AIR QUALITY IMPACT ASSESSMENT

Eastern Creek Data Centre
17 Roberts Road, Eastern Creek
SSD-10330

Prepared for:

Canberra Data Centres Pty Ltd
PO Box 304
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Canberra Data Centres Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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1 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) was engaged by Canberra Data Centres Pty Ltd (CDC) to prepare an Air Quality Impact Assessment (AQIA) to accompany the State Significant Development (SSD) application for a proposed Data Centre (the Project) at 17 Roberts Road, Eastern Creek.

SLR issued a qualitative AQIA report (610.18883-R03-v3.0) for the Project, on 25 October 2019. The AQIA focussed on potential impacts associated with emissions to air during the construction of the Data Centre.

On 22 January 2020, the NSW EPA issued comments on the EIS prepared for the project. In relation to air quality, the EPA has requested a revised AQIA which provides further information on:

- Generator specifications, electrical generation capacity and generator fuel rate to assess against the criteria for a scheduled activity
- Assessment of emissions from the generators against the POEO (Clean Air) Regulation standards of concentration
- Assessment of offsite impacts from the operation of the proposed generators in strict accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.

This revised AQIA incorporates responses to the EPA's request.

1.2 Relevant Policies, Guidelines and Plans100

This assessment has been prepared with consideration of the following policies, guidelines and plans:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2017) (the Approved Methods)
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (NSW DEC, 2005)
- Protection of the Environment Operations Act 1997 (NSW Parliament, 1997)
- Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW Parliament, 2010)

The Approved Methods outlines the requirements for conducting an air quality impact assessment as follows (also indicated are the relevant sections of this report where the requirements are met):

- Description of local topographic features and sensitive receptor locations (Section **7.1**7.1 and Section **7.2** respectively)
- Establishment of air quality assessment criteria (**Section 6.2**)
- Analysis of climate and dispersion meteorology for the region (**Section 7.3**)
- Description of existing air quality environment (**Section 7.4**)
- Compilation of a comprehensive emissions inventory for the proposed activities (**Section 8.2.5**)
- Completion of atmospheric dispersion modelling and analysis of results (Section **8.2** and Section **9.2**)
- Preparation of an air quality impact assessment report comprising the above.

2 Glossary and Abbreviations

Table 1 below shows the glossary of terms and their definitions used in this AQIA.

Table 1 Glossary

Term	Definition
The Site	Canberra Data Centres Pty Ltd owns the site at 17 Roberts Road, Eastern Creek and is legally known as Lot 2 in Deposited Plan 1159804.
The Project	The construction of a new Data Centre and ancillary office space to expand the operation of the existing Data Centre to the east of the site.

Table 2 below shows the abbreviations and their definitions used in this AQIA.

Table 2 Abbreviations

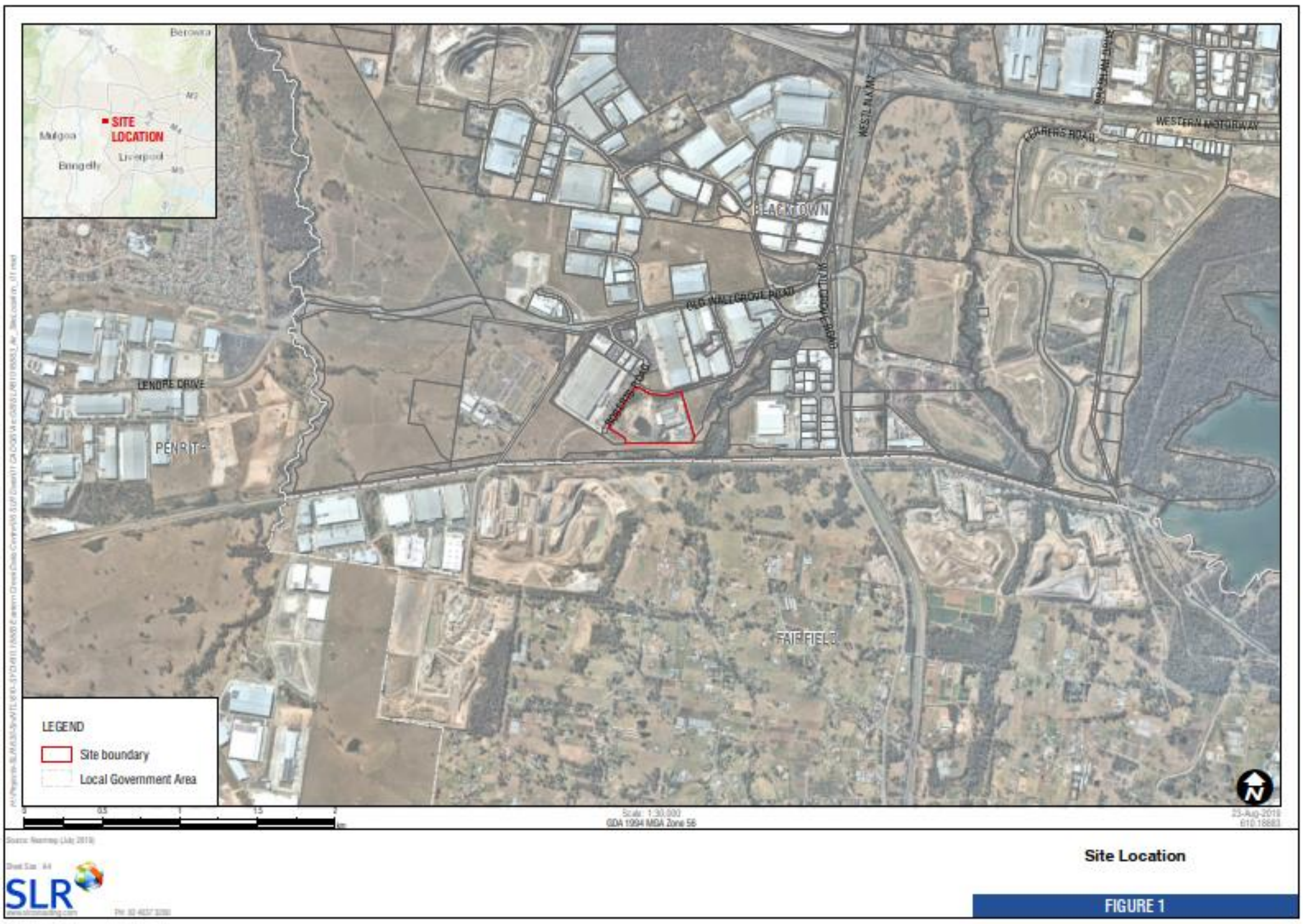
Term	Definition
AQIA	Air Quality Impact Assessment
AQMS	Air Quality Monitoring Station
AWS	Automatic weather station
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CO	Carbon Monoxide
DPIE	NSW Department of Planning, Industry and Environment
EES	DPIE's Environment, Energy and Science Group
EPA	NSW Environment Protection Authority
g/m^2/month	Grams per meter squared per month
IAQM	Institute of Air Quality Management
IN1	General industrial land (planning zone)
m/s	Metres per second
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
O_3	Ozone
OEH	Office of Environment and Heritage
PM	Particulate matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns or less
PM_{10}	Particulate matter with an aerodynamic diameter of 10 microns or less
SO_2	Sulfur dioxide
SP2	Infrastructure (planning zone)
VOC	Volatile Organic Compounds

3 Project Description

3.1 Project Location

The Project is located at 17 Roberts Road, Eastern Creek, within the Eastern Creek Business Park (the Site, **Figure 1**). The Site is formally described as Lot 2 DP 1159804, and has an approximate area of 14.5 hectares. The Site is bordered by Roberts Road in the west, Capicure Drive in the north, transmission line easement in the south and a vacant lot in the east. The portion of the Site relevant to this project is the Project footprint located in the central and western portions of the Site.

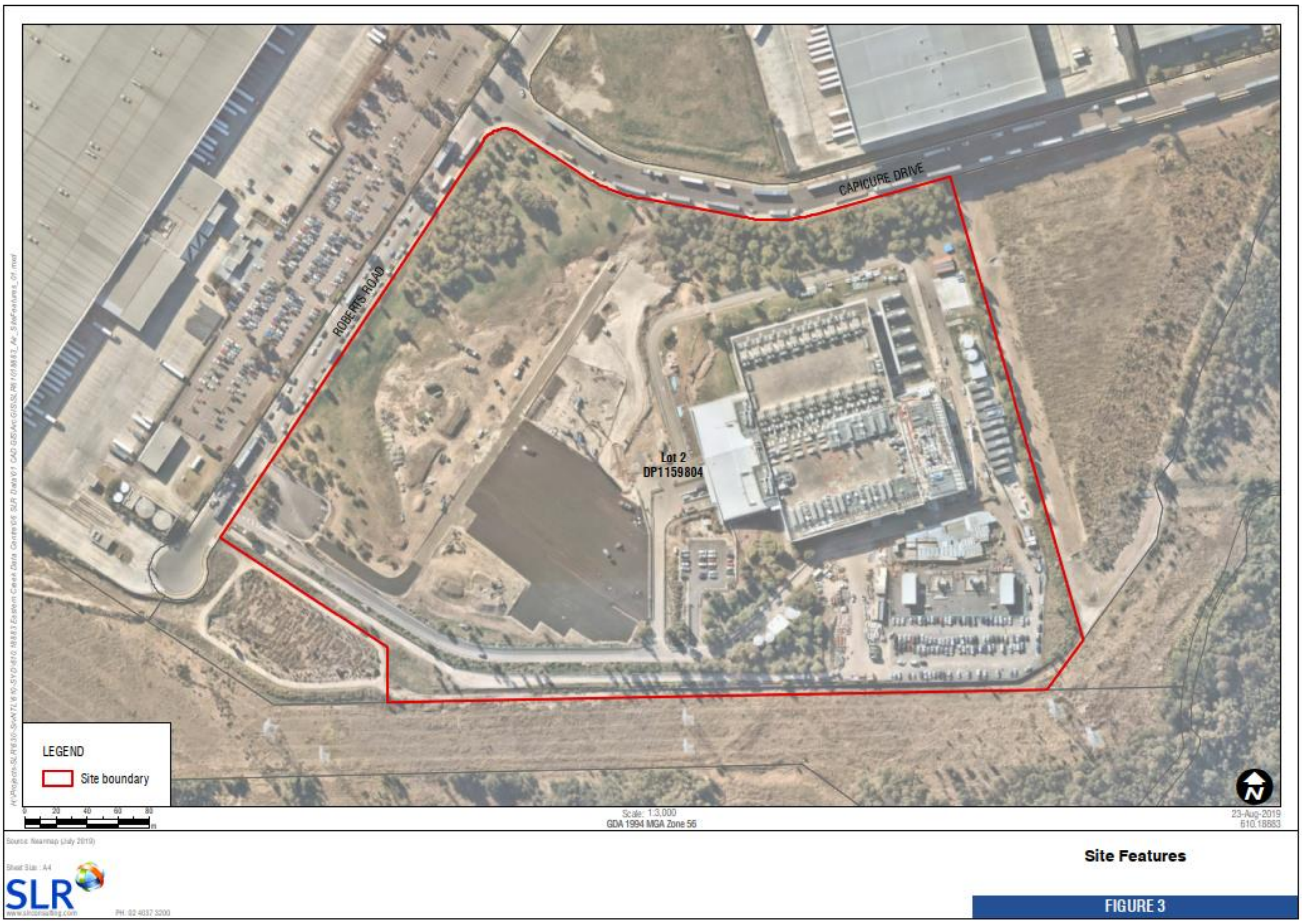
Figure 1 Project Location



3.2 Project Overview

From aerial imagery provided in **Figure 2,** currently on the eastern side of the Site are nine operational data halls with a rear annexe building, an administrative building, internal roads, car parks and other evidence of Site development activities.

Figure 2 Aerial Image of the Site



The SSDA proposes the construction of a new Data Centre and ancillary office space to expand the operation of the existing Data Centre (**Figure 3**). The proposed Data Centre including three large warehouse buildings and ancillary office space.

