0.00010	0.00007	0.00009	0.00008	0.00102	0.00097	0.00090	0.00095
82	0.00011	0.00009	0.00009	0.00009	0.00120	0.00117	0.00094	0.00099
83	0.00009	0.00008	0.00008	0.00008	0.00084	0.00073	0.00073	0.00081
84	0.00009	0.00008	0.00008	0.00007	0.00118	0.00089	0.00081	0.00082
85	0.00006	0.00005	0.00005	0.00006	0.00064	0.00055	0.00066	0.00064
86	0.00013	0.00011	0.00010	0.00009	0.00141	0.00120	0.00109	0.00097
87	0.00011	0.00009	0.00007	0.00008	0.00107	0.00084	0.00078	0.00074

Receptor ID	99.9th Percentile Acetaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
88	0.00014	0.00010	0.00009	0.00007	0.00138	0.00116	0.00097	0.00086
89	0.00010	0.00008	0.00007	0.00007	0.00113	0.00080	0.00077	0.00068
90	0.00009	0.00007	0.00007	0.00007	0.00091	0.00082	0.00077	0.00071
91	0.00007	0.00006	0.00006	0.00005	0.00058	0.00062	0.00056	0.00062
92	0.00008	0.00004	0.00004	0.00005	0.00052	0.00044	0.00048	0.00046
93	0.00005	0.00005	0.00005	0.00005	0.00062	0.00048	0.00056	0.00057
94	0.00007	0.00007	0.00007	0.00006	0.00065	0.00065	0.00073	0.00072
95	0.00005	0.00005	0.00005	0.00005	0.00050	0.00052	0.00060	0.00056
96	0.00005	0.00006	0.00006	0.00006	0.00056	0.00058	0.00068	0.00062
97	0.00005	0.00005	0.00005	0.00005	0.00057	0.00048	0.00054	0.00052
98	0.00004	0.00004	0.00005	0.00005	0.00043	0.00049	0.00054	0.00056
99	0.00006	0.00006	0.00005	0.00005	0.00065	0.00062	0.00051	0.00054
100	0.00005	0.00005	0.00005	0.00005	0.00040	0.00050	0.00056	0.00056
101	0.00007	0.00007	0.00007	0.00007	0.00055	0.00057	0.00056	0.00055
102	0.00011	0.00009	0.00009	0.00008	0.00116	0.00088	0.00083	0.00083
103	0.00011	0.00010	0.00009	0.00008	0.00113	0.00094	0.00095	0.00088
104	0.00015	0.00011	0.00012	0.00011	0.00164	0.00122	0.00124	0.00121
105	0.00019	0.00015	0.00015	0.00014	0.00200	0.00159	0.00170	0.00150
106	0.00010	0.00009	0.00008	0.00007	0.00108	0.00084	0.00088	0.00072
107	0.00009	0.00007	0.00007	0.00007	0.00102	0.00083	0.00084	0.00074
108	0.00008	0.00007	0.00007	0.00006	0.00084	0.00062	0.00062	0.00067
109	0.00007	0.00006	0.00005	0.00005	0.00061	0.00054	0.00057	0.00060
110	0.00007	0.00006	0.00005	0.00006	0.00051	0.00055	0.00053	0.00049
111	0.00007	0.00006	0.00006	0.00005	0.00063	0.00057	0.00054	0.00050
112	0.00007	0.00007	0.00006	0.00006	0.00082	0.00069	0.00063	0.00057
113	0.00008	0.00005	0.00005	0.00005	0.00055	0.00047	0.00046	0.00047
114	0.00008	0.00007	0.00006	0.00007	0.00079	0.00072	0.00070	0.00073

Table 44 1 Hour Maximum Benzene Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile Benzene Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	29							
Maximum	0.0211	0.0170	0.0150	0.0166	0.2284	0.2100	0.2100	0.2100
1	0.0053	0.0048	0.0046	0.0044	0.0557	0.0470	0.0487	0.0469
2	0.0077	0.0062	0.0064	0.0062	0.0758	0.0648	0.0656	0.0688
3	0.0059	0.0050	0.0046	0.0042	0.0579	0.2100	0.2100	0.2100
4	0.0053	0.0048	0.0045	0.0043	0.0659	0.0485	0.0520	0.0500
5	0.0046	0.0045	0.0043	0.0040	0.0521	0.0456	0.0432	0.0423
6	0.0027	0.0019	0.0029	0.0029	0.0292	0.0207	0.0318	0.0317
7	0.0031	0.0022	0.0028	0.0027	0.0300	0.0244	0.0291	0.0283
8	0.0045	0.0038	0.0044	0.0047	0.0419	0.0372	0.0413	0.0447
9	0.0065	0.0042	0.0053	0.0050	0.0516	0.0403	0.0501	0.0497
10	0.0070	0.0050	0.0052	0.0053	0.0700	0.0531	0.0519	0.0549
11	0.0191	0.0170	0.0150	0.0166	0.2283	0.1784	0.1693	0.1665
12	0.0194	0.0143	0.0132	0.0123	0.1941	0.1444	0.1290	0.1258
13	0.0117	0.0098	0.0109	0.0113	0.1228	0.1112	0.1109	0.1351
14	0.0124	0.0106	0.0110	0.0113	0.1445	0.1193	0.1247	0.1257
15	0.0188	0.0154	0.0131	0.0118	0.2284	0.1698	0.1436	0.1460
16	0.0092	0.0079	0.0078	0.0082	0.0825	0.0822	0.0734	0.0733
17	0.0144	0.0120	0.0115	0.0112	0.1642	0.1170	0.1140	0.1112
18	0.0174	0.0139	0.0135	0.0132	0.2009	0.1415	0.1529	0.1324
19	0.0211	0.0163	0.0145	0.0150	0.2109	0.1699	0.1541	0.1378
20	0.0075	0.0065	0.0061	0.0064	0.0810	0.0695	0.0699	0.0672
21	0.0063	0.0053	0.0059	0.0061	0.0674	0.0574	0.0633	0.0698
22	0.0046	0.0054	0.0054	0.0060	0.0487	0.0639	0.0667	0.0626
23	0.0049	0.0041	0.0039	0.0038	0.0561	0.0453	0.0446	0.0402
24	0.0078	0.0083	0.0078	0.0071	0.0868	0.0857	0.0870	0.0797
25	0.0051	0.0040	0.0047	0.0037	0.0585	0.0496	0.0522	0.0490
26	0.0048	0.0036	0.0041	0.0035	0.0512	0.0588	0.0482	0.0446
27	0.0036	0.0034	0.0037	0.0032	0.0420	0.0345	0.0422	0.0377

Receptor ID	99.9th Percentile Benzene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
28	0.0036	0.0026	0.0029	0.0026	0.0357	0.0318	0.0307	0.0297
29	0.0044	0.0039	0.0042	0.0043	0.0432	0.0425	0.0462	0.0467
30	0.0050	0.0041	0.0046	0.0042	0.0581	0.0492	0.0497	0.0450
31	0.0072	0.0060	0.0051	0.0047	0.0784	0.0616	0.0551	0.0515
32	0.0065	0.0052	0.0050	0.0043	0.0692	0.0571	0.0597	0.0498
33	0.0038	0.0029	0.0027	0.0027	0.0369	0.0320	0.0306	0.0310
34	0.0049	0.0043	0.0038	0.0035	0.0576	0.0412	0.0381	0.0348
35	0.0035	0.0028	0.0029	0.0029	0.0429	0.0322	0.0307	0.0334
36	0.0032	0.0027	0.0025	0.0026	0.0336	0.0275	0.0275	0.0281
37	0.0033	0.0024	0.0023	0.0023	0.0314	0.0263	0.0245	0.0253
38	0.0049	0.0040	0.0040	0.0045	0.0581	0.0457	0.0423	0.0446
39	0.0060	0.0049	0.0048	0.0050	0.0717	0.0541	0.0515	0.0548
40	0.0034	0.0031	0.0033	0.0034	0.0344	0.0332	0.0351	0.0363
41	0.0051	0.0042	0.0037	0.0041	0.0648	0.0516	0.0412	0.0466
42	0.0049	0.0037	0.0034	0.0035	0.0542	0.0445	0.0363	0.0407
43	0.0032	0.0040	0.0047	0.0052	0.0235	0.0260	0.0360	0.0391
44	0.0120	0.0086	0.0079	0.0062	0.1297	0.1006	0.0812	0.0719
45	0.0032	0.0030	0.0032	0.0036	0.0283	0.0219	0.0257	0.0256
46	0.0031	0.0025	0.0027	0.0031	0.0326	0.0229	0.0257	0.0272
47	0.0031	0.0033	0.0040	0.0040	0.0233	0.0266	0.0345	0.0416
48	0.0031	0.0030	0.0029	0.0028	0.0334	0.0282	0.0265	0.0263
49	0.0061	0.0047	0.0045	0.0044	0.0579	0.0476	0.0441	0.0481
50	0.0036	0.0027	0.0027	0.0028	0.0377	0.0291	0.0280	0.0295
51	0.0026	0.0021	0.0022	0.0023	0.0309	0.0241	0.0258	0.0255
52	0.0030	0.0025	0.0025	0.0024	0.0333	0.0300	0.0274	0.0258
53	0.0033	0.0028	0.0026	0.0027	0.0350	0.0309	0.0298	0.0306
54	0.0035	0.0028	0.0028	0.0029	0.0358	0.0321	0.0315	0.0312
55	0.0032	0.0024	0.0024	0.0023	0.0267	0.0251	0.0228	0.0261
56	0.0129	0.0120	0.0123	0.0112	0.1514	0.1432	0.1393	0.1321
57	0.0063	0.0048	0.0054	0.0055	0.0641	0.0543	0.0546	0.0594