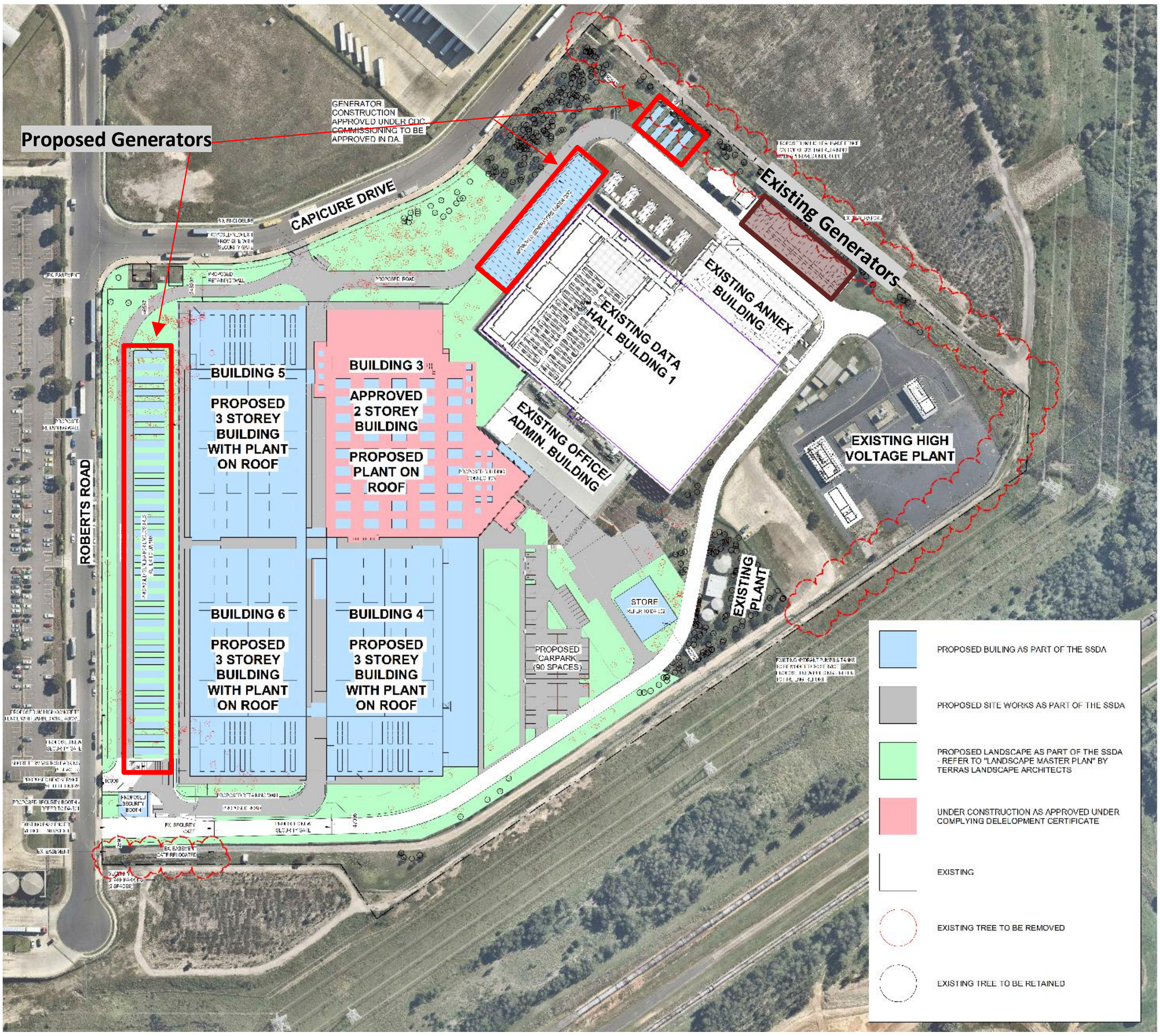
Specifically, the SSDA seeks consent for:

- Site preparation works comprising:
  - Site preparation and mobilisation including clearing of land and importation of fill material
  - Bulk and detail earthworks and support structures
  - Estate stormwater management including construction of detention basins
  - Construction of site access and estate internal roads
  - Service and infrastructure augmentation
  - Perimeter fencing
  - Retaining wall
  - Removal of trees
  - Environmental protection and management measures

- Staged construction of buildings for a Data Centre with 24 hour per day, seven day per week operation:
  - Construction of three 3 storey warehouse facilities (E4, E5, E6) including ancillary office spaces
  - Additional rooftop plant and equipment for Building E3 in associated with Data Centre use
  - Fit out of buildings
  - Construction of a storeroom
  - Security booth
  - Backup generators within generator enclosures- a total of 48 generators (36 generators to be constructed and commissioned under the SSDA in addition to 12 generators constructed under Complying Certificate and to be commissioned under SSDA)
  - Landscaping works
  - Construction of hardstand, loading area and a new car park

The proposal does not involve the installation of any form of signage to the façade of the building.

Figure 3 Proposed Site Plan[1]



[1] Adapted from EJE Architecture's drawing 12706/SD/DA-001E dated 16 April 2020

4 Potential Sources of Air Emissions

4.1 Construction Phase

During the construction works, fugitive dust emissions are considered to be the primary emission type, which could give rise to nuisance and/or health impacts for the surrounding sensitive areas.

The main emissions to air during the construction phase are likely to be emissions of suspended particulate matter and nuisance dust from the movement of vehicles and construction equipment, excavation and rehabilitation, demolition, clearing and grading, truck loading and unloading and wind erosion.

4.2 Operational Phase

The Project includes uninterruptible power supplies (UPS) with battery back-up for power conditioning and short-term interruptions, however, standby generators are required to ensure ongoing operation if the mains grid electricity supply is interrupted for more than a few minutes. The function of the standby generators is to provide power when there is an unexpected interruption of mains grid electricity.

During the operational phase, the emergency generators would be a source of products of combustion while undergoing testing and in the event of a power failure. In general, power interruptions last anything from a few seconds to a few hours and therefore even when required the generators would only operate for a short time.

The Project is anticipated to incorporate 48 standby generators. 32 generators are to be located along the west walls of Building 5 and 6, 12 generators are to be located to the north of the existing data hall, and four generators are to be located to the north of the Site (refer **Figure 3**).

Table 3 provides the proposed testing regime for which this AQIA is based.

Table 3 Proposed Generator Testing Regime

Parameter	Value
Run time per test	60 minutes
No of generators per test	5 (Maximum, including existing generators)
Number of tests per day	1
Testing schedule	Monday to Friday (9 am to 5 pm)
Total testing time	12 hours / annum / generator

As outlined in **Table 3**, testing of generators is proposed to be conducted for 1 hour between 9am to 5pm, Monday to Friday, and a total of 12 tests (12 hours) will be undertaken per year per generator. No more than five generators will be tested per day.

As major power interruptions requiring the simultaneous operation of all standby generators would only occur very infrequently and for a limited time period, modelling of impacts during this emergency scenario has not been undertaken. This AQIA focuses on assessing the potential worst-case impact associated with the typical operations at the Site which involves the testing of a maximum of five generators simultaneously.

In order to assess the worst case scenario, the modelling undertaken for the operational scenario assumes that:

- Each generator would be tested for a period of 60 minutes.
- Five generators will be tested concurrently within the same hour.
- Testing of generators is conducted every hour of the year between 9am and 5 pm (to assess the operation of the generators under varying meteorological conditions).

5 Regulatory Framework

5.1 Relevant Legislation, Policy and Guidance

The following Air Quality Policy and Guidance documents have been referenced within this assessment and have been used to identify the relevant air quality criteria (see **Section 6.2**).

5.1.1 Protection of the Environment Operations (POEO) Act 1997 & Amendment Act 2011

The POEO Act (and Amendment Act 2011) is a key piece of environment protection legislation administered by the NSW Department of Planning, Industry and Environment's Environment, Energy and Science (EES) group which enables the Government to establish instruments for setting environmental standards, goals, protocols and guidelines.

The following sections of the POEO Act are of general relevance to the Project:

- Section 124 and 125 of the POEO Act states that any plant located at a premise (e.g. standby generators) should be maintained in an efficient condition and operated in a proper and efficient manner to reduce the potential for air pollution.
- Section 128 of the POEO Act states:
    1. The occupier of a premises must not carry out any activity or operate any plant in or on the premises in such a manner to cause or permit the emission at any point specified in or determined in accordance with the regulation of air impurities in excess of [the standard of concentration and/or the rate] prescribed by the regulations in respect of any such activity or any such plant.
    2. Where neither such a standard nor rate has been so prescribed, the occupier of any premises must carry on activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.

5.1.2 Protection of the Environment Operations (Clean Air) Regulation 2010

The POEO (Clean Air) Regulation 2010 (the Regulation) is the core regulatory instrument for air quality issues in NSW. In relation to industry, the Regulation:

- sets maximum limits on emissions from activities and plant for a number of substances;
- deals with the transport and storage of volatile organic liquids;
- restricts the use of high sulphur liquid fuel; and
- imposes operational requirements for certain afterburners, flares, vapour recovery units and other treatment plant.

Part 5 of the POEO (Clean Air) Regulation 2010 (the Regulation) also deals with emissions of air impurities from activities and plant, and sets maximum limits on emissions for a number of substances (including solid particles and visible smoke) as noted below in **Table 4** and **Table 5**. The standards of concentrations prescribed by Part 5, Division 3 do not apply to plant during start-up and shutdown periods, however such emissions are still subject to the requirements of Section 128 (2) of the POEO Act in relation to the prevention and minimisation of air pollution.

Table 4 Schedule 6 Standards of Concentration for (Group C[1]) Non-Scheduled Premises

Air Impurity	Activity	Concentration [2]
Particles	Any activity/ plant	100 mg/m^3
Smoke	Solid fuel is burnt	Ringlemann 1 or 20% opacity
	Liquid fuel is burnt	Ringlemann 1 or 20% opacity

Note 1 Group C: Activity granted DA consent and commenced to operate after 1 September 2005.

Note 2 Reference conditions are: Dry, 273 K, 101.3 kPa for any activity.

Table 5 Schedule 4 Standards of Concentration for (Group 6[1]) Scheduled Premises

Air Impurity	Activity [2]	Concentration [3]
Solid Particles	Any activity/ plant	50 mg/m^3
NO_2 or NO or both, as NO_2 equivalent	Stationary reciprocating internal combustion engines	450 mg/m^3
VOCs as n-propane	Any stationary reciprocating internal combustion engine using a liquid fuel	1140 mg/m^3 VOCs or 5880 mg/m^3 CO
Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	Ringlemann 1 or 20% opacity

Note 1 Group 6: Activity granted DA consent and commenced to operate after 1 September 2005.

Note 2 only concentration standards relevant to the operations at the Site have been listed.

Note 3 Reference conditions are: Dry, 273 K, 101.3 kPa for any activity.

The Regulation exempts emergency standby plant (comprising a stationary reciprocating internal combustion engine) for generating electricity from the air impurities standard for NO_2 and NO specified in Schedule 4 (see **Table 5**) relevant to that plant if the plant is used for a total of not more than 200 hours per year.

As outlined in **Section 4.2**, each generator (plant) is proposed to be operated for 12 hours per year for the purposes of testing. While generators will be required to operate for the purpose of electricity generation during major power interruptions. Such events would only occur very infrequently and for a limited time period. Therefore, it is not anticipated that each generator would be required to operate for a total of less than 200 hours per year. As such the Project is exempt from the concentration limits outlined in **Table 5**.

5.1.3 NSW Environment Protection Authority Air Quality Policy and Guidance

The EPA is the NSW regulatory authority responsible for air quality regulation and associated activities.

The Approved Methods lists the statutory methods for modelling and assessing air pollutants from stationary sources and specifies criteria which reflect the environmental outcomes adopted by the EPA. The Approved Methods are referred to in the POEO (Clean Air) Regulation 2002 for assessment of impacts of air pollutants. The air quality criteria set out in the Approved Methods have been reproduced and discussed in **Section 6.2**.

5.1.4 Local Air Quality Toolkit

The Local Government Air Quality Toolkit (AQ Toolkit) has been developed by the EPA to assist local government in their management of air quality issues and provides guidelines for air quality management and for the use of air pollution control techniques. Relevant AQ Toolkit air quality guidance notes include:

- Dust from urban construction sites (NSW EPA, 2007-1)
- Construction sites (NSW EPA, 2007-2).

6 Relevant Pollutants and Air Quality Criteria

6.1 Pollutants of Concern

6.1.1 Construction

Potential air pollutants of interest for the construction of the Project are considered to be both:

- Suspended particulate matter
- Deposited dust.

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The health effects of particulate matter are strongly influenced by the size of the airborne particles. Smaller particles can penetrate further into the respiratory tract, with the smallest particles having a greater impact on human health as they penetrate to the gas exchange areas of the lungs. Larger particles primarily cause nuisance associated with coarse particles settling on surfaces and possessions (dust deposition), affecting visibility and contaminating tank water supplies. High rates of dust deposition can also adversely affect vegetation by blanketing leaf surfaces.

The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP). Epidemiological studies suggest a relationship between health impacts and exposure to concentrations of finer particulate matter, for example particulate matter with an aerodynamic diameter of 10 microns or less, which is referred to as PM_{10}. The PM_{10} size fraction is sufficiently small to penetrate the large airways of the lungs, while $PM_{2.5}$ (2.5 microns or less) particulates are generally small enough to be drawn in and deposited into the deepest portions of the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children. In an urban setting, the emission of $PM_{2.5}$ is primarily associated with vehicles exhausts resulting from the incomplete combustion of diesel. It is anticipated that the primary particle fraction associated with construction will be PM_{10}.

The key potential health and amenity issues associated with construction of Project are, respectively:

- Elevated PM_{10} concentrations
- Nuisance due to dust deposition and visible dust plumes.

6.1.2 Operation

Potential air pollutants of interest for the operation of the Project are considered to be emissions associated with the combustion of fuel in standby generators which include:

- carbon monoxide (CO)
- oxides of nitrogen (NO_x)
- PM_{10} and $PM_{2.5}$
- sulfur dioxide (SO_2)
- volatile organic compounds (VOCs)

In atmospheric chemistry, NO_x generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. NO will be converted to NO_2 after leaving the combustion source.

CO is an odourless, colourless gas formed from the incomplete burning of fuels. It can be a common pollutant at the roadside and highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road.

Sulfur in the burner fuel will convert to sulfur oxides during combustion, hence emissions of SO_2 are directly related to the concentration of sulfur in the fuel and the burner operation has little effect on the percent of this. Diesel contains more sulfur than gas, as there is negligible sulfur content in Australian natural gas and LPG.

VOCs are organic compounds (i.e. contain carbon) that have high vapour pressure at normal room-temperature conditions. Their high vapour pressure leads to evaporation from liquid or solid form and emission release to the atmosphere. VOCs are emitted by a variety of sources, including motor vehicles. VOCs that are often typical of these sources include benzene, toluene, ethylbenzene and xylenes (often referred to as 'BTEX'). Biogenic (natural) sources of VOC emissions are also significant (e.g. vegetation).

Impacts due to emissions of VOCs can be health or nuisance (odour) related. Benzene is a known carcinogen and a key VOC linked with the combustion of motor vehicle fuels.

The rate and composition of air pollutant emissions from generators is a function of a number of factors, including the type and size of the generators and fuel type.

Based on information provided to SLR, it is understood that the proposed backup generators will be Cummins QSK95-G4 diesel fired generators. Refer to **Appendix C** for the QSK95-G4 generator specification sheet which includes details on the fuel usage and pollutant emission rates.

6.2 Ambient Air Quality Criteria

NSW OEH has established ground level air quality impact assessment criteria for air pollutants to achieve appropriate environmental outcomes and to minimise associated risks to human health as published in the Approved Methods. The AQIA air quality criteria for the pollutants of concern during the operational phase of the Project, adopted from the Approved Methods, are provided in **Table 6,** referenced as mass concentrations.

Table 6 Project Air Quality Goals

Pollutant	Averaging Time	Goal
PM_{10}	24 hours	50 µg/m³
	Annual	25 µg/m³
$PM_{2.5}$	24 hours	25 µg/m³
	Annual	8 µg/m³
Deposited dust	Annual	2 g/m²/month (maximum increase) 4 g/m²/month (maximum cumulative)
NO_2	1 hour	246 µg/m³
	Annual	62 µg/m³
CO	15 minutes	100 mg/m³
	1 hour	30 mg/m³
	8 hours	10 mg/m³
SO_2	10 minutes	712 µg/m³
	1 hour	570 µg/m³
	24 hours	228 µg/m³
	Annual	60 µg/m³
Benzene	1 hour	0.029 mg/m³
Toluene	1 hour	0.36 mg/m³
Ethylbenzene	1 hour	8 mg/m³
Xylene	1 hour	0.19 mg/m³

In accordance with the Approved Methods, the impact assessment criteria are to be applied as follows:

- At the nearest existing or likely future off-site sensitive receptor.
- The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in units and averaging periods consistent with the impact assessment criteria.
- For individual toxic air pollutants, the incremental impact for each pollutant must be reported in concentration units consistent with the criteria (mg/m^3 or ppm), for an averaging period of 1 hour and as the 99.9^{th} percentile of dispersion model predictions for Level 2 impact assessments.
- Background concentrations must be included using the procedures specified in Section 5 of the Approved Methods.
- Total cumulative impact (incremental impact plus background) must be reported as the 100^{th} percentile (P=100) (or 99^{th} percentile (P=99) for odour) in concentration or deposition units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

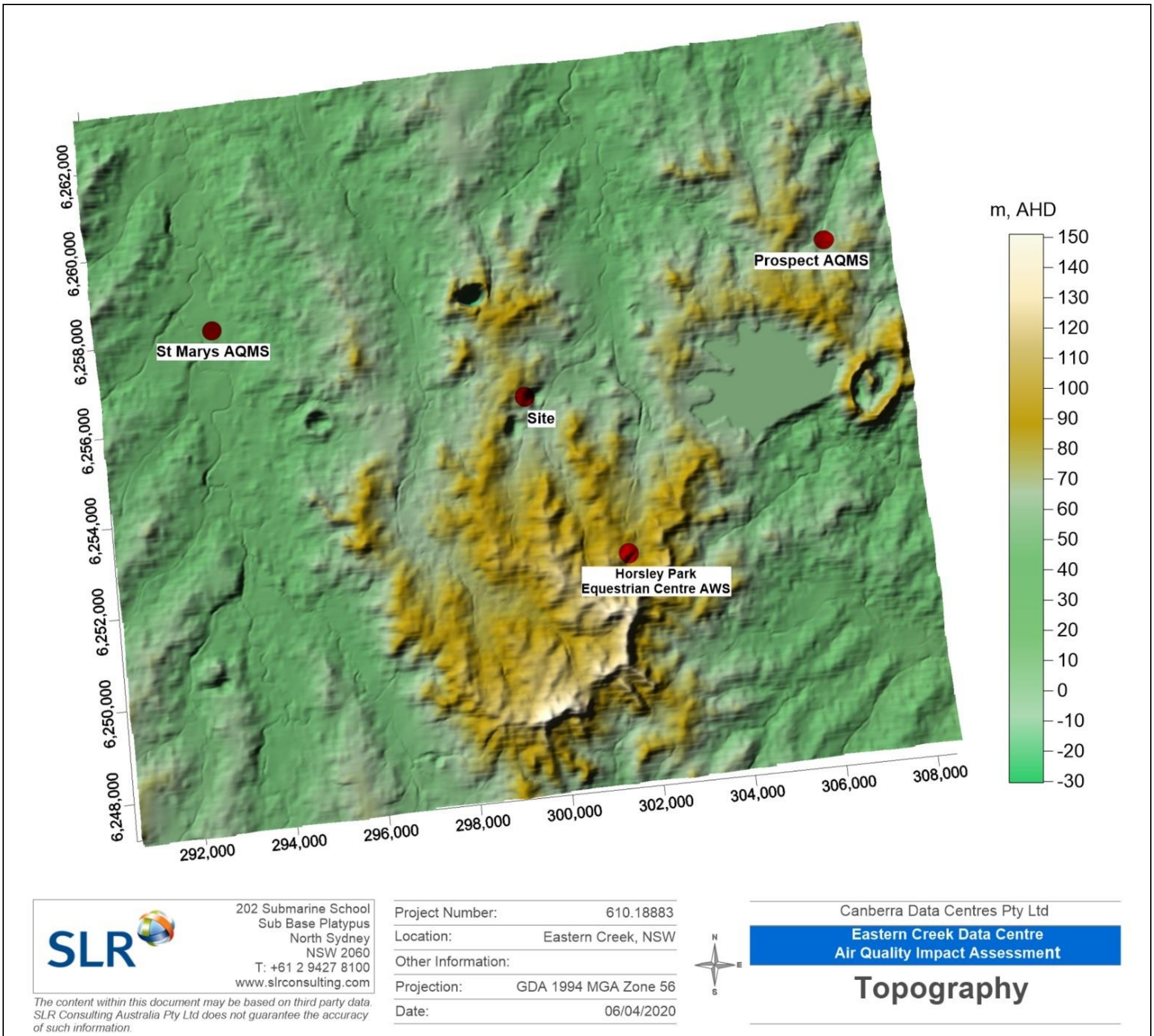
7 Existing Environment

7.1 Topography

Topography is important in air quality studies as local atmospheric dispersion can be influenced by night-time katabatic (downhill) drainage flows from elevated terrain or channelling effects in valleys or gullies.

A three-dimensional representation of the area surrounding the Site is given in **Figure 4**. The topography of the local area generally ranges from an approximate elevation of 30 metres (m) to 150 m Australian Height Datum (AHD). It is noted that the former Wallgrove quarry (with elevations as low as -30 m AHD) lies approximately 2 km north-northwest of the Site.The topography of the Site itself is relatively flat, gently sloping from the northwest to the southeast.

Figure 4 Local Topographical Features



7.2 Land Use and Sensitive Receptors

The Site is zoned as IN1 General Industrial land (NSW Department of Planning, 2019), as is the land immediately to the west, north and east (**Figure 5**). The land to the south is zoned SP2 Infrastructure.

Based on available aerial images, SLR has identified the nearest sensitive receptors as residences in a rural setting on Flavex Lane, approximately 900 m to the southeast. The nearest *human receptor* (a location where a person or property may experience adverse effects of airborne dust or dust soiling) is the distribution centre 50 m beyond the northwest boundary of the Site. For the purposes of the AQIA, six additional receptor locations have been selected to represent those nearest sensitive receptors beyond the boundaries of the Site in different directions, as provided in **Table 7** and illustrated in **Figure 6.**

Figure 5 Planning Zones

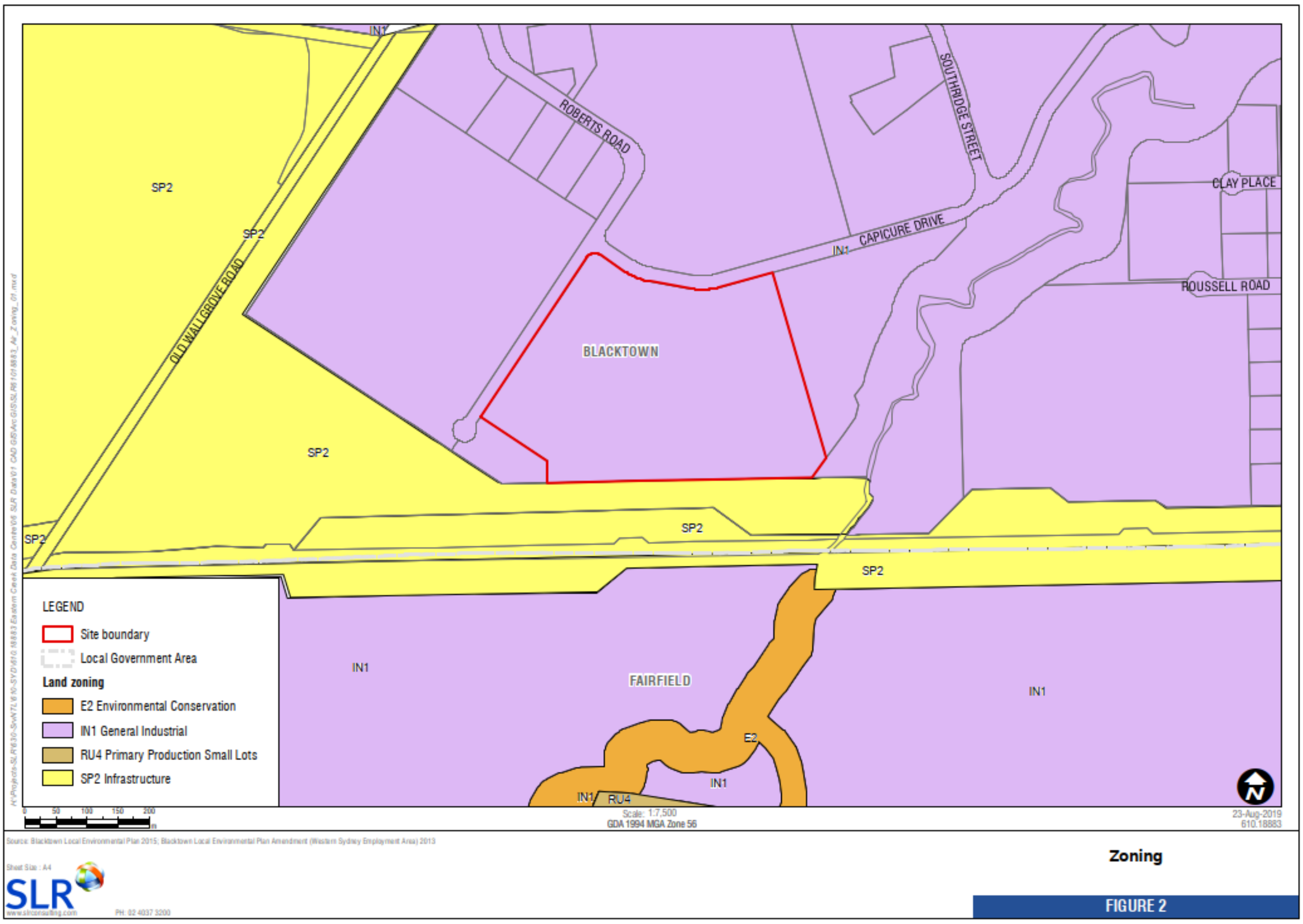
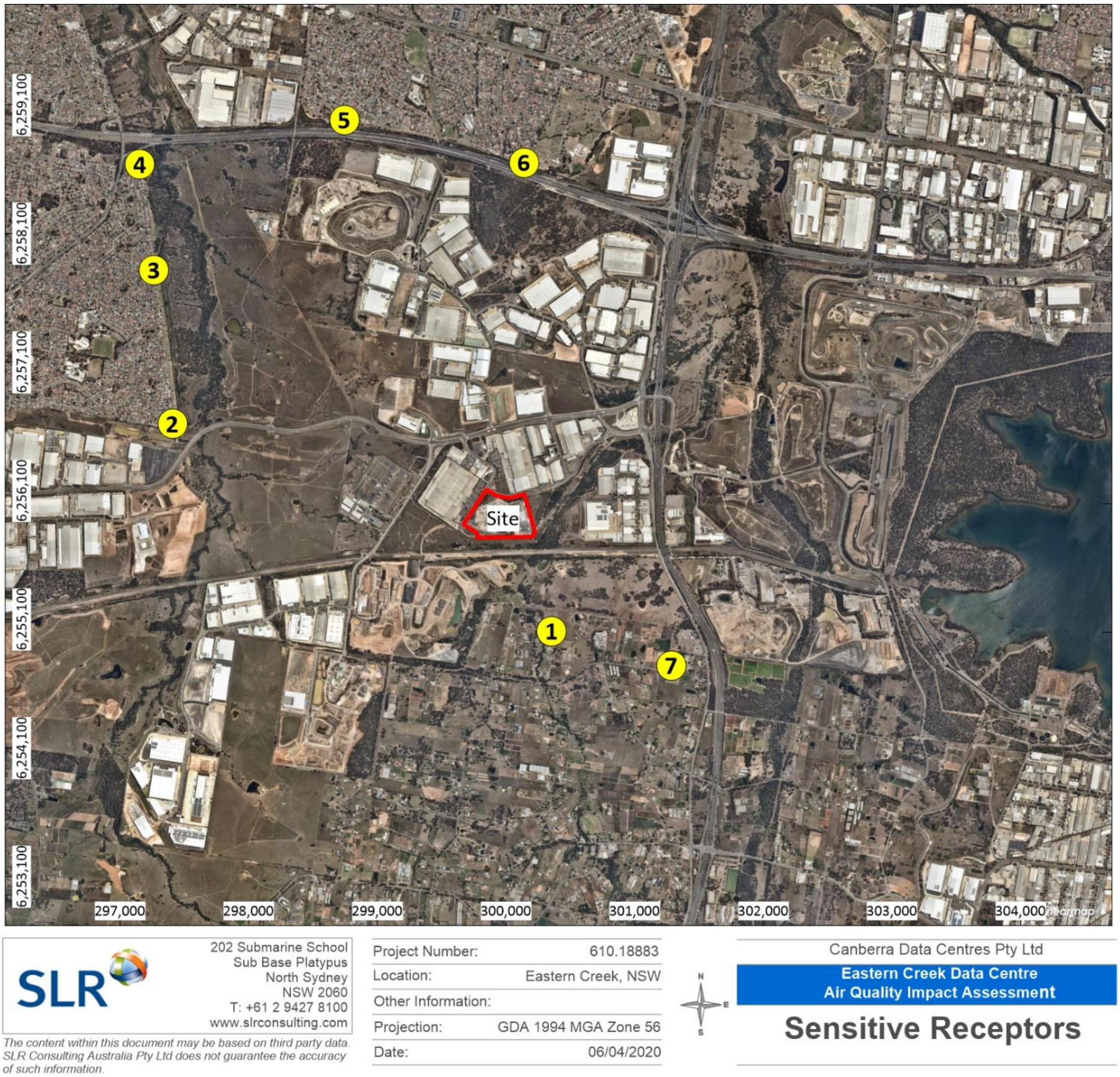