Receptor ID	99.9th Percentile Benzene Concentration(µg/m^3)							
	CAT Generators				Cummins Generators			
58	0.0060	0.0049	0.0046	0.0045	0.0761	0.0552	0.0485	0.0492
59	0.0060	0.0052	0.0058	0.0058	0.0697	0.0585	0.0652	0.0667
60	0.0046	0.0038	0.0033	0.0041	0.0545	0.0401	0.0436	0.0473
61	0.0038	0.0035	0.0033	0.0034	0.0505	0.0374	0.0379	0.0395
62	0.0045	0.0034	0.0034	0.0034	0.0554	0.0355	0.0332	0.0289
63	0.0035	0.0023	0.0027	0.0027	0.0323	0.0376	0.0382	0.0370
64	0.0038	0.0027	0.0028	0.0029	0.0414	0.0258	0.0270	0.0293
65	0.0039	0.0034	0.0032	0.0034	0.0398	0.0344	0.0333	0.0350
66	0.0038	0.0036	0.0036	0.0030	0.0435	0.0407	0.0402	0.0318
67	0.0024	0.0029	0.0031	0.0032	0.0293	0.0343	0.0341	0.0336
68	0.0034	0.0033	0.0030	0.0032	0.0391	0.0330	0.0347	0.0317
69	0.0062	0.0042	0.0038	0.0042	0.0675	0.0457	0.0496	0.0426
70	0.0042	0.0039	0.0035	0.0035	0.0455	0.0416	0.0404	0.0360
71	0.0048	0.0039	0.0040	0.0041	0.0599	0.0449	0.0438	0.0447
72	0.0045	0.0040	0.0036	0.0038	0.0483	0.0424	0.0401	0.0401
73	0.0028	0.0027	0.0027	0.0031	0.0322	0.0297	0.0312	0.0332
74	0.0049	0.0036	0.0028	0.0032	0.0591	0.0423	0.0406	0.0418
75	0.0030	0.0023	0.0024	0.0028	0.0328	0.0287	0.0224	0.0287
76	0.0033	0.0032	0.0027	0.0029	0.0340	0.0271	0.0285	0.0285
77	0.0042	0.0037	0.0036	0.0037	0.0430	0.0364	0.0397	0.0406
78	0.0044	0.0036	0.0033	0.0034	0.0543	0.0382	0.0352	0.0397
79	0.0042	0.0027	0.0026	0.0023	0.0371	0.0345	0.0263	0.0267
80	0.0046	0.0039	0.0031	0.0029	0.0518	0.0392	0.0348	0.0311
81	0.0032	0.0024	0.0027	0.0024	0.0323	0.0308	0.0284	0.0301
82	0.0035	0.0029	0.0029	0.0030	0.0382	0.0373	0.0298	0.0313
83	0.0029	0.0026	0.0025	0.0027	0.0267	0.0233	0.0232	0.0257
84	0.0030	0.0026	0.0026	0.0023	0.0376	0.0283	0.0258	0.0261
85	0.0020	0.0014	0.0017	0.0019	0.0202	0.0176	0.0211	0.0203
86	0.0043	0.0036	0.0032	0.0028	0.0449	0.0382	0.0345	0.0307
87	0.0033	0.0028	0.0023	0.0025	0.0339	0.0266	0.0246	0.0236

Receptor ID	99.9th Percentile Benzene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
88	0.0043	0.0032	0.0030	0.0023	0.0439	0.0367	0.0309	0.0272
89	0.0033	0.0025	0.0023	0.0023	0.0359	0.0253	0.0244	0.0215
90	0.0027	0.0023	0.0022	0.0023	0.0290	0.0262	0.0243	0.0225
91	0.0021	0.0018	0.0019	0.0017	0.0185	0.0198	0.0178	0.0195
92	0.0024	0.0013	0.0014	0.0017	0.0164	0.0141	0.0151	0.0145
93	0.0017	0.0015	0.0016	0.0016	0.0195	0.0153	0.0177	0.0181
94	0.0021	0.0021	0.0023	0.0020	0.0205	0.0206	0.0230	0.0228
95	0.0016	0.0015	0.0017	0.0017	0.0157	0.0164	0.0191	0.0178
96	0.0017	0.0019	0.0020	0.0018	0.0177	0.0184	0.0217	0.0196
97	0.0016	0.0014	0.0016	0.0016	0.0181	0.0151	0.0171	0.0166
98	0.0012	0.0014	0.0014	0.0017	0.0138	0.0156	0.0170	0.0177
99	0.0019	0.0018	0.0016	0.0016	0.0206	0.0196	0.0162	0.0172
100	0.0014	0.0015	0.0017	0.0017	0.0127	0.0159	0.0179	0.0179
101	0.0024	0.0022	0.0022	0.0021	0.0173	0.0182	0.0178	0.0175
102	0.0035	0.0028	0.0028	0.0026	0.0368	0.0281	0.0265	0.0262
103	0.0035	0.0031	0.0028	0.0027	0.0358	0.0300	0.0303	0.0278
104	0.0047	0.0036	0.0037	0.0036	0.0521	0.0388	0.0395	0.0383
105	0.0061	0.0049	0.0049	0.0044	0.0634	0.0505	0.0540	0.0476
106	0.0031	0.0027	0.0024	0.0022	0.0342	0.0268	0.0280	0.0228
107	0.0027	0.0023	0.0023	0.0024	0.0324	0.0265	0.0266	0.0234
108	0.0025	0.0021	0.0022	0.0021	0.0268	0.0196	0.0195	0.0214
109	0.0024	0.0018	0.0017	0.0017	0.0193	0.0173	0.0180	0.0191
110	0.0023	0.0018	0.0016	0.0018	0.0160	0.0176	0.0169	0.0156
111	0.0023	0.0019	0.0019	0.0017	0.0200	0.0182	0.0172	0.0158
112	0.0023	0.0021	0.0018	0.0019	0.0260	0.0219	0.0200	0.0180
113	0.0024	0.0017	0.0017	0.0015	0.0176	0.0151	0.0145	0.0150
114	0.0024	0.0022	0.0021	0.0023	0.0252	0.0228	0.0224	0.0231

Table 45 1 Hour Maximum Formaldehyde Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile Formaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	20							
Maximum	0.0021	0.0017	0.0015	0.0017	0.0228	0.0210	0.0210	0.0210
1	0.0005	0.0005	0.0005	0.0004	0.0056	0.0047	0.0049	0.0047
2	0.0008	0.0006	0.0006	0.0006	0.0076	0.0065	0.0066	0.0069
3	0.0006	0.0005	0.0005	0.0004	0.0058	0.0210	0.0210	0.0210
4	0.0005	0.0005	0.0004	0.0004	0.0066	0.0048	0.0052	0.0050
5	0.0005	0.0005	0.0004	0.0004	0.0052	0.0046	0.0043	0.0042
6	0.0003	0.0002	0.0003	0.0003	0.0029	0.0021	0.0032	0.0032
7	0.0003	0.0002	0.0003	0.0003	0.0030	0.0024	0.0029	0.0028
8	0.0004	0.0004	0.0004	0.0005	0.0042	0.0037	0.0041	0.0045
9	0.0006	0.0004	0.0005	0.0005	0.0052	0.0040	0.0050	0.0050
10	0.0007	0.0005	0.0005	0.0005	0.0070	0.0053	0.0052	0.0055
11	0.0019	0.0017	0.0015	0.0017	0.0228	0.0178	0.0169	0.0167
12	0.0019	0.0014	0.0013	0.0012	0.0194	0.0144	0.0129	0.0126
13	0.0012	0.0010	0.0011	0.0011	0.0123	0.0111	0.0111	0.0135
14	0.0012	0.0011	0.0011	0.0011	0.0145	0.0119	0.0125	0.0126
15	0.0019	0.0015	0.0013	0.0012	0.0228	0.0170	0.0144	0.0146
16	0.0009	0.0008	0.0008	0.0008	0.0082	0.0082	0.0073	0.0073
17	0.0014	0.0012	0.0012	0.0011	0.0164	0.0117	0.0114	0.0111
18	0.0017	0.0014	0.0013	0.0013	0.0201	0.0142	0.0153	0.0132
19	0.0021	0.0016	0.0014	0.0015	0.0211	0.0170	0.0154	0.0138
20	0.0007	0.0006	0.0006	0.0006	0.0081	0.0070	0.0070	0.0067
21	0.0006	0.0005	0.0006	0.0006	0.0067	0.0057	0.0063	0.0070
22	0.0005	0.0005	0.0005	0.0006	0.0049	0.0064	0.0067	0.0063
23	0.0005	0.0004	0.0004	0.0004	0.0056	0.0045	0.0045	0.0040
24	0.0008	0.0008	0.0008	0.0007	0.0087	0.0086	0.0087	0.0080
25	0.0005	0.0004	0.0005	0.0004	0.0058	0.0050	0.0052	0.0049
26	0.0005	0.0004	0.0004	0.0003	0.0051	0.0059	0.0048	0.0045
27	0.0004	0.0003	0.0004	0.0003	0.0042	0.0034	0.0042	0.0038