Table 7 Location of the Identified Sensitive Receptors

ID	Easting (m)	Northing (m)	Elevation (m)	Distance from Site (m)
R1	300,354	6,255,009	65	900
R2	297,407	6,256,621	52	2,400
R3	297,263	6,257,816	47	3,000
R4	297,154	6,258,637	54	3,700
R5	298,742	6,258,982	59	3,100
R6	300,139	6,258,653	78	2,600
R7	301,283	6,254,743	72	1,800

Figure 6 Surrounding Sensitive Receptors



7.3 Local Meteorology

The Bureau of Meteorology (BoM) maintains and publishes data from weather stations across Australia. The closest such station recording wind speed and wind direction data is the Horsley Park Equestrian Centre Automatic Weather Station (HPEC AWS) (Station ID 67119), located approximately 4 kilometres (km) southeast of the Project. It is noted that considering the terrain between the Project and HPEC AWS, wind conditions at the Site may be slightly different from those recorded at the HPEC AWS.

Wind

Local wind speed and direction influence the dispersion of air pollutants. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of 'plume' stretching. Wind direction, and the variability in wind direction, determines the general path pollutants will follow and the extent of crosswind spreading. Surface roughness (characterised by features such as the topography of the land and the presence of buildings, structures and trees) will also influence dispersion.

Annual and seasonal wind roses for the past five years, 2015 to 2019, compiled from data recorded by the HPEC AWS are presented in **Figure 7**. Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from North). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus, it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

The annual wind rose indicates the predominant wind directions in the area are from southwest. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 13.9% of the time throughout the investigated period. The average seasonal wind roses for the year 2015-2019 indicate that:

- In summer, winds are mostly gentle (between 3.0 m/s and 5.5 m/s) predominantly from the southeast quadrant, with very few winds from the northwest quadrant. Calms were predicted to occur 12.7% of the time during the summer months.
- In autumn, winds are light to gentle (between 0.5 m/s and 5.5 m/s) predominantly from the southwest direction, with very few winds from the northeast. Calms were predicted to occur 15.5% of the time during the autumn months.
- In winter, winds are mostly light to gentle (between 0.5 m/s and 5.5 m/s) and are from the southwest direction, with very few winds from the eastern quadrant. Calms were predicted to occur 13.8% of the time during the winter months.
- In spring, winds are mostly light to gentle (between 0.5 m/s and 5.5 m/s) and blow from all directions with the majority blowing from the southwest. Calms were predicted to occur 13.5% of the time during the summer months.

As identified in **Section 7.2**, the closest existing sensitive receptors are located southeast of the Site. Winds from between the west-northwest and north-northwest directions, which would blow air emissions from the Site towards the closest residences, occur approximately 19% of the time.

It is noted that given the topographical features between the Site and HPEC AWS (see **Figure 4**), the actual winds experienced at the Site may be different to those recorded by the AQMS station.

Wind erosion of dust from exposed surfaces is usually initiated when wind speeds exceed the threshold friction velocity for a given surface or material, however a general rule of thumb is that wind erosion can be expected to occur above 5 m/s. The frequency of wind speeds for the period of 2015-2019 is presented in **Figure 8**. The plot shows that the frequency of wind speeds exceeding 5 m/s for the period 2015-2019 at HPEC AWS was approximately 6%.

Figure 7 Average Annual and Seasonal Wind Roses for Horsley Park Equestrian Centre AWS – 2015-2019

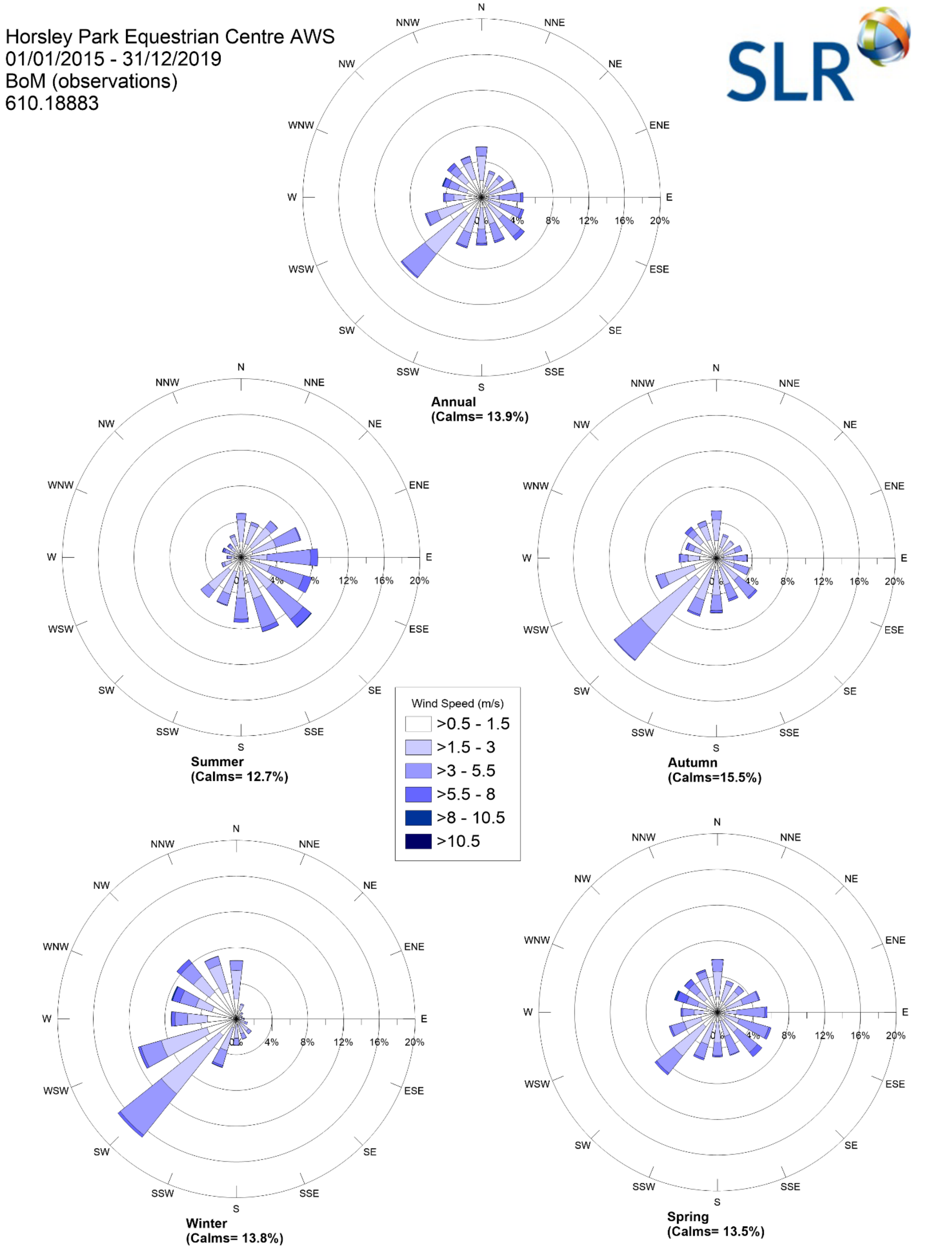
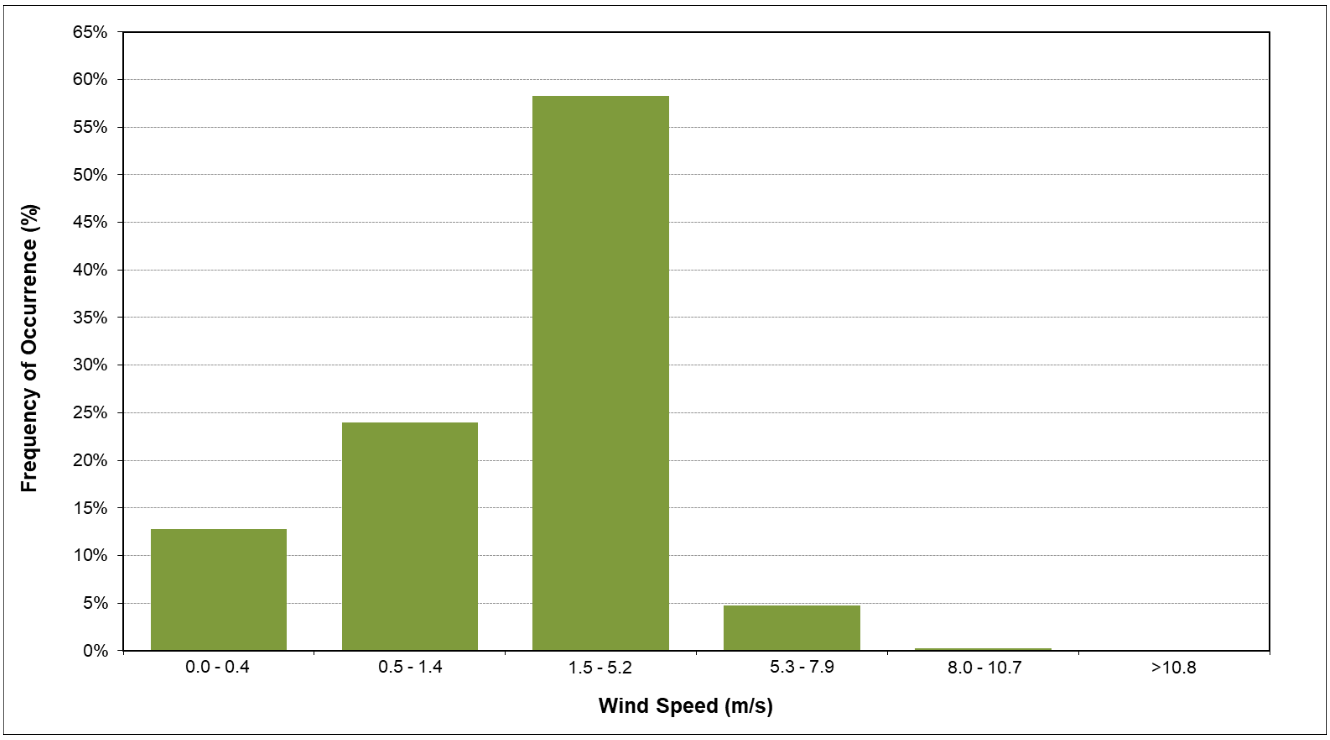