Receptor ID	99.9th Percentile Formaldehyde Concentration(μg/m³)							
	CAT Generators				Cummins Generators			
28	0.0004	0.0003	0.0003	0.0003	0.0036	0.0032	0.0031	0.0030
29	0.0004	0.0004	0.0004	0.0004	0.0043	0.0043	0.0046	0.0047
30	0.0005	0.0004	0.0005	0.0004	0.0058	0.0049	0.0050	0.0045
31	0.0007	0.0006	0.0005	0.0005	0.0078	0.0062	0.0055	0.0051
32	0.0006	0.0005	0.0005	0.0004	0.0069	0.0057	0.0060	0.0050
33	0.0004	0.0003	0.0003	0.0003	0.0037	0.0032	0.0031	0.0031
34	0.0005	0.0004	0.0004	0.0004	0.0058	0.0041	0.0038	0.0035
35	0.0003	0.0003	0.0003	0.0003	0.0043	0.0032	0.0031	0.0033
36	0.0003	0.0003	0.0002	0.0003	0.0034	0.0028	0.0027	0.0028
37	0.0003	0.0002	0.0002	0.0002	0.0031	0.0026	0.0025	0.0025
38	0.0005	0.0004	0.0004	0.0004	0.0058	0.0046	0.0042	0.0045
39	0.0006	0.0005	0.0005	0.0005	0.0072	0.0054	0.0051	0.0055
40	0.0003	0.0003	0.0003	0.0003	0.0034	0.0033	0.0035	0.0036
41	0.0005	0.0004	0.0004	0.0004	0.0065	0.0052	0.0041	0.0047
42	0.0005	0.0004	0.0003	0.0003	0.0054	0.0044	0.0036	0.0041
43	0.0003	0.0004	0.0005	0.0005	0.0023	0.0026	0.0036	0.0039
44	0.0012	0.0009	0.0008	0.0006	0.0130	0.0101	0.0081	0.0072
45	0.0003	0.0003	0.0003	0.0004	0.0028	0.0022	0.0026	0.0026
46	0.0003	0.0003	0.0003	0.0003	0.0033	0.0023	0.0026	0.0027
47	0.0003	0.0003	0.0004	0.0004	0.0023	0.0027	0.0034	0.0042
48	0.0003	0.0003	0.0003	0.0003	0.0033	0.0028	0.0027	0.0026
49	0.0006	0.0005	0.0005	0.0004	0.0058	0.0048	0.0044	0.0048
50	0.0004	0.0003	0.0003	0.0003	0.0038	0.0029	0.0028	0.0029
51	0.0003	0.0002	0.0002	0.0002	0.0031	0.0024	0.0026	0.0026
52	0.0003	0.0002	0.0002	0.0002	0.0033	0.0030	0.0027	0.0026
53	0.0003	0.0003	0.0003	0.0003	0.0035	0.0031	0.0030	0.0031
54	0.0004	0.0003	0.0003	0.0003	0.0036	0.0032	0.0031	0.0031
55	0.0003	0.0002	0.0002	0.0002	0.0027	0.0025	0.0023	0.0026
56	0.0013	0.0012	0.0012	0.0011	0.0151	0.0143	0.0139	0.0132
57	0.0006	0.0005	0.0005	0.0006	0.0064	0.0054	0.0055	0.0059

Receptor ID	99.9th Percentile Formaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
58	0.0006	0.0005	0.0005	0.0004	0.0076	0.0055	0.0048	0.0049
59	0.0006	0.0005	0.0006	0.0006	0.0070	0.0058	0.0065	0.0067
60	0.0005	0.0004	0.0003	0.0004	0.0054	0.0040	0.0044	0.0047
61	0.0004	0.0003	0.0003	0.0003	0.0050	0.0037	0.0038	0.0040
62	0.0005	0.0003	0.0003	0.0003	0.0055	0.0036	0.0033	0.0029
63	0.0004	0.0002	0.0003	0.0003	0.0032	0.0038	0.0038	0.0037
64	0.0004	0.0003	0.0003	0.0003	0.0041	0.0026	0.0027	0.0029
65	0.0004	0.0003	0.0003	0.0003	0.0040	0.0034	0.0033	0.0035
66	0.0004	0.0004	0.0004	0.0003	0.0044	0.0041	0.0040	0.0032
67	0.0002	0.0003	0.0003	0.0003	0.0029	0.0034	0.0034	0.0034
68	0.0003	0.0003	0.0003	0.0003	0.0039	0.0033	0.0035	0.0032
69	0.0006	0.0004	0.0004	0.0004	0.0068	0.0046	0.0050	0.0043
70	0.0004	0.0004	0.0004	0.0004	0.0046	0.0042	0.0040	0.0036
71	0.0005	0.0004	0.0004	0.0004	0.0060	0.0045	0.0044	0.0045
72	0.0004	0.0004	0.0004	0.0004	0.0048	0.0042	0.0040	0.0040
73	0.0003	0.0003	0.0003	0.0003	0.0032	0.0030	0.0031	0.0033
74	0.0005	0.0004	0.0003	0.0003	0.0059	0.0042	0.0041	0.0042
75	0.0003	0.0002	0.0002	0.0003	0.0033	0.0029	0.0022	0.0029
76	0.0003	0.0003	0.0003	0.0003	0.0034	0.0027	0.0028	0.0029
77	0.0004	0.0004	0.0004	0.0004	0.0043	0.0036	0.0040	0.0041
78	0.0004	0.0004	0.0003	0.0003	0.0054	0.0038	0.0035	0.0040
79	0.0004	0.0003	0.0003	0.0002	0.0037	0.0035	0.0026	0.0027
80	0.0005	0.0004	0.0003	0.0003	0.0052	0.0039	0.0035	0.0031
81	0.0003	0.0002	0.0003	0.0002	0.0032	0.0031	0.0028	0.0030
82	0.0004	0.0003	0.0003	0.0003	0.0038	0.0037	0.0030	0.0031
83	0.0003	0.0003	0.0003	0.0003	0.0027	0.0023	0.0023	0.0026
84	0.0003	0.0003	0.0003	0.0002	0.0038	0.0028	0.0026	0.0026
85	0.0002	0.0001	0.0002	0.0002	0.0020	0.0018	0.0021	0.0020
86	0.0004	0.0004	0.0003	0.0003	0.0045	0.0038	0.0034	0.0031
87	0.0003	0.0003	0.0002	0.0002	0.0034	0.0027	0.0025	0.0024

Receptor ID	99.9th Percentile Formaldehyde Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
88	0.0004	0.0003	0.0003	0.0002	0.0044	0.0037	0.0031	0.0027
89	0.0003	0.0003	0.0002	0.0002	0.0036	0.0025	0.0024	0.0022
90	0.0003	0.0002	0.0002	0.0002	0.0029	0.0026	0.0024	0.0022
91	0.0002	0.0002	0.0002	0.0002	0.0018	0.0020	0.0018	0.0020
92	0.0002	0.0001	0.0001	0.0002	0.0016	0.0014	0.0015	0.0014
93	0.0002	0.0001	0.0002	0.0002	0.0020	0.0015	0.0018	0.0018
94	0.0002	0.0002	0.0002	0.0002	0.0020	0.0021	0.0023	0.0023
95	0.0002	0.0001	0.0002	0.0002	0.0016	0.0016	0.0019	0.0018
96	0.0002	0.0002	0.0002	0.0002	0.0018	0.0018	0.0022	0.0020
97	0.0002	0.0001	0.0002	0.0002	0.0018	0.0015	0.0017	0.0017
98	0.0001	0.0001	0.0001	0.0002	0.0014	0.0016	0.0017	0.0018
99	0.0002	0.0002	0.0002	0.0002	0.0021	0.0020	0.0016	0.0017
100	0.0001	0.0002	0.0002	0.0002	0.0013	0.0016	0.0018	0.0018
101	0.0002	0.0002	0.0002	0.0002	0.0017	0.0018	0.0018	0.0018
102	0.0003	0.0003	0.0003	0.0003	0.0037	0.0028	0.0027	0.0026
103	0.0004	0.0003	0.0003	0.0003	0.0036	0.0030	0.0030	0.0028
104	0.0005	0.0004	0.0004	0.0004	0.0052	0.0039	0.0040	0.0038
105	0.0006	0.0005	0.0005	0.0004	0.0063	0.0051	0.0054	0.0048
106	0.0003	0.0003	0.0002	0.0002	0.0034	0.0027	0.0028	0.0023
107	0.0003	0.0002	0.0002	0.0002	0.0032	0.0026	0.0027	0.0023
108	0.0003	0.0002	0.0002	0.0002	0.0027	0.0020	0.0020	0.0021
109	0.0002	0.0002	0.0002	0.0002	0.0019	0.0017	0.0018	0.0019
110	0.0002	0.0002	0.0002	0.0002	0.0016	0.0018	0.0017	0.0016
111	0.0002	0.0002	0.0002	0.0002	0.0020	0.0018	0.0017	0.0016
112	0.0002	0.0002	0.0002	0.0002	0.0026	0.0022	0.0020	0.0018
113	0.0002	0.0002	0.0002	0.0002	0.0018	0.0015	0.0015	0.0015
114	0.0002	0.0002	0.0002	0.0002	0.0025	0.0023	0.0022	0.0023

Table 46 1 Hour Maximum Toluene Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile Toluene Concentration(µg/m^3)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	360							
Maximum	0.0075	0.0060	0.0053	0.0059	0.0808	0.0743	0.0743	0.0743
1	0.0019	0.0017	0.0016	0.0016	0.0197	0.0166	0.0172	0.0166
2	0.0027	0.0022	0.0023	0.0022	0.0268	0.0229	0.0232	0.0243
3	0.0021	0.0018	0.0016	0.0015	0.0205	0.0743	0.0743	0.0743
4	0.0019	0.0017	0.0016	0.0015	0.0233	0.0171	0.0184	0.0177
5	0.0016	0.0016	0.0015	0.0014	0.0184	0.0161	0.0153	0.0150
6	0.0010	0.0007	0.0010	0.0010	0.0103	0.0073	0.0112	0.0112
7	0.0011	0.0008	0.0010	0.0010	0.0106	0.0086	0.0103	0.0100
8	0.0016	0.0014	0.0016	0.0017	0.0148	0.0132	0.0146	0.0158
9	0.0023	0.0015	0.0019	0.0018	0.0183	0.0143	0.0177	0.0176
10	0.0025	0.0018	0.0018	0.0019	0.0248	0.0188	0.0184	0.0194
11	0.0067	0.0060	0.0053	0.0059	0.0808	0.0631	0.0599	0.0589
12	0.0069	0.0051	0.0047	0.0043	0.0687	0.0511	0.0456	0.0445
13	0.0041	0.0035	0.0039	0.0040	0.0434	0.0393	0.0392	0.0478
14	0.0044	0.0038	0.0039	0.0040	0.0511	0.0422	0.0441	0.0445
15	0.0066	0.0054	0.0046	0.0042	0.0808	0.0601	0.0508	0.0516
16	0.0032	0.0028	0.0028	0.0029	0.0292	0.0291	0.0260	0.0259
17	0.0051	0.0042	0.0041	0.0040	0.0581	0.0414	0.0403	0.0393
18	0.0062	0.0049	0.0048	0.0047	0.0711	0.0501	0.0541	0.0468
19	0.0075	0.0058	0.0051	0.0053	0.0746	0.0601	0.0545	0.0487
20	0.0026	0.0023	0.0022	0.0023	0.0287	0.0246	0.0247	0.0238
21	0.0022	0.0019	0.0021	0.0021	0.0238	0.0203	0.0224	0.0247
22	0.0016	0.0019	0.0019	0.0021	0.0172	0.0226	0.0236	0.0222
23	0.0017	0.0014	0.0014	0.0013	0.0198	0.0160	0.0158	0.0142
24	0.0028	0.0029	0.0028	0.0025	0.0307	0.0303	0.0308	0.0282
25	0.0018	0.0014	0.0016	0.0013	0.0207	0.0176	0.0185	0.0173
26	0.0017	0.0013	0.0015	0.0012	0.0181	0.0208	0.0171	0.0158
27	0.0013	0.0012	0.0013	0.0011	0.0149	0.0122	0.0149	0.0134

Receptor ID	99.9th Percentile Toluene Concentration(μg/m³)							
	CAT Generators				Cummins Generators			
28	0.0013	0.0009	0.0010	0.0009	0.0126	0.0112	0.0109	0.0105
29	0.0016	0.0014	0.0015	0.0015	0.0153	0.0150	0.0164	0.0165
30	0.0018	0.0015	0.0016	0.0015	0.0206	0.0174	0.0176	0.0159
31	0.0025	0.0021	0.0018	0.0017	0.0277	0.0218	0.0195	0.0182
32	0.0023	0.0018	0.0018	0.0015	0.0245	0.0202	0.0211	0.0176
33	0.0013	0.0010	0.0010	0.0010	0.0131	0.0113	0.0108	0.0110
34	0.0017	0.0015	0.0014	0.0012	0.0204	0.0146	0.0135	0.0123
35	0.0012	0.0010	0.0010	0.0010	0.0152	0.0114	0.0109	0.0118
36	0.0011	0.0010	0.0009	0.0009	0.0119	0.0097	0.0097	0.0099
37	0.0012	0.0008	0.0008	0.0008	0.0111	0.0093	0.0087	0.0089
38	0.0017	0.0014	0.0014	0.0016	0.0206	0.0162	0.0150	0.0158
39	0.0021	0.0017	0.0017	0.0018	0.0254	0.0192	0.0182	0.0194
40	0.0012	0.0011	0.0012	0.0012	0.0122	0.0118	0.0124	0.0128
41	0.0018	0.0015	0.0013	0.0014	0.0229	0.0182	0.0146	0.0165
42	0.0017	0.0013	0.0012	0.0012	0.0192	0.0157	0.0128	0.0144
43	0.0011	0.0014	0.0017	0.0018	0.0083	0.0092	0.0127	0.0138
44	0.0042	0.0030	0.0028	0.0022	0.0459	0.0356	0.0287	0.0254
45	0.0011	0.0011	0.0011	0.0013	0.0100	0.0077	0.0091	0.0091
46	0.0011	0.0009	0.0010	0.0011	0.0115	0.0081	0.0091	0.0096
47	0.0011	0.0012	0.0014	0.0014	0.0082	0.0094	0.0122	0.0147
48	0.0011	0.0011	0.0010	0.0010	0.0118	0.0100	0.0094	0.0093
49	0.0022	0.0016	0.0016	0.0016	0.0205	0.0168	0.0156	0.0170
50	0.0013	0.0010	0.0010	0.0010	0.0134	0.0103	0.0099	0.0104
51	0.0009	0.0007	0.0008	0.0008	0.0109	0.0085	0.0091	0.0090
52	0.0011	0.0009	0.0009	0.0008	0.0118	0.0106	0.0097	0.0091
53	0.0012	0.0010	0.0009	0.0010	0.0124	0.0109	0.0105	0.0108
54	0.0013	0.0010	0.0010	0.0010	0.0127	0.0114	0.0111	0.0110
55	0.0011	0.0008	0.0008	0.0008	0.0094	0.0089	0.0081	0.0092
56	0.0046	0.0042	0.0044	0.0040	0.0535	0.0507	0.0493	0.0467
57	0.0022	0.0017	0.0019	0.0020	0.0227	0.0192	0.0193	0.0210

Receptor ID	99.9th Percentile Toluene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
58	0.0021	0.0017	0.0016	0.0016	0.0269	0.0195	0.0172	0.0174
59	0.0021	0.0018	0.0020	0.0021	0.0247	0.0207	0.0231	0.0236
60	0.0016	0.0013	0.0012	0.0014	0.0193	0.0142	0.0154	0.0167
61	0.0014	0.0012	0.0012	0.0012	0.0179	0.0132	0.0134	0.0140
62	0.0016	0.0012	0.0012	0.0012	0.0196	0.0126	0.0118	0.0102
63	0.0012	0.0008	0.0010	0.0010	0.0114	0.0133	0.0135	0.0131
64	0.0013	0.0010	0.0010	0.0010	0.0146	0.0091	0.0096	0.0104
65	0.0014	0.0012	0.0011	0.0012	0.0141	0.0122	0.0118	0.0124
66	0.0013	0.0013	0.0013	0.0011	0.0154	0.0144	0.0142	0.0112
67	0.0009	0.0010	0.0011	0.0011	0.0104	0.0121	0.0121	0.0119
68	0.0012	0.0012	0.0011	0.0011	0.0138	0.0117	0.0123	0.0112
69	0.0022	0.0015	0.0013	0.0015	0.0239	0.0162	0.0175	0.0151
70	0.0015	0.0014	0.0012	0.0013	0.0161	0.0147	0.0143	0.0127
71	0.0017	0.0014	0.0014	0.0015	0.0212	0.0159	0.0155	0.0158
72	0.0016	0.0014	0.0013	0.0013	0.0171	0.0150	0.0142	0.0142
73	0.0010	0.0010	0.0010	0.0011	0.0114	0.0105	0.0110	0.0117
74	0.0017	0.0013	0.0010	0.0011	0.0209	0.0150	0.0144	0.0148
75	0.0011	0.0008	0.0009	0.0010	0.0116	0.0102	0.0079	0.0102
76	0.0012	0.0011	0.0009	0.0010	0.0120	0.0096	0.0101	0.0101
77	0.0015	0.0013	0.0013	0.0013	0.0152	0.0129	0.0140	0.0144
78	0.0016	0.0013	0.0012	0.0012	0.0192	0.0135	0.0125	0.0140
79	0.0015	0.0010	0.0009	0.0008	0.0131	0.0122	0.0093	0.0094
80	0.0016	0.0014	0.0011	0.0010	0.0183	0.0139	0.0123	0.0110
81	0.0011	0.0008	0.0010	0.0009	0.0114	0.0109	0.0101	0.0106
82	0.0013	0.0010	0.0010	0.0010	0.0135	0.0132	0.0105	0.0111
83	0.0010	0.0009	0.0009	0.0009	0.0095	0.0082	0.0082	0.0091
84	0.0011	0.0009	0.0009	0.0008	0.0133	0.0100	0.0091	0.0092
85	0.0007	0.0005	0.0006	0.0007	0.0071	0.0062	0.0075	0.0072
86	0.0015	0.0013	0.0011	0.0010	0.0159	0.0135	0.0122	0.0109
87	0.0012	0.0010	0.0008	0.0009	0.0120	0.0094	0.0087	0.0084