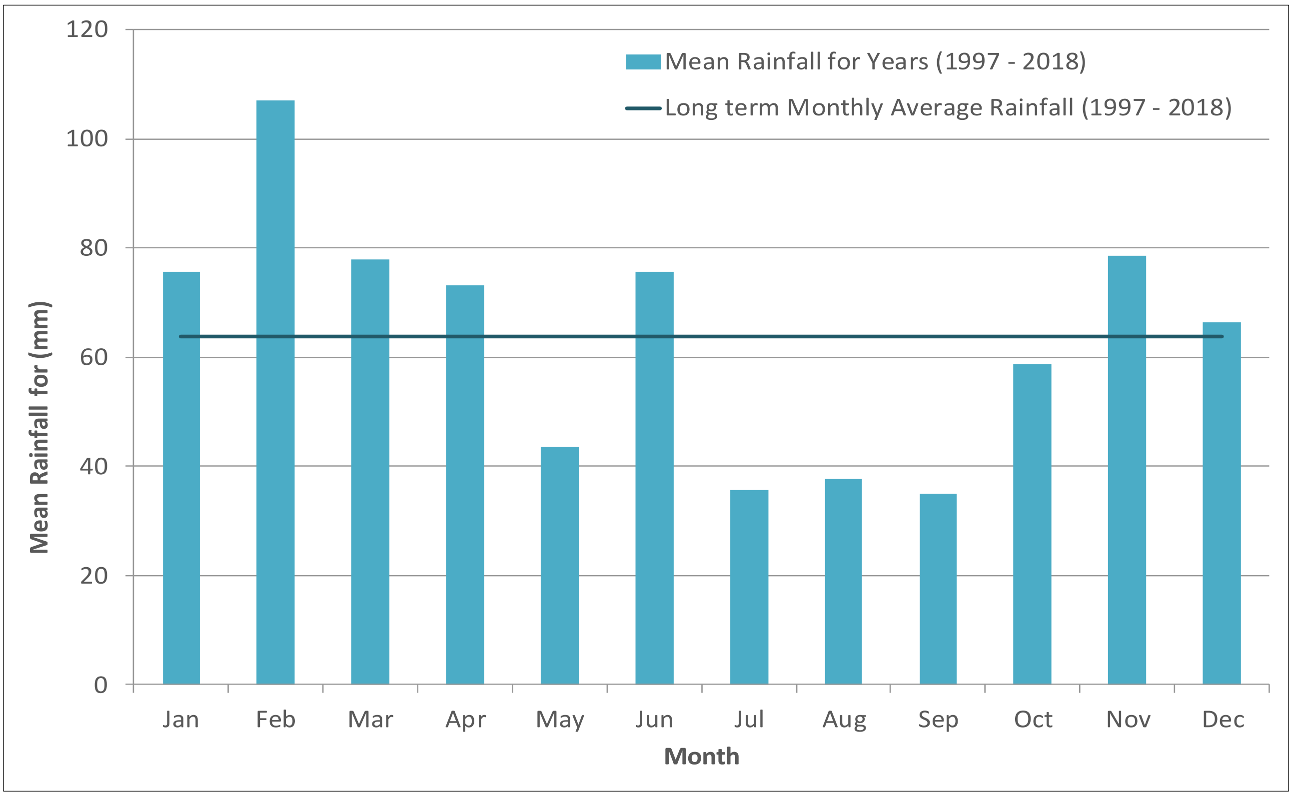
Figure 8 Wind Speed Frequency Chart for Horsley Park Equestrian Centre AWS – 2015-2019



Rainfall

Dry periods (no rainfall) have a greater risk of generating fugitive dust emissions during construction as moisture binds dust particles together. The long-term monthly rainfall averages recorded by the HPEC AWS rain gauge are shown in **Figure 9**. Generally, rainfall is lowest in the mid-winter to mid spring period.

Figure 9 Long term Mean Rainfall for Horsley Park Equestrian Centre AWS – 1997 to 2018



7.4 Background Air Quality

Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment's Environment, Energy and Science (EES) group at a number of monitoring stations across NSW. The closest such stations include:

- St Marys Air Quality Monitoring Station (AQMS), located approximately 7 km west-northwest of the Project
- Prospect AQMS, located approximately 7.5 km east-northeast of the Project

The St Marys AQMS was commissioned in 1992 and is located on a residential property in close proximity to horticulture, agriculture and the vehicle activity along Mamre Road, St Marys. It is situated in the centre of the Hawkesbury Basin and is at an elevation of 29 m. SLR considers air quality data from this station to be a better representation of air quality conditions experienced at the Site (due to surrounding land use). However, not all pollutants identified under **Section 6** are measured at the St Marys AQMS. The air pollutants are currently measured by the St Marys AQMS include:

- NO, NO_2 & NO_X
- PM_{10}
- $PM_{2.5}$
- O_3

The St Marys AQMS was commissioned in 1992 and is located in William Lawson Park, Myrtle Street, Prospect. It is situated at an elevation of 66 m. The Prospect AQMS measures CO and SO_2 in addition to pollutants measured by the St Marys AQMS

Air quality monitoring data recorded by the St Marys AQMS were obtained for the past five calendar years, 2015 to 2019, and are summarised in **Table 8**. To be consistent with the NSW EES monitoring reports, the data for gaseous pollutants are presented in parts per hundred million (pphm) or parts per million (ppm), rather than µg/m^3 and mg/m^3 as used in **Section 6**.

A review of the data shows that exceedances of the 24-hour average PM_{10} criterion were recorded by the St Marys AQMS in 2015, 2016, 2018 and 2019. Exceedances of the 24-hour average $PM_{2.5}$ criterion were recorded by the St Marys AQMS in all years reviewed.

A review of the exceedances recorded during these years 2015 (NSW OEH, 2017),2017 (NSW OEH, 2017b) and 2018 (NSW OEH, 2019)indicates that they were due to natural events such as bushfires or dust storms, or hazard reduction burns.

A review of the available compliance monitoring reports indicates that the exceedances recorded by the St Marys AQMS were primarily due to exceptional events such as bushfire emergencies, dust storms and hazard reduction burns. The high number of exceedances recorded by the St Marys AQMS in 2019 is due to bush fires smoke that blanketed Sydney and the surrounding areas for a significant number of days in November and December of 2019.

While no exceedances of the annual average PM_{10} criterion were recorded by the St Marys AQMS, annual average $PM_{2.5}$ concentrations exceeded the relevant criterion in 2019. This is believed to be primarily due to the abovementioned bush fires in the areas surrounding Sydney in late 2019.

Ambient concentrations of NO_2 were below the relevant criteria for all five years reviewed.

Table 8 Summary of St Marys AQMS Data (2015 – 2019)

Pollutant	Averaging Period	Criteria	Year	St Marys AQMS		Units
				Maximum Concentration	Number of Exceedances	
NO_2	1-hour	12 pphm	2015	3.2	0	pphm
			2016	4.2	0	pphm
			2017	3.7	0	pphm
			2018	3.7	0	pphm
			2019	3.3	0	pphm
	Annual	3 pphm	2015	0.4	0	pphm
			2016	0.4	0	pphm
			2017	0.4	0	pphm
			2018	0.5	0	pphm
			2019	0.4	0	pphm

Pollutant	Averaging Period	Criteria	Year	St Marys AQMS		Units
				Maximum Concentration	Number of Exceedances	
PM_{10}	24-hour	50 µg/m³	2015	53	1	µg/m³
			2016	100.	3	µg/m³
			2017	49.8	0	µg/m³
			2018	100.5	2	µg/m³
			2019	159.8	26	µg/m³
	Annual	25 µg/m³	2015	15.0	0	µg/m³
			2016	16.0	0	µg/m³
			2017	16.2	0	µg/m³
			2018	19.4	0	µg/m³
			2019	24.7	0	µg/m³
$PM_{2.5}$	24-hour	25 µg/m³	2015	ND	ND	µg/m³
			2016	93.2	5	µg/m³
			2017	38.2	3	µg/m³
			2018	80.5	4	µg/m³
			2019	88.3	21	µg/m³
	Annual	8 µg/m³	2015	ND	ND	µg/m³
			2016	7.8*	0	µg/m³
			2017	7.0	0	µg/m³
			2018	7.8	0	µg/m³
			2019	9.8	1	µg/m³

Notes:

ND- No data

*Based on approximately 9 months of data as $PM_{2.5}$ monitoring commenced end of March 2016

As outlined above, limited no CO or SO_2 data are available from the St Marys AQMS. In order to characterise background CO and SO_2 concentrations, data from the next nearest EES AQMSs with a full set of data, (Prospect AQMS) were used.

CO and SO_2 data recorded by the Prospect AQMS were obtained for the calendar years 2015 - 2019 and are summarised in **Table 9**. No exceedances of the CO or SO_2 criteria were recorded by the Prospect AQMS over this period.

Table 9 Summary of Prospect AQMS CO Data (2015 – 2019)

Pollutant	Averaging Period	Criteria	Year	Prospect AQMS		Units
				Maximum Concentration	Number of Exceedances	
CO	1-hour	25 ppm	2015	1.9	0	ppm
			2016	1.6	0	ppm
			2017	1.6	0	ppm
			2018	1.3	0	ppm
			2019	5.5	0	ppm
	8-hour	9 ppm	2015	ND	0	ppm
			2016	1.5	0	ppm
			2017	1.1	0	ppm
			2018	1.1	0	ppm
			2019	2.8	0	ppm
SO_2	1-hour	20 pphm	2015	2.7	0	pphm
			2016	2.1	0	pphm
			2017	2.3	0	pphm
			2018	2.5	0	pphm
			2019	2.1	0	pphm
	24-hour	8 pphm	2015	0.3	0	pphm
			2016	0.4	0	pphm
			2017	0.4	0	pphm
			2018	0.5	0	pphm
			2019	0.4	0	pphm
	Annual	2 pphm	2015	0.1	0	pphm
			2016	0.1	0	pphm
			2017	0.1	0	pphm
			2018	0.1	0	pphm
			2019	0.1	0	pphm

8 Assessment Methodology

8.1 Construction Phase Qualitative Impact Assessment

Quantitatively assessing impacts of fugitive dust emissions from construction projects using predictive modelling is seldom considered appropriate, primarily due to the uncertainty in the details of the construction activities, including equipment type, number, location and scheduling, which are unlikely to be available at the time of the assessment. Furthermore, they are also likely to change as construction progresses. In comparison, the equipment and operations of a mine or quarry are determined during the planning stages and more likely to remain consistent for long periods (several months or years).

Instead, it is considered appropriate to conduct a qualitative assessment. Potential impacts of dust emissions associated with proposed demolition and construction activities at the Site has been performed based on the methodology outlined in the Institute of Air Quality Management (UK) (IAQM) document, "*Assessment of dust from demolition and construction*" (Holman et al 2014). This guidance document provides a structured approach for classifying construction sites according to the risk of air quality impacts, to identify relevant mitigation measures appropriate to the risk (see **Appendix A** for full methodology).

The IAQM approach has been used widely in Australia for the assessment of air quality impacts from construction projects and the identification of appropriate mitigation measures and has been accepted by regulators across all states and territories for a variety of construction projects.

The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- **Step 1**: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition and human health impacts of the identified sensitive receptors is determined.
- **Step 2**: Assess risk of dust effects from activities based on:
  - the scale and nature of the works, which determines the potential dust emission magnitude; and
  - the sensitivity of the area surrounding dust-generating activities.
- **Step 3**: Determine site-specific mitigation for remaining activities with greater than negligible effects.
- **Step 4**: Assess significance of remaining activities after management measures have been considered.

8.2 Operational Phase Dispersion Modelling Study

The assessment of air emissions from the operational phase of the Project has been performed quantitatively through the use of dispersion modelling techniques.

8.2.1 Dispersion Modelling

Emissions from the proposed operations of the Project identified as having the potential to impact upon the nearby residences have been modelled using the AERMOD modelling system.
AERMOD is a steady-state plume modelling system with three components: AERMOD (dispersion model), AERMAP (terrain data pre-processor) and AERMET (meteorological data pre-processor).

AERMOD was used to predict maximum pollutant ground level concentrations (GLC) resulting from the emissions to air from the Project.

8.2.2 Environmental Inputs

AERMOD requires a range of inputs to describe the Project environment:

- Topographical data
- Meteorological data
- Background pollutant concentrations
- Building downwash (point sources only)

The sources of the required data are summarised in **Table 10** and these inputs are discussed in the following sections.