Receptor ID	99.9th Percentile Toluene Concentration($\mu g/m^3$)							
	CAT Generators				Cummins Generators			
88	0.0015	0.0011	0.0010	0.0008	0.0155	0.0130	0.0109	0.0096
89	0.0012	0.0009	0.0008	0.0008	0.0127	0.0090	0.0086	0.0076
90	0.0010	0.0008	0.0008	0.0008	0.0103	0.0093	0.0086	0.0080
91	0.0008	0.0007	0.0007	0.0006	0.0065	0.0070	0.0063	0.0069
92	0.0008	0.0004	0.0005	0.0006	0.0058	0.0050	0.0053	0.0051
93	0.0006	0.0005	0.0006	0.0006	0.0069	0.0054	0.0063	0.0064
94	0.0008	0.0007	0.0008	0.0007	0.0072	0.0073	0.0082	0.0081
95	0.0006	0.0005	0.0006	0.0006	0.0056	0.0058	0.0068	0.0063
96	0.0006	0.0007	0.0007	0.0007	0.0063	0.0065	0.0077	0.0069
97	0.0006	0.0005	0.0006	0.0006	0.0064	0.0054	0.0060	0.0059
98	0.0004	0.0005	0.0005	0.0006	0.0049	0.0055	0.0060	0.0063
99	0.0007	0.0006	0.0006	0.0006	0.0073	0.0069	0.0057	0.0061
100	0.0005	0.0005	0.0006	0.0006	0.0045	0.0056	0.0063	0.0063
101	0.0008	0.0008	0.0008	0.0007	0.0061	0.0064	0.0063	0.0062
102	0.0012	0.0010	0.0010	0.0009	0.0130	0.0099	0.0094	0.0093
103	0.0013	0.0011	0.0010	0.0009	0.0127	0.0106	0.0107	0.0098
104	0.0017	0.0013	0.0013	0.0013	0.0184	0.0137	0.0140	0.0135
105	0.0022	0.0017	0.0017	0.0016	0.0224	0.0179	0.0191	0.0168
106	0.0011	0.0010	0.0009	0.0008	0.0121	0.0095	0.0099	0.0081
107	0.0010	0.0008	0.0008	0.0008	0.0115	0.0094	0.0094	0.0083
108	0.0009	0.0007	0.0008	0.0007	0.0095	0.0069	0.0069	0.0076
109	0.0008	0.0006	0.0006	0.0006	0.0068	0.0061	0.0064	0.0068
110	0.0008	0.0006	0.0006	0.0006	0.0057	0.0062	0.0060	0.0055
111	0.0008	0.0007	0.0007	0.0006	0.0071	0.0064	0.0061	0.0056
112	0.0008	0.0007	0.0006	0.0007	0.0092	0.0078	0.0071	0.0064
113	0.0009	0.0006	0.0006	0.0005	0.0062	0.0053	0.0051	0.0053
114	0.0009	0.0008	0.0007	0.0008	0.0089	0.0081	0.0079	0.0082

Table 47 1 Hour Maximum Xylene Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile Xylene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	360							
Maximum	0.0052	0.0042	0.0037	0.0041	0.0562	0.0517	0.0517	0.0517
1	0.0013	0.0012	0.0011	0.0011	0.0137	0.0116	0.0120	0.0116
2	0.0019	0.0015	0.0016	0.0015	0.0187	0.0160	0.0162	0.0169
3	0.0015	0.0012	0.0011	0.0010	0.0142	0.0517	0.0517	0.0517
4	0.0013	0.0012	0.0011	0.0011	0.0162	0.0119	0.0128	0.0123
5	0.0011	0.0011	0.0011	0.0010	0.0128	0.0112	0.0106	0.0104
6	0.0007	0.0005	0.0007	0.0007	0.0072	0.0051	0.0078	0.0078
7	0.0008	0.0005	0.0007	0.0007	0.0074	0.0060	0.0072	0.0070
8	0.0011	0.0009	0.0011	0.0011	0.0103	0.0092	0.0102	0.0110
9	0.0016	0.0010	0.0013	0.0012	0.0127	0.0099	0.0123	0.0122
10	0.0017	0.0012	0.0013	0.0013	0.0172	0.0131	0.0128	0.0135
11	0.0047	0.0042	0.0037	0.0041	0.0562	0.0439	0.0417	0.0410
12	0.0048	0.0035	0.0032	0.0030	0.0478	0.0355	0.0318	0.0310
13	0.0029	0.0024	0.0027	0.0028	0.0302	0.0274	0.0273	0.0333
14	0.0030	0.0026	0.0027	0.0028	0.0356	0.0294	0.0307	0.0310
15	0.0046	0.0038	0.0032	0.0029	0.0562	0.0418	0.0353	0.0359
16	0.0023	0.0019	0.0019	0.0020	0.0203	0.0202	0.0181	0.0180
17	0.0036	0.0030	0.0028	0.0028	0.0404	0.0288	0.0281	0.0274
18	0.0043	0.0034	0.0033	0.0033	0.0495	0.0348	0.0377	0.0326
19	0.0052	0.0040	0.0036	0.0037	0.0519	0.0418	0.0379	0.0339
20	0.0018	0.0016	0.0015	0.0016	0.0200	0.0171	0.0172	0.0165
21	0.0016	0.0013	0.0015	0.0015	0.0166	0.0141	0.0156	0.0172
22	0.0011	0.0013	0.0013	0.0015	0.0120	0.0157	0.0164	0.0154
23	0.0012	0.0010	0.0010	0.0009	0.0138	0.0111	0.0110	0.0099
24	0.0019	0.0020	0.0019	0.0017	0.0214	0.0211	0.0214	0.0196
25	0.0013	0.0010	0.0011	0.0009	0.0144	0.0122	0.0129	0.0121
26	0.0012	0.0009	0.0010	0.0009	0.0126	0.0145	0.0119	0.0110
27	0.0009	0.0008	0.0009	0.0008	0.0103	0.0085	0.0104	0.0093

Receptor ID	99.9th Percentile Xylene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
28	0.0009	0.0006	0.0007	0.0006	0.0088	0.0078	0.0076	0.0073
29	0.0011	0.0010	0.0010	0.0011	0.0106	0.0105	0.0114	0.0115
30	0.0012	0.0010	0.0011	0.0010	0.0143	0.0121	0.0122	0.0111
31	0.0018	0.0015	0.0012	0.0012	0.0193	0.0152	0.0136	0.0127
32	0.0016	0.0013	0.0012	0.0011	0.0170	0.0141	0.0147	0.0123
33	0.0009	0.0007	0.0007	0.0007	0.0091	0.0079	0.0075	0.0076
34	0.0012	0.0011	0.0009	0.0009	0.0142	0.0101	0.0094	0.0086
35	0.0009	0.0007	0.0007	0.0007	0.0106	0.0079	0.0076	0.0082
36	0.0008	0.0007	0.0006	0.0006	0.0083	0.0068	0.0068	0.0069
37	0.0008	0.0006	0.0006	0.0006	0.0077	0.0065	0.0060	0.0062
38	0.0012	0.0010	0.0010	0.0011	0.0143	0.0113	0.0104	0.0110
39	0.0015	0.0012	0.0012	0.0012	0.0176	0.0133	0.0127	0.0135
40	0.0008	0.0008	0.0008	0.0008	0.0085	0.0082	0.0086	0.0089
41	0.0012	0.0010	0.0009	0.0010	0.0160	0.0127	0.0101	0.0115
42	0.0012	0.0009	0.0008	0.0009	0.0134	0.0109	0.0089	0.0100
43	0.0008	0.0010	0.0011	0.0013	0.0058	0.0064	0.0089	0.0096
44	0.0030	0.0021	0.0019	0.0015	0.0319	0.0248	0.0200	0.0177
45	0.0008	0.0007	0.0008	0.0009	0.0070	0.0054	0.0063	0.0063
46	0.0008	0.0006	0.0007	0.0008	0.0080	0.0056	0.0063	0.0067
47	0.0008	0.0008	0.0010	0.0010	0.0057	0.0066	0.0085	0.0102
48	0.0008	0.0007	0.0007	0.0007	0.0082	0.0069	0.0065	0.0065
49	0.0015	0.0011	0.0011	0.0011	0.0143	0.0117	0.0109	0.0118
50	0.0009	0.0007	0.0007	0.0007	0.0093	0.0072	0.0069	0.0073
51	0.0006	0.0005	0.0005	0.0006	0.0076	0.0059	0.0063	0.0063
52	0.0007	0.0006	0.0006	0.0006	0.0082	0.0074	0.0067	0.0063
53	0.0008	0.0007	0.0006	0.0007	0.0086	0.0076	0.0073	0.0075
54	0.0009	0.0007	0.0007	0.0007	0.0088	0.0079	0.0078	0.0077
55	0.0008	0.0006	0.0006	0.0006	0.0066	0.0062	0.0056	0.0064
56	0.0032	0.0030	0.0030	0.0028	0.0373	0.0353	0.0343	0.0325
57	0.0016	0.0012	0.0013	0.0014	0.0158	0.0134	0.0134	0.0146

Receptor ID	99.9th Percentile Xylene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
58	0.0015	0.0012	0.0011	0.0011	0.0187	0.0136	0.0119	0.0121
59	0.0015	0.0013	0.0014	0.0014	0.0172	0.0144	0.0161	0.0164
60	0.0011	0.0009	0.0008	0.0010	0.0134	0.0099	0.0107	0.0117
61	0.0009	0.0009	0.0008	0.0008	0.0124	0.0092	0.0093	0.0097
62	0.0011	0.0008	0.0008	0.0008	0.0136	0.0087	0.0082	0.0071
63	0.0009	0.0006	0.0007	0.0007	0.0079	0.0092	0.0094	0.0091
64	0.0009	0.0007	0.0007	0.0007	0.0102	0.0063	0.0067	0.0072
65	0.0010	0.0008	0.0008	0.0008	0.0098	0.0085	0.0082	0.0086
66	0.0009	0.0009	0.0009	0.0007	0.0107	0.0100	0.0099	0.0078
67	0.0006	0.0007	0.0008	0.0008	0.0072	0.0085	0.0084	0.0083
68	0.0008	0.0008	0.0007	0.0008	0.0096	0.0081	0.0086	0.0078
69	0.0015	0.0010	0.0009	0.0010	0.0166	0.0112	0.0122	0.0105
70	0.0010	0.0010	0.0009	0.0009	0.0112	0.0102	0.0099	0.0089
71	0.0012	0.0010	0.0010	0.0010	0.0148	0.0111	0.0108	0.0110
72	0.0011	0.0010	0.0009	0.0009	0.0119	0.0104	0.0099	0.0099
73	0.0007	0.0007	0.0007	0.0008	0.0079	0.0073	0.0077	0.0082
74	0.0012	0.0009	0.0007	0.0008	0.0146	0.0104	0.0100	0.0103
75	0.0007	0.0006	0.0006	0.0007	0.0081	0.0071	0.0055	0.0071
76	0.0008	0.0008	0.0007	0.0007	0.0084	0.0067	0.0070	0.0070
77	0.0010	0.0009	0.0009	0.0009	0.0106	0.0090	0.0098	0.0100
78	0.0011	0.0009	0.0008	0.0008	0.0134	0.0094	0.0087	0.0098
79	0.0010	0.0007	0.0006	0.0006	0.0091	0.0085	0.0065	0.0066
80	0.0011	0.0010	0.0008	0.0007	0.0128	0.0097	0.0086	0.0077
81	0.0008	0.0006	0.0007	0.0006	0.0079	0.0076	0.0070	0.0074
82	0.0009	0.0007	0.0007	0.0007	0.0094	0.0092	0.0073	0.0077
83	0.0007	0.0006	0.0006	0.0007	0.0066	0.0057	0.0057	0.0063
84	0.0007	0.0006	0.0006	0.0006	0.0093	0.0070	0.0063	0.0064
85	0.0005	0.0004	0.0004	0.0005	0.0050	0.0043	0.0052	0.0050
86	0.0011	0.0009	0.0008	0.0007	0.0111	0.0094	0.0085	0.0076
87	0.0008	0.0007	0.0006	0.0006	0.0084	0.0065	0.0061	0.0058

Receptor ID	99.9th Percentile Xylene Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
88	0.0011	0.0008	0.0007	0.0006	0.0108	0.0090	0.0076	0.0067
89	0.0008	0.0006	0.0006	0.0006	0.0088	0.0062	0.0060	0.0053
90	0.0007	0.0006	0.0005	0.0006	0.0071	0.0064	0.0060	0.0055
91	0.0005	0.0005	0.0005	0.0004	0.0045	0.0049	0.0044	0.0048
92	0.0006	0.0003	0.0003	0.0004	0.0040	0.0035	0.0037	0.0036
93	0.0004	0.0004	0.0004	0.0004	0.0048	0.0038	0.0044	0.0045
94	0.0005	0.0005	0.0006	0.0005	0.0050	0.0051	0.0057	0.0056
95	0.0004	0.0004	0.0004	0.0004	0.0039	0.0040	0.0047	0.0044
96	0.0004	0.0005	0.0005	0.0005	0.0043	0.0045	0.0053	0.0048
97	0.0004	0.0004	0.0004	0.0004	0.0045	0.0037	0.0042	0.0041
98	0.0003	0.0003	0.0004	0.0004	0.0034	0.0039	0.0042	0.0044
99	0.0005	0.0004	0.0004	0.0004	0.0051	0.0048	0.0040	0.0042
100	0.0004	0.0004	0.0004	0.0004	0.0031	0.0039	0.0044	0.0044
101	0.0006	0.0005	0.0006	0.0005	0.0043	0.0045	0.0044	0.0043
102	0.0009	0.0007	0.0007	0.0006	0.0091	0.0069	0.0065	0.0065
103	0.0009	0.0008	0.0007	0.0007	0.0088	0.0074	0.0075	0.0069
104	0.0012	0.0009	0.0009	0.0009	0.0128	0.0095	0.0097	0.0094
105	0.0015	0.0012	0.0012	0.0011	0.0156	0.0124	0.0133	0.0117
106	0.0008	0.0007	0.0006	0.0005	0.0084	0.0066	0.0069	0.0056
107	0.0007	0.0006	0.0006	0.0006	0.0080	0.0065	0.0065	0.0058
108	0.0006	0.0005	0.0005	0.0005	0.0066	0.0048	0.0048	0.0053
109	0.0006	0.0004	0.0004	0.0004	0.0047	0.0043	0.0044	0.0047
110	0.0006	0.0004	0.0004	0.0004	0.0040	0.0043	0.0042	0.0038
111	0.0006	0.0005	0.0005	0.0004	0.0049	0.0045	0.0042	0.0039
112	0.0006	0.0005	0.0004	0.0005	0.0064	0.0054	0.0049	0.0044
113	0.0006	0.0004	0.0004	0.0004	0.0043	0.0037	0.0036	0.0037
114	0.0006	0.0005	0.0005	0.0006	0.0062	0.0056	0.0055	0.0057

Table 48 1 Hour Maximum PAH Concentrations – All receptor elevations, all operational modes

Receptor ID	99.9th Percentile PAH Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
Elevation (mAGL)	0.5	5	10	15	0.5	5	10	15
Criteria	4.0E-2							
Maximum	2.8E-06	2.3E-06	2.0E-06	2.2E-06	3.0E-05	2.4E-05	2.3E-05	2.2E-05
1	7.0E-07	6.4E-07	6.1E-07	5.8E-07	7.4E-06	6.3E-06	6.5E-06	6.2E-06
2	9.7E-07	8.1E-07	7.3E-07	8.2E-07	1.0E-05	8.3E-06	8.7E-06	8.9E-06
3	7.2E-07	6.0E-07	5.8E-07	5.1E-07	7.7E-06	7.1E-06	5.9E-06	5.4E-06
4	7.1E-07	6.4E-07	5.9E-07	5.7E-07	8.8E-06	6.4E-06	6.9E-06	6.7E-06
5	6.1E-07	6.0E-07	5.8E-07	5.3E-07	6.9E-06	6.1E-06	5.7E-06	5.6E-06
6	3.6E-07	2.4E-07	3.8E-07	3.8E-07	3.9E-06	2.8E-06	4.2E-06	4.2E-06
7	4.0E-07	3.0E-07	3.7E-07	3.5E-07	4.0E-06	3.2E-06	3.9E-06	3.8E-06
8	5.6E-07	4.7E-07	5.9E-07	5.9E-07	5.6E-06	4.9E-06	5.5E-06	5.9E-06
9	8.6E-07	5.4E-07	7.1E-07	6.7E-07	6.9E-06	5.4E-06	6.7E-06	6.6E-06
10	9.3E-07	6.6E-07	6.9E-07	7.0E-07	9.3E-06	7.1E-06	6.9E-06	7.3E-06
11	2.5E-06	2.3E-06	2.0E-06	2.2E-06	3.0E-05	2.4E-05	2.3E-05	2.2E-05
12	2.6E-06	1.8E-06	1.7E-06	1.6E-06	2.6E-05	1.9E-05	1.7E-05	1.7E-05
13	1.6E-06	1.3E-06	1.4E-06	1.5E-06	1.6E-05	1.5E-05	1.5E-05	1.8E-05
14	1.6E-06	1.4E-06	1.5E-06	1.5E-06	1.9E-05	1.6E-05	1.7E-05	1.7E-05
15	2.5E-06	2.0E-06	1.7E-06	1.6E-06	3.0E-05	2.3E-05	1.9E-05	1.9E-05
16	1.2E-06	1.0E-06	1.0E-06	1.1E-06	1.1E-05	1.1E-05	9.8E-06	9.7E-06
17	1.9E-06	1.6E-06	1.5E-06	1.5E-06	2.2E-05	1.6E-05	1.5E-05	1.5E-05
18	2.3E-06	1.8E-06	1.8E-06	1.8E-06	2.7E-05	1.9E-05	2.0E-05	1.8E-05
19	2.8E-06	2.2E-06	1.9E-06	2.0E-06	2.8E-05	2.3E-05	2.0E-05	1.8E-05
20	1.0E-06	8.6E-07	8.2E-07	8.5E-07	1.1E-05	9.3E-06	9.3E-06	8.9E-06
21	8.0E-07	7.1E-07	7.2E-07	8.0E-07	9.0E-06	7.6E-06	8.4E-06	9.3E-06
22	6.1E-07	7.2E-07	7.2E-07	7.9E-07	6.5E-06	8.5E-06	8.9E-06	8.3E-06
23	6.5E-07	5.3E-07	5.2E-07	4.7E-07	7.5E-06	6.0E-06	5.9E-06	5.4E-06
24	1.0E-06	1.1E-06	1.0E-06	9.4E-07	1.2E-05	1.1E-05	1.2E-05	1.1E-05
25	6.8E-07	5.3E-07	6.2E-07	5.0E-07	7.8E-06	6.5E-06	6.3E-06	6.5E-06
26	6.4E-07	4.7E-07	5.5E-07	4.6E-07	6.8E-06	5.3E-06	6.1E-06	5.3E-06
27	4.7E-07	4.5E-07	5.0E-07	4.3E-07	5.6E-06	4.6E-06	5.6E-06	5.0E-06