Table 10 Air Quality Model Input Data

Item	Source	Description
Topographical data	Shuttle Radar Topography Mission (SRTM) Derived Digital Elevation Model (DEM)	1 second (~30m) resolution
Meteorological data	TAPM	Wind speed, wind direction, temperature, relative humidity, cloud cover
Background pollutant concentrations	EES St Marys AQMS	Contemporaneous analysis in accordance with the Approved methods*

8.2.2.1 Topography

The AERMOD model incorporates terrain information with heights being applied to all receptors and sources. In order to account for the potential influence on pollution dispersion and varying receptor elevations across the modelling domain, a gap filled and filtered (vegetation and obstacles removed) topography file with 1 second resolution (approximately 30 m) derived from the Shuttle Radar Topography Mission (SRTM) data was obtained from Geoscience Australia and was processed with AERMAP for use in AERMOD.

8.2.2.2 Meteorology

Meteorological input files were developed using the AERMET module. AERMET requires on-site hourly data for the following meteorological parameters:

- Wind speed
- Wind direction
- Temperature
- Cloud cover

In the absence of on-site meteorological data for the Project location, The Air Pollution Model (TAPM v4.05) was used to generate a synthetic meteorological data set for the Project. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. Wind speed and direction observations obtained from the nearest BoM and OEH AQMS stations have been included in the TAPM run.

A summary of AERMET modelling options and parameters used for the assessment is provided in **Table 11**

Table 11 Meteorological Parameters used for this Study (TAPM)

Modelling Period	1 January 2016 to 31 December 2016
Centre of analysis	299,466 mE 6,256,061 mN (UTM Coordinates)
Number of grid points	25 × 25 × 25
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 0.3 km)
Data assimilation	Penrith Lakes AWS (#67113), Horsley Park Equestrian Centre AWS (#67119), Badgerys Creek AWS (#67108), Bankstown Airport AWS (#66137), Sydney Olympic Park AWS (Archery Centre) (#66212), Vineyard AQMS, St Marys AQMS, Prospect AQMS, Bringelly AQMS
Terrain	AUSLIG 9 second DEM

AERMET also requires vertical temperature and moisture profiles (upper air) data. In Australia this is generally limited to major airports. The nearest source of this data is Sydney Airport approximately 35 km southeast of the Site. The distance and topography between Sydney Airport and the Project means this upper air data may not be representative of the Site. In the absence of representative upper air data, the upper air estimator feature of the AERMET View software has been used for the purpose of this assessment.

Meteorological conditions for the site were extracted from the innermost TAPM grid and were used to construct an AERMET input file. AERMET (version 18081) was used to process this data to produce the *surface* and *profile* meteorological input files required by AERMOD.

Surface characteristics (albedo, Bowen ratio and surface roughness) of the Project location were determined using publicly available on-line aerial imagery.

A summary of AERMET modelling options and parameters used for the assessment is provided in **Table 12**.

Table 12 AERMET Model Parameters

Parameter	Option / Source
Adjusted U* (surface friction velocity)	Yes
Mixing Heights from Onsite Data or Upper Air Data	Upper Air Data
Randomise Wind Direction	No
Apply Missing Cloud Cover Substitution	None
Apply Missing Ambient Air Substitution	None
Wind speed and Direction, Temperature, Relative Humidity, Cloud Cover, Ceiling Height, Station Pressure, Global Horizontal Radiation	TAPM
Upper Air Data	Upper Air Estimator

8.2.2.3 Background Pollutant Concentrations

Hourly varying air quality data recorded by the St Marys AQMS during the modelling period (2016) were used for the contemporaneous analysis of cumulative ground level concentrations.

It is noted that in circumstances where the existing ambient air pollutant concentrations exceed the impact assessment criteria, the Approved Methods requires the AQIA to demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity.

8.2.2.4 Building Downwash

Building downwash is a phenomenon caused by structures near to pollutant emission sources influencing atmospheric turbulence. Airflow is rapidly mixed to the ground as frictional forces and pressure gradients cause stagnations and eddies to develop in the wake of buildings downwind of elevated sources.

The USEPA has established a Good Engineering Practice (GEP) stack height which is defined as the ‘height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutants in the immediate vicinity of the source as a result of atmospheric downwash, eddies or wakes which may be created by the source itself, nearby structures or nearby terrain obstacles’ (USEPA, 1985). The definition of GEP stack height is the stack height plus 1.5 times the lesser of the building height or projected building width.

A stack is considered to be wake affected when the stack and building are located less than five times the lesser of the building height or project building width apart.

AERMOD contains the *Prime* algorithm which was used to predict building downwash effects. Influencing building dimensions were calculated using the USEPA’s Building Profile Input Program (BPIP).

For modelling purposes, proposed site buildings as well as enclosures the proposed generators will be housed in were included. **Table 13** provides the buildings as input into the model. These buildings are illustrated in **Figure 10**.

Table 13 Buildings Included in Model

ID	Description*	Height (m)
BLD_1 – BLD_32	Proposed generator enclosures	5
BLD_33	Building 3	14
BLD_34	Building 4	20
BLD_35	Building 4 – Deck	15
BLD_36	Building 5	20
BLD_37	Building 5 – Deck	15
BLD_38	Building 6	20
BLD_39	Building 6 - Deck	15

* Refer to **Figure 3**

8.2.3 NO_x to NO_2 conversion

NO_x emitted from combustion processes mainly consist of NO with a small portion (approximately 10%) of NO_2. In the atmosphere however, NO emitted from the source oxidises to NO_2 in the presence of ozone (O_3) and sunlight as it travels further from the source. The rate of oxidation depends on a number of parameters including the ambient O_3 concentration. The following methods can be applied to take account the oxidation of NO to NO_2 in estimating downwind NO_2 concentrations at receptor locations.

Method 1 – 100% Conversion

This method is usually used as a screening level assessment and assumes 100% conversion of NO to NO_2 before the plume arrives at the receptor location. Use of this method can significantly over-predict NO_2 concentrations at nearfield receptors.

Method 2 – Ambient Ozone Limiting Method (OLM)

This method assumes that all the available ozone in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. This approach assumes that the atmospheric reaction is instantaneous. In reality, the reaction takes place over a number of hours (NSW OEH 2005). NO_2 concentrations can be estimated by this method using the following equation:

$$[NO_2]_{total} = \{0.1 \times [NO_x]_{pred}\} + MIN\{(0.9) \times [NO_x]_{pred} \text{ or } (46/48) \times [O3]_{bkgd}\} + [NO_2]_{bkgd}$$

Given the close proximity of industrial receptors to the Site the use of Method 1 (100% conversion) is not appropriate. Therefore Method 2 has been adopted using ozone data available from the ST Marys AQMS.

8.2.4 Conversion of Averaging Times

For pollutants with short-term (sub-hourly) air quality impact assessment criteria, in the absence of specific guidance in the Approved methods, the short term impacts have been estimated using the formula cited in the *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* (EPAV, 2013) as follows:

$$C_t = C(t_0) \times ({}^{t_0}/_{t})^{0.2}$$

Where

C_t = concentration for the longer time-averaging period

C_0 = concentration for the shorter time-averaging period

t_0 = longer averaging time

t = shorter averaging time

8.2.5 Source Characteristics and Emission Rates

AERMOD requires a range of inputs to describe the emissions to air as a result of the proposed activities.

Potential air emissions and relevant stack parameters for the generator stack were estimated based on the Cummins QSK95-G4 diesel engine technical specifications. **Table 14** presents a summary of stack parameters and emission rates for each generator. SLR understands that the generators will be operating in 'Full Continuous' mode during testing. Refer to **Appendix C** for the Cummins QSK95-G4 generator set specifications sheet and **Appendix D** for the general arrangement of the generators. As illustrated in **Appendix D**, the generator exhausts will be oriented horizontally. This has been accounted for in the model by enabling the horizontal stack option which reduces the exit velocity of the exhaust, accounts for plume rise and stack-tip downwash and assumes that the release is oriented with the wind direction.

Table 14 Stack Parameters and Emission Rates – Generator

Parameter	Data	Unit	Reference/Base
Temperature	384	°C	Engine specifications (Refer **Appendix C**)
Stack height	6	m	Drawing KSOSU8IP\P2390-D-001.01C (Refer **Appendix D**)
Exhaust gas flow	473	m^3/min	Engine specifications (Refer **Appendix C**)
Stack diameter	0.54	m	Provided by Equipment Supplier
PM emission rate	0.01	g/s	Calculated using engine specifications (Refer **Appendix C**)
NO_x emission rate	7	g/s	
CO emission rate	0.1	g/s	
SO_2 emission rate	0.004	g/s	
PM in-stack concentration	1.2	mg/m^3	Calculated using engine specifications (Refer **Appendix C**)
NO_x in-stack concentration	847^	mg/m^3	
CO in-stack concentration	12.1	mg/m^3	
SO_2 in-stack concentration	0.5	mg/m^3	

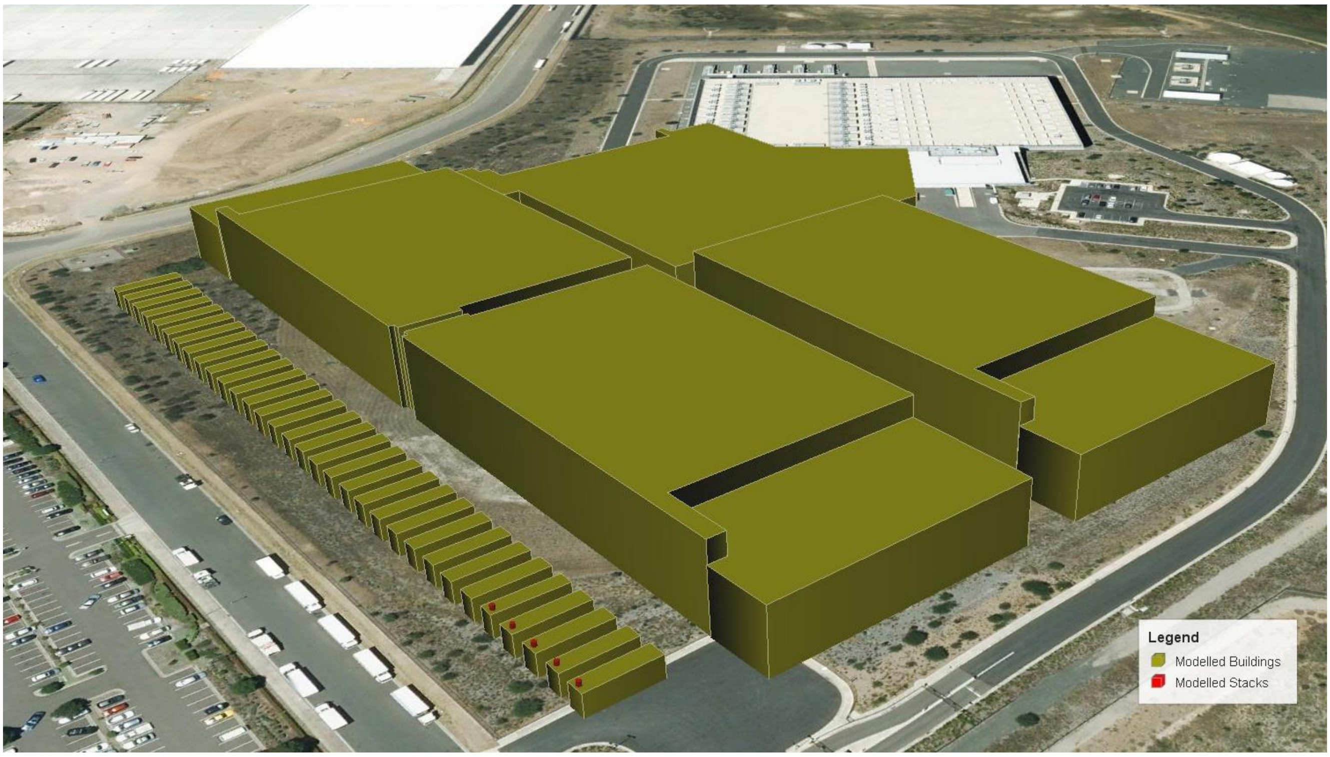
^ It is noted that the anticipated maximum in-stack NO_x concentration exceeds the 450 mg/m^3 Group 6 limit. However, as each emergency standby plant is not anticipated to operate over 200 hours per year, it is exempt from the limits under the Regulation (Refer **Section 5.1.2**)

The Cummins QSK95-G4 generator set specifications sheet includes emission rates of the pollutants of concern with the exception of VOC. It is noted that VOC emissions from the combustion of diesel are low relative to their assessment criteria when compared with other products of combustion. Therefore if no exceedances of other combustion gas criteria are predicted, it is considered appropriate to assume that VOC emissions from the operation of the Project are would also result in no exceedances of the relevant criteria. VOC emissions from the project have therefore not been considered further in this assessment.