Receptor ID	99.9th Percentile PAH Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
28	4.1E-07	3.4E-07	3.5E-07	3.3E-07	4.8E-06	4.2E-06	4.1E-06	3.9E-06
29	5.2E-07	4.8E-07	5.6E-07	5.8E-07	5.7E-06	5.7E-06	6.1E-06	6.2E-06
30	6.7E-07	5.5E-07	6.1E-07	5.5E-07	7.7E-06	6.5E-06	6.6E-06	6.0E-06
31	9.6E-07	7.9E-07	6.4E-07	6.3E-07	1.0E-05	8.2E-06	7.3E-06	6.8E-06
32	8.3E-07	6.9E-07	6.7E-07	5.7E-07	9.2E-06	7.6E-06	7.9E-06	6.6E-06
33	5.0E-07	3.9E-07	3.6E-07	3.5E-07	4.9E-06	4.3E-06	4.1E-06	4.1E-06
34	6.5E-07	5.7E-07	5.1E-07	4.7E-07	7.7E-06	5.5E-06	5.1E-06	4.6E-06
35	4.6E-07	3.7E-07	3.9E-07	3.8E-07	5.7E-06	4.3E-06	4.1E-06	4.4E-06
36	4.0E-07	3.4E-07	3.2E-07	3.4E-07	4.5E-06	3.7E-06	3.7E-06	3.7E-06
37	3.6E-07	3.1E-07	2.8E-07	3.1E-07	4.2E-06	3.5E-06	3.3E-06	3.4E-06
38	6.5E-07	5.1E-07	5.3E-07	5.9E-07	7.7E-06	6.1E-06	5.6E-06	5.9E-06
39	8.0E-07	6.6E-07	6.4E-07	6.6E-07	9.5E-06	7.2E-06	6.8E-06	7.3E-06
40	4.2E-07	4.1E-07	4.1E-07	4.4E-07	4.6E-06	4.4E-06	4.7E-06	4.8E-06
41	6.7E-07	5.6E-07	5.0E-07	5.4E-07	8.6E-06	6.9E-06	5.5E-06	6.2E-06
42	6.5E-07	4.8E-07	4.5E-07	4.6E-07	7.2E-06	5.9E-06	4.8E-06	5.4E-06
43	3.5E-07	3.2E-07	4.2E-07	4.4E-07	3.1E-06	3.5E-06	4.8E-06	5.2E-06
44	1.6E-06	1.1E-06	1.1E-06	8.3E-07	1.7E-05	1.3E-05	1.1E-05	9.6E-06
45	3.7E-07	2.8E-07	3.0E-07	3.1E-07	3.8E-06	2.9E-06	3.4E-06	3.4E-06
46	3.1E-07	3.0E-07	3.6E-07	3.2E-07	4.3E-06	3.0E-06	3.4E-06	3.6E-06
47	3.1E-07	3.3E-07	4.6E-07	5.2E-07	3.1E-06	3.5E-06	4.6E-06	5.5E-06
48	3.8E-07	3.6E-07	3.2E-07	3.3E-07	4.4E-06	3.7E-06	3.5E-06	3.5E-06
49	7.8E-07	6.0E-07	6.0E-07	5.8E-07	7.7E-06	6.3E-06	5.9E-06	6.4E-06
50	4.5E-07	3.6E-07	3.6E-07	3.7E-07	5.0E-06	3.9E-06	3.7E-06	3.9E-06
51	3.5E-07	2.7E-07	2.9E-07	3.1E-07	4.1E-06	3.2E-06	3.4E-06	3.4E-06
52	4.0E-07	3.2E-07	3.3E-07	3.2E-07	4.4E-06	4.0E-06	3.6E-06	3.4E-06
53	4.4E-07	3.7E-07	3.5E-07	3.6E-07	4.7E-06	4.1E-06	4.0E-06	4.1E-06
54	4.7E-07	3.7E-07	3.7E-07	3.9E-07	4.8E-06	4.3E-06	4.2E-06	4.1E-06
55	3.3E-07	3.0E-07	3.1E-07	3.1E-07	3.6E-06	3.3E-06	3.0E-06	3.5E-06
56	1.7E-06	1.6E-06	1.6E-06	1.5E-06	2.0E-05	1.9E-05	1.9E-05	1.8E-05
57	8.4E-07	6.4E-07	7.2E-07	7.3E-07	8.5E-06	7.2E-06	7.3E-06	7.9E-06

Receptor ID	99.9th Percentile PAH Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
58	8.0E-07	6.5E-07	6.0E-07	5.6E-07	1.0E-05	7.3E-06	6.5E-06	6.5E-06
59	7.9E-07	6.9E-07	7.7E-07	7.7E-07	9.3E-06	7.8E-06	8.7E-06	8.9E-06
60	6.1E-07	5.0E-07	4.4E-07	5.4E-07	7.2E-06	5.3E-06	5.8E-06	6.3E-06
61	5.1E-07	4.6E-07	4.3E-07	4.3E-07	6.7E-06	5.0E-06	5.0E-06	5.3E-06
62	5.4E-07	4.3E-07	4.3E-07	3.6E-07	7.4E-06	4.7E-06	4.4E-06	3.8E-06
63	4.7E-07	3.1E-07	3.5E-07	3.4E-07	4.3E-06	3.5E-06	3.9E-06	4.0E-06
64	5.0E-07	3.3E-07	3.7E-07	3.5E-07	5.5E-06	3.4E-06	3.6E-06	3.9E-06
65	5.2E-07	4.5E-07	4.3E-07	4.5E-07	5.3E-06	4.6E-06	4.4E-06	4.7E-06
66	5.0E-07	4.7E-07	4.2E-07	4.0E-07	5.8E-06	5.4E-06	5.3E-06	4.2E-06
67	3.2E-07	3.9E-07	4.1E-07	4.2E-07	3.9E-06	4.6E-06	4.5E-06	4.5E-06
68	4.6E-07	4.3E-07	4.0E-07	4.3E-07	5.2E-06	4.4E-06	4.6E-06	4.2E-06
69	8.3E-07	5.6E-07	5.0E-07	4.9E-07	9.0E-06	6.1E-06	6.6E-06	5.7E-06
70	5.7E-07	5.2E-07	4.7E-07	4.4E-07	6.1E-06	5.5E-06	5.4E-06	4.8E-06
71	6.3E-07	5.2E-07	5.2E-07	5.5E-07	8.0E-06	6.0E-06	5.8E-06	6.0E-06
72	5.8E-07	5.4E-07	4.8E-07	5.0E-07	6.4E-06	5.6E-06	5.3E-06	5.3E-06
73	3.4E-07	3.6E-07	3.6E-07	4.1E-07	4.3E-06	4.0E-06	4.2E-06	4.4E-06
74	6.5E-07	4.7E-07	3.7E-07	4.3E-07	7.9E-06	5.6E-06	5.4E-06	5.6E-06
75	3.9E-07	3.1E-07	2.9E-07	3.6E-07	4.4E-06	3.8E-06	3.0E-06	3.8E-06
76	4.3E-07	3.5E-07	3.5E-07	3.1E-07	4.5E-06	3.6E-06	3.8E-06	3.8E-06
77	5.6E-07	4.9E-07	4.7E-07	4.9E-07	5.7E-06	4.8E-06	5.3E-06	5.4E-06
78	5.9E-07	4.8E-07	4.4E-07	4.6E-07	7.2E-06	5.1E-06	4.7E-06	5.3E-06
79	5.6E-07	3.7E-07	3.4E-07	3.1E-07	4.9E-06	4.6E-06	3.5E-06	3.6E-06
80	6.1E-07	4.8E-07	4.0E-07	3.8E-07	6.9E-06	5.2E-06	4.6E-06	4.1E-06
81	4.3E-07	3.1E-07	3.6E-07	3.2E-07	4.3E-06	4.1E-06	3.8E-06	4.0E-06
82	4.7E-07	3.8E-07	3.9E-07	3.9E-07	5.1E-06	5.0E-06	4.0E-06	4.2E-06
83	3.4E-07	3.4E-07	2.9E-07	2.9E-07	3.6E-06	3.1E-06	3.1E-06	3.4E-06
84	3.8E-07	3.4E-07	3.3E-07	3.0E-07	5.0E-06	3.8E-06	3.4E-06	3.5E-06
85	2.6E-07	1.9E-07	2.3E-07	2.4E-07	2.7E-06	2.3E-06	2.8E-06	2.7E-06
86	5.7E-07	4.8E-07	4.2E-07	3.7E-07	6.0E-06	5.1E-06	4.6E-06	4.1E-06
87	4.3E-07	3.4E-07	2.9E-07	2.7E-07	4.5E-06	3.5E-06	3.3E-06	3.1E-06

Receptor ID	99.9th Percentile PAH Concentration(µg/m³)							
	CAT Generators				Cummins Generators			
88	5.7E-07	4.2E-07	3.9E-07	3.0E-07	5.8E-06	4.9E-06	4.1E-06	3.6E-06
89	3.9E-07	3.3E-07	3.0E-07	3.0E-07	4.8E-06	3.4E-06	3.2E-06	2.9E-06
90	3.6E-07	3.0E-07	2.9E-07	3.1E-07	3.9E-06	3.5E-06	3.2E-06	3.0E-06
91	2.9E-07	2.5E-07	2.5E-07	2.3E-07	2.5E-06	2.6E-06	2.4E-06	2.6E-06
92	1.7E-07	1.6E-07	1.9E-07	1.9E-07	2.2E-06	1.9E-06	2.0E-06	1.9E-06
93	2.1E-07	1.9E-07	2.0E-07	1.9E-07	2.6E-06	2.0E-06	2.4E-06	2.4E-06
94	2.8E-07	2.6E-07	2.6E-07	2.6E-07	2.7E-06	2.7E-06	3.1E-06	3.0E-06
95	1.8E-07	1.9E-07	2.0E-07	2.2E-07	2.1E-06	2.2E-06	2.5E-06	2.4E-06
96	2.2E-07	2.3E-07	2.7E-07	2.2E-07	2.3E-06	2.4E-06	2.9E-06	2.6E-06
97	2.0E-07	1.9E-07	2.1E-07	2.2E-07	2.4E-06	2.0E-06	2.3E-06	2.2E-06
98	1.6E-07	1.9E-07	1.9E-07	2.3E-07	1.8E-06	2.1E-06	2.3E-06	2.4E-06
99	2.3E-07	1.9E-07	2.1E-07	2.1E-07	2.7E-06	2.6E-06	2.2E-06	2.3E-06
100	1.9E-07	2.0E-07	2.2E-07	2.3E-07	1.7E-06	2.1E-06	2.4E-06	2.4E-06
101	2.3E-07	2.3E-07	2.2E-07	2.4E-07	2.3E-06	2.4E-06	2.4E-06	2.3E-06
102	4.6E-07	3.6E-07	3.1E-07	3.2E-07	4.9E-06	3.7E-06	3.5E-06	3.5E-06
103	4.0E-07	3.9E-07	3.7E-07	3.6E-07	4.8E-06	4.0E-06	4.0E-06	3.7E-06
104	6.2E-07	4.8E-07	4.9E-07	4.8E-07	6.9E-06	5.2E-06	5.3E-06	5.1E-06
105	8.1E-07	6.5E-07	6.5E-07	5.9E-07	8.4E-06	6.7E-06	7.2E-06	6.3E-06
106	3.9E-07	3.6E-07	3.2E-07	2.9E-07	4.6E-06	3.6E-06	3.7E-06	3.0E-06
107	3.6E-07	3.1E-07	3.0E-07	3.1E-07	4.3E-06	3.5E-06	3.5E-06	3.1E-06
108	3.2E-07	2.4E-07	2.9E-07	2.4E-07	3.6E-06	2.6E-06	2.6E-06	2.8E-06
109	2.6E-07	2.1E-07	2.2E-07	2.1E-07	2.6E-06	2.3E-06	2.4E-06	2.5E-06
110	2.5E-07	1.7E-07	1.8E-07	1.8E-07	2.1E-06	2.3E-06	2.3E-06	2.1E-06
111	3.1E-07	2.1E-07	2.4E-07	2.2E-07	2.7E-06	2.4E-06	2.3E-06	2.1E-06
112	3.0E-07	2.4E-07	2.2E-07	2.3E-07	3.5E-06	2.9E-06	2.7E-06	2.4E-06
113	2.0E-07	1.6E-07	1.7E-07	2.0E-07	2.3E-06	2.0E-06	1.9E-06	2.0E-06
114	3.2E-07	2.9E-07	2.7E-07	3.0E-07	3.3E-06	3.0E-06	3.0E-06	3.1E-06

Appendix F

Pollutant Statistics Calculation Summary

Appendix F Pollutant Statistics Calculation Summary

Given that the Data Centre emergency generators do not operate continuously, the calculated statistics for comparison with the NSW EPA criteria need to be carefully considered to ensure the results are both representative of worst-case conditions, but also are not unrealistically high. To ensure an appropriate comparison with EPA criteria, the pollutant statistics were calculated assuming the test modes considered (as discussed in **Section 6.0**) were as follows:

- A single generator operating for 15 minutes assuming 10% generator load.
- A single generator operating for 1 hour assuming 50% generator load
- A single generator operating for 15 minutes assuming 100% generator load
- Generators were modelled as a single stack either in the north stack cluster or south stack cluster.

Pollutant specific calculations were as follows:

- ***Nitrogen Dioxide***: the maximum 1-hour NO_X and NO_2 ground level concentration for the engine test modes were determined for each month of the year. To enable a comparison with NSW EPA criteria, two pollutant averaging periods are required. The maximum 1-hour average NO_2 concentration and the annual average NO_2 concentration were calculated based on the following assumptions:
  - Maximum 1-hour average concentration was based on the maximum of all predicted concentrations obtained across all modelled hours and all operating modes.
  - The annual average predicted concentration was calculated by determining the relative contribution from each of the operating modes modelled for each month over a full year of meteorology (to ensure seasonal bias was addressed as much as possible). This included all 18 generators being tested for each month of the year according to the operational profiles listed above.

  The annual average concentration calculation was undertaken for each receptor as follows:

$$Ann\ Ave\ NO_2 = \left\{ \sum_{Jan \rightarrow Dec} Maximum\ Hourly\ Average\ per\ Month\ (for\ 10\%, 50\%, 100\%\ Operting\ Mode\ ) \times 18 \right\} \div 8760$$

- ***Particulate Matter ($PM_{2.5}$)***: the maximum 1-hour NO_X and NO_2 ground level concentration for the engine test modes were determined for each month of the year. To enable a comparison with NSW EPA criteria, two calculated pollutant averaging periods were required. The maximum 24-hour average and the annual average $PM_{2.5}$ concentrations were calculated based on the following assumptions:
  - Maximum 24-hour average concentration was calculated by using the maximum 1-hour predicted concentration obtained across all modelled hours for a single 24-hour period within each month of the year. As there may be up to 3 engines operating per day, the maximum concentration was increase by a factor of three to enable the single hour $PM_{2.5}$ concentration to occur up to 3 times. The calculation was undertaken for each receptor as follows:

$$24\ Hour\ Ave\ PM_{2.5} = \{Maximum\ 1\ Hour\ PM_{2.5}\ Concentration\ for\ a\ 24\ hour\ Period\} \times 3 \div 24$$

  - The annual average predicted concentration was calculated using the worst case 24-hour $PM_{2.5}$ concentration occurring up to 6 times per month (to allow for the 3 tests to occur per day for up to 6 days) across a full year of meteorology. The calculation was undertaken for each receptor as follows:

$$Ann\ Ave\ PM_{2.5} = \sum_{Jan \rightarrow Dec} [\{Maximum\ Monthly\ 24\ Hour\ PM_{2.5}\ Concentration\} \times 6] \div 365$$

- ***Carbon Monoxide***: the maximum 1-hour and 8-hour CO ground level concentrations for the engine test modes were determined for each month of the year. To enable a comparison with

NSW EPA criteria, both pollutant averaging periods were required. The maximum 1-hour and 8-hour concentrations were calculated based on the following assumptions:

- Maximum 1-hour average concentration was calculated from all predicted concentrations obtained across all modelled hours and all operating modes.
- Maximum 8-hour average concentrations were based on the maximum 1-hour concentrations occurring up to a maximum of three times during an 8-hour period (in line with 3 tests per day assumed for $PM_{2.5}$ calculations).

- ***Volatile Organic Compounds***: the 99.9th percentile VOC ground level concentration for the engine test modes were determined across the full year of data. The calculation of the percentile statistic for the operation of a variable mode facility is different to the determination of the maximum and annual statistics listed above as the calculation of as there are a range of different emissions data possible across a year between which the emissions are zero.

  To establish the likely realistic 99.9^{th} percentile concentration, the statistic has been calculated assuming the continuous daytime operation of a single stack. The 99.9^{th} percentile concentration across a full year is approximately equal to the 9^{th} highest concentration. As all of the generators are expected to be operating for at least 12 hours per year each, the top 9 predictions are considered to represent a realistic percentile estimation.

  In addition to the percentile concentrations, a ratio of expected pollutant concentrations has been extracted for Diesel VOC emissions. This ratio has been applied to the predictions to enable comparison to speciated VOC compounds expected to be present in diesel exhaust.

- ***Polycyclic Aromatic Hydrocarbons (PAHs)***: predictions have been calculated for the same statistics as the Volatile Organic Compounds. No speciation has been undertaken however as it is assumed that all PAH is present as Benzo(a)Pyrene