To conservatively represent the testing regime (**Section 4.2**), the modelling assumes that five generators run continuously between 9 am and 5 pm, every day of the year. It is noted that the use of this approach is likely to significantly overestimate the 24-hour average and annual average downwind air pollutant concentrations as the five generators will only operate for an hour between 9 am to 5 pm and a total of 12 tests are to been conducted a year per generator..

The five generators closest to the location of the nearest identified sensitive receptors were modelled. **Figure 10** illustrates the modelled sources and buildings.

Figure 10 Modelled Buildings and Point Sources



8.2.6 Accuracy of Modelling

All atmospheric dispersion models, including AERMOD, represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below:

- **Oversimplification of physics:** This can lead to both under-prediction and over-prediction of ground level pollutant concentrations. Uncertainties are greater in Gaussian plume models as they do not include the effects of non-steady-state meteorology (i.e., spatially- and temporally-varying meteorology).
- **Uncertainties in emission rates:** Ground level concentrations are proportional to the pollutant emission rate. In addition, most modelling studies assume constant worst-case emission levels or are based on the results of a small number of stack tests, however operations (and thus emissions) are often quite variable. Accurate measurement of emission rates and source parameters requires continuous monitoring.
- **Uncertainties in wind direction and wind speed**: Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of plume. Uncertainties in these parameters can result in errors in the predicted distance from the source of the plume impact, and magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions. The preference to use rugged meteorological instruments to reduce maintenance requirements also means that light winds are often not well characterised.

- **Uncertainties in mixing height:** If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion.
- **Uncertainties in temperature:** Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and magnitude of that impact.
- **Uncertainties in stability estimates:** Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, uncertainties in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The USEPA makes the following statement in its Modelling Guideline (US EPA, 2005) on the relative accuracy of models:

> *"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ±10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognised for these models. However, estimates of concentrations that occur at a specific time and site are poorly correlated with actually observed concentrations and are much less reliable."*

This AQIA utilises the AERMOD dispersion model, incorporating meteorological output from TAPM. The meteorological dataset has been compiled using observations from a nearby automatic weather station for a five-year period.

9 Assessment of Air Quality Impacts

9.1 Construction Phase

9.1.1 Step 1 – Screening Based on Separation Distance

As noted in **Section 3.1**, the nearest sensitive receptor is located approximately 900 m from the nearest Site boundary.

The screening criteria for detailed assessment are:

- a '*human receptor*[2]' within:
    - 350 m of the boundary of the site; or
    - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).
- an '*ecological receptor*[3]' within:
    - 50 m of the boundary of the site; or
    - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

The Project does not meet any of these criteria and therefore a detailed assessment is not deemed necessary. However, it is noted that immediately beyond the northwest boundary of the Site there is a large car park for the distribution centre workers. A common impact of nuisance dust is the soiling of vehicles stored on neighbouring properties. It is therefore considered appropriate to progress the assessment, but only in relation to impacts on amenity, or dust soiling.

In relation to the wind roses presented in **Section 7.1**, it is apparent that winds that would blow fugitive dust emissions from the demolition/construction works towards the receptor are most likely to occur during the summer months and least likely to occur during the winter months.

9.1.2 Step 2a – Assessment of Scale and Nature of the Works

Based on the IAQM definitions presented in **Appendix A**, dust emission magnitudes for the anticipated works have been categorised as presented in **Table 15**.

[2] A 'human receptor', refers to any location where a person or property may experience the adverse effects of airborne dust or dust soiling, or exposure to PM_{10} over a time period. In terms of annoyance effects, this will most commonly relate to dwellings, but may also refer to other premises such as buildings housing cultural heritage collections (e.g. museums and galleries), vehicle showrooms, food manufacturers, electronics manufacturers, amenity areas and horticultural operations (e.g. salad or soft-fruit production).

[3] An 'ecological receptor' refers to any sensitive habitat affected by dust soiling. This includes the direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats).

Table 15 Categorisation of Dust Emission Magnitude

Activity	Dust Emission Magnitude	Basis
Demolition	Small	Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months. *There are no buildings to be demolished as part of the Project.*
Earthworks	Large	Total site area greater than 10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t. *Total area where the earthworks will be undertaken for the Project, including removal of carparks and internal roads is estimated to be greater than 30,000 m^2.*
Construction	Large	Total building volume greater than 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching. *The total building area is estimated to be greater than 25,000 m^2. Therefore, the total volume is likely to be greater than 100,000 m^3.*
Trackout	Large	More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length. *The unpaved road length is estimated to be greater than 100 m.*

9.1.3 Step 2b – Risk Assessment

Receptor Sensitivity

Based on the criteria listed in **Table A1** in **Appendix A**, the sensitivity of the identified receptor in this study is conservatively classified *medium* for dust soiling, as it is a place of work where users would expect to enjoy a reasonable level of amenity. **Table A1** also describes short-term carparks as a low sensitivity.

Sensitivity of an Area

Based on the classifications shown in **Table A2** and **Table A3** in **Appendix A**, the sensitivity of the area to dust soiling may be classified as l*ow*.

Risk Assessment

Table 16 presents the preliminary risk of air quality impacts from uncontrolled construction activities determined using the risk matrix provided in **Table A4** in **Appendix A**, based on the identified receptor sensitivity and sensitivity of the area**.**

Table 16 Preliminary Risk of Air Quality Impacts from Construction Activities (Uncontrolled)

Impact	Sensitivity of Area	Dust Emission Magnitude				Preliminary Risk			
		Demolition	Earthworks	Construction	Trackout	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	Small	Large	Large	Large	Negligible	Low	Low	Low

The results indicate that there is a low risk of adverse dust soiling occurring at the off-site sensitive receptor locations if no mitigation measures were to be applied to control emissions during the works.

9.1.4 Step 3 - Mitigation Measures

For almost all construction activity, the IAQM Methods notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible.

The IAQM document provides guidance on appropriate mitigation measures for construction activities determined to have low, medium and high preliminary risk of adverse air quality impacts. **Table 17** lists the relevant mitigation measures by the IAQM methodology for a project shown to have a low risk of adverse impacts. Not all these measures would be practical or relevant for the Project, hence a detailed review of the recommendations should be performed as part of the development of the Construction Environmental Management Plan (CEMP) and the most appropriate measures adopted.

Table 17 Proactive Dust Mitigation Measures

#	Mitigation Measure
1	**Communications**
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.
1.2	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the Site Manager.
1.3	Display the head or regional office contact information.
2	**Site Management**
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
2.2	Make the complaints log available to the Local Authority when requested.
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.
3	**Preparing and Maintaining the Site**
3.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.

#	Mitigation Measure
3.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.
3.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.
3.4	Avoid site runoff of water or mud.
3.5	Keep site fencing, barriers and scaffolding clean using wet methods.
3.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
3.7	Cover, seed or fence stockpiles to prevent wind erosion.
4	**Operating Vehicle/Machinery and Sustainable Travel**
4.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable.
4.2	Stationary trucks will switch off engines if idling time on-site is likely to exceed 2 minutes.
4.3	Avoid using the local road network during peak traffic periods, where possible.
4.4	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.
4.5	Minimise truck queuing and unnecessary trips through logistical planning.
5	**Operations**
5.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
5.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate.
5.3	Use enclosed chutes and conveyors and covered skips.
5.4	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
6	**Waste Management**
6.1	No on-site burning of waste materials.
7	**Excavation**
7.1	Only the minimum area necessary is disturbed at any one time.
7.2	Where applicable, rehabilitation of disturbed areas will be undertaken as soon as practicable.
7.2	If unanticipated strong odours are encountered or significant dust emissions are noted on site, stop related work and seek advice from the Environmental Coordinator or equivalent role.
7.3	Carry out excavation works and vehicle loading/unloading when weather conditions are favourable (i.e. receptors are upwind from the works).
8	**Construction**
8.1	Avoid scabbling (roughening of concrete surfaces) if possible.
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
9	**Trackout**
9.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.

#	Mitigation Measure
9.2	Avoid dry sweeping of large areas.
9.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
9.4	Record all inspections of haul routes and any subsequent action in a site log book.
9.5	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site).
10	**Contingency Plan for Prolonged Dust Events**
10.1	Deployment of additional water sprays where practicable
10.2	Relocation or modification of dust-generating sources, where possible
10.3	Temporary halting of activities and resuming when conditions have improved

In addition to the mitigation measures proposed in **Table 17**, daily site inspections will be carried out during construction works. Daily environmental inspections will include, but not be limited to:

- Visual inspection of any airborne dust being generated on-site or being observed blowing off-site
- Ensuring roads leaving the Site are free of soil, and that there is no observable soil tracking onto the road network
- Inspection of the erosion and sediment control systems for silt build-up
- Inspection of stockpiles and waste storage areas to ensure no significant wind erosion is observable.

Any environmental inspection reports will include the above observations, with remedial or corrective actions noted (as appropriate). Any remedial or corrective actions must be reported to the Site Manager as soon as is practicable.

9.1.5 Step 4 - Residual Impacts

A reappraisal of the predicted unmitigated air quality impacts on sensitive receptors has been performed to demonstrate the opportunity for minimising risks associated with the use of mitigation strategies. These are termed 'residual impacts'. The results of the reappraisal are presented below in **Table 18**.

Table 18 Residual Risk of Air Quality Impacts from Construction

Impact	Sensitivity of Area	Residual Risk			
		Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	Negligible	Negligible	Negligible	Negligible

The dust deposition for mitigated activities are anticipated to be *negligible*.

9.2 Operational Phase

9.2.1 Particulates

Table 19 presents maximum 24-hour and annual average incremental particulate matter concentrations at surrounding sensitive receptor locations. Given the insignificant incremental increase of particulate matter predicted at the identified receptors, additional exceedances of PM_{10} and $PM_{2.5}$ criteria due to the operation of the Project are considered unlikely.

Table 19 Predicted PM Concentrations at Sensitive Receptors

Receptor ID	Increment (µg/m³)	
	Maximum 24-Hour	Annual
R1	0.1	< 0.01
R2	< 0.1	< 0.01
R3	< 0.1	< 0.01
R4	< 0.1	< 0.01
R5	< 0.1	< 0.01
R6	< 0.1	< 0.01
R7	0.1	< 0.01

9.2.2 NO_2

Table 20 presents the incremental and cumulative maximum 1-hour and annual average NO_2 concentrations predicted at identified sensitive receptor locations. Contour plots of the predicted incremental NO_x concentrations are presented in **Table 21**, Figure 11 and Figure 12.

The modelling results show that the predicted cumulative maximum 1-hour and annual average NO_2 concentrations are below the relevant ambient air quality criteria at all receptor locations modelled.

A contemporaneous analysis of the ten highest 1-hour average NO_2 concentrations predicted at receptor R1 is presented in **Table 21**. The contemporaneous analysis shows that the nine highest 1-hour average incremental NO_2 predictions occur at 5 pm.

The highest predicted incremental 1-hour average NO_2 concentration predicted for other hours (ie 9:00 am to 4:00 pm) is 66.4 µg/m³ which would not result in an exceedance of the 1-hour average NO_2 criterion of 246 µg/m³ even if combined with the highest 1-hr average background NO_2 concentration recorded in the last five years (79.0 µg/m³, recorded at 6:00 pm on 6 May 2016).

Based on the above, revising the proposed testing hours from 9:00 am to 5:00 pm to 9:00 am to 4:00 pm would reduce the likelihood of any exceedances at nearby sensitive receptors even during days of exceptionally high NO_2 concentrations.

Table 20 Predicted NO_2 Concentrations at Sensitive Receptors

Receptor ID	Increment (µg/m³)		Cumulative (µg/m³)	
	Maximum 1-Hour	Annual	Maximum 1-Hour	Annual
R1	229	1.3	239	8.2
R2	34.5	0.36	80.5	7.2
R3	96.2	0.28	107	7.1
R4	24.1	0.19	79.4	7.1
R5	29.4	0.19	79.7	7.1
R6	28.2	0.23	80.2	7.1
R7	145	0.71	145	7.6
Criteria			**246**	**62**

Table 21 Assessment of Ten Highest Contemporaneous 1-Hour Average NO_2 Predictions at Receptor 1

Date / Time	1-Hour Average NO_2 Concentrations (µg/m³)			Date / Time	1-Hour Average NO_2 Concentrations (µg/m³)		
	Background	Predicted Increment	Cumulative Impact		Background	Predicted Increment	Cumulative Impact
Ten Highest Maximum Background Hours				**Ten Highest Maximum Incremental Impact Hours**			
06/05/2016 18:00	79.0	0.0	79.0	14/05/2016 17:00	9.4	229	239
07/05/2016 11:00	77.1	7.6	84.7	19/07/2016 17:00	28.2	161	189
06/09/2016 19:00	60.2	0.0	60.2	05/07/2016 17:00	9.4	125	134
06/05/2016 19:00	58.3	0.0	58.3	06/04/2016 17:00	0.0	84.6	84.6
13/12/2016 22:00	52.6	0.0	52.6	03/05/2016 17:00	1.9	80.5	82.4
04/07/2016 10:00	48.9	12.4	61.3	10/08/2016 17:00	5.6	70.1	75.7

08/11/2016 13:00	48.9	0.6	49.5	21/06/2016 17:00	5.6	69.2	74.8
07/05/2016 10:00	45.1	10.0	55.1	14/09/2016 17:00	0.0	68.7	68.7
29/04/2016 12:00	45.1	3.1	48.2	18/07/2016 17:00	1.9	66.8	68.7
11/05/2016 10:00	45.1	1.1	46.2	01/05/2016 16:00	0.0	66.4	66.4
Criteria			246	**Criteria**			246

Figure 11 Predicted 1-hour Average Incremental NO_X Isopleth Plot

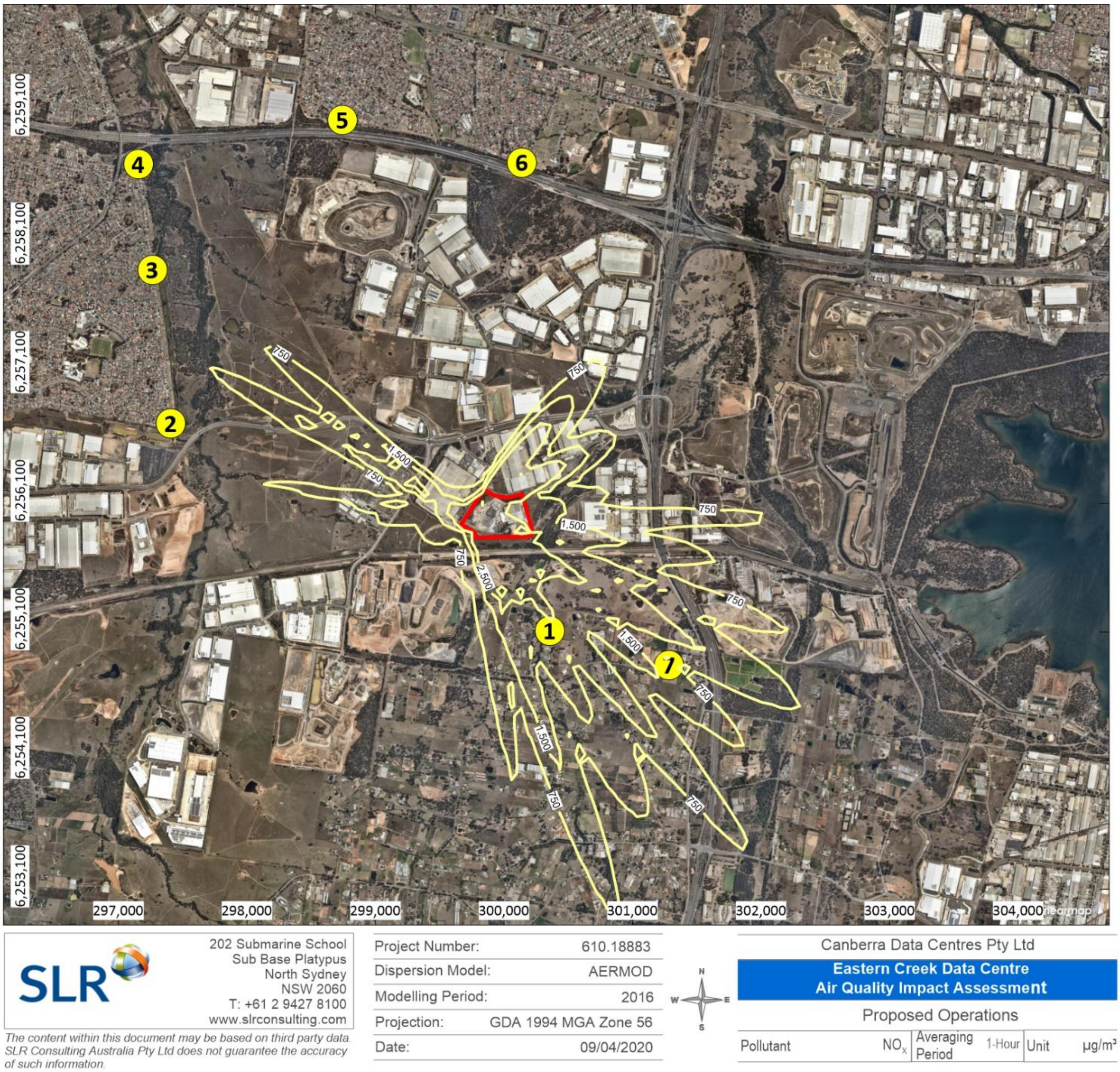
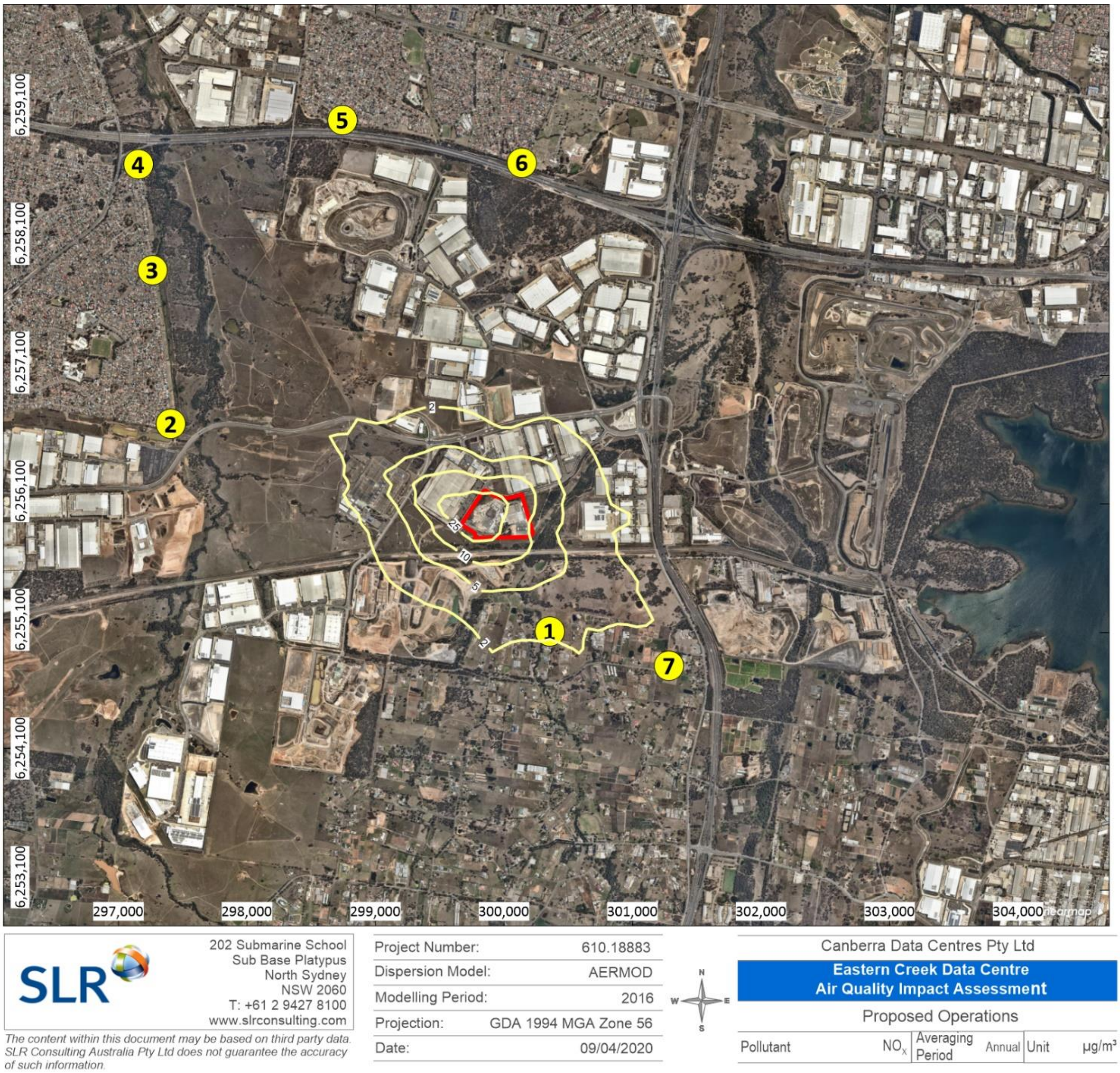


Figure 12 Predicted Annual Average Incremental NO_X Isopleth Plot



9.2.3 CO

Table 22 presents the maximum incremental 15-minute, 1-hour and 8-hour average CO concentrations predicted at surrounding sensitive receptor locations. Given the insignificant incremental increase of CO predicted at the identified receptors, exceedances of the relevant CO criteria due to the operation of the Project are considered unlikely.

Table 22 Predicted CO Concentrations at Sensitive Receptors

Receptor ID	Increment (mg/m³)		
	Maximum 15-Minute*	Maximum 1-Hour	Maximum 8-Hour
R1	0.2	0.2	0.02
R2	<0.1	<0.1	<0.01
R3	<0.1	<0.1	<0.01
R4	<0.1	<0.1	<0.01
R5	<0.1	<0.1	<0.01
R6	<0.1	<0.1	<0.01
R7	0.1	0.1	0.01
Criteria	**100**	**30**	**10**

* The 1-hour average CO concentrations predicted by the modelling were converted to 15-minute averages using the power law formula.

9.2.4 SO_2

Table 23 presents the incremental maximum 10-minute, 1-hour, 24-hour and annual average SO_2 concentrations predicted at surrounding sensitive receptor locations Given the insignificant incremental increase of SO_2 predicted at the identified receptors, exceedances of the relevant SO_2 criteria due to the operation of the Project are considered unlikely.

Table 23 Predicted SO_2 Concentrations at Residential Receptors

Receptor ID	Increment (µg /m³)			
	Maximum 10-Minute*	Maximum 1-Hour	Maximum 24-Hour	Annual
R1	9	6	<1	<0.1
R2	<1	<1	<1	<0.1
R3	1	1	<1	<0.1
R4	<1	<1	<1	<0.1
R5	<1	<1	<1	<0.1
R6	<1	<1	<1	<0.1
R7	5	4	<1	<0.1
Criteria	**712**	**570**	**228**	**60**

* The 1-hour average CO concentrations predicted by the modelling were converted to 10-minute averages using the power law formula.

9.2.5 Summary

The dispersion modelling study, which accounted for worst case testing conditions (**Section 4.2**) predicted no exceedances of the relevant ambient air quality criteria as a result of the operation of the Project. It is noted that given the insignificant incremental increase in ground level concentrations of particulate matter, CO and SO_2 at the modelled sensitive receptor locations, a contemporaneous cumulative assessment was not undertaken.

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10 Air Quality Monitoring Program

10.1 Construction Phase

The AQIA concluded that the risk of construction dust emissions causing nuisance impacts at off-site sensitive receptor locations is low. It is also noted that any impacts will be temporary and managed through the implementation of appropriate mitigation measures.

Considering the low risk from the construction dust emissions to cause nuisance at off-site sensitive receptor locations, dust monitoring at the nearest sensitive receptors is not considered necessary.

However utilising static dust gauge(s) for the duration of Project construction, started at least one month before commencement of construction work, would be an inexpensive monitoring method that could be used to demonstrate that dust emissions are being managed effectively.

A summary of the proposed nuisance dust monitoring program is shown in **Table 24**.

Table 24 Nuisance Dust Monitoring Program

Parameter	Methodology	Duration	Location	Frequency
Deposited dust	AS/NZS 3580.1.1:2016 - Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment	During Site preparation, earthworks, construction	Inside Site boundary along Roberts Road	Monthly

An air quality contingency management plan for the Project construction, based on the monitoring approach outlined above, is provided in **Table 25**.

Table 25 Nuisance Dust Contingency Management Plan for Project

Trigger	Dust Deposition Rate <4 $g/m^2/month$	Dust Deposition Rate >4 $g/m^2/month$
Response	No response required. Continue monitoring program	Review and investigate construction activities and respective control measures, where appropriate. Implement additional remedial measures, such as: • Deployment of additional water sprays. • Relocation or modification of dust-generating sources. • Temporary halting of activities and resuming when conditions have improved.

10.2 Operational Phase

Given the nature and scale of the proposed activities, it is not anticipated that any impacts upon human health or amenity values would be experienced during the operational phase. Therefore, monitoring of air quality is not considered to be required during the operational phase.

11 Mitigation measures

The SEARs require an environmental risk analysis to identify potential environmental impacts associated with the Project. The following represents the way in which risks, impacts and mitigation measures are identified and quantified in relation to dust management at the Project.

This analysis comprises a qualitative assessment consistent with AS/NZS ISO 31000:2009 *Risk Management–Principles and Guidelines* (Standards Australia 2009). The level of risk was assessed by considering the potential impacts of the Project prior to application of any mitigation or management measures.

Risk comprises the likelihood of an event occurring and the consequences of that event. For the Project, the descriptors shown in **Table 26** were adopted for 'likelihood' and 'consequence'.

Table 26 Risk Descriptors

Likelihood		Consequence	
A	Almost certain	1	Widespread and/or irreversible impact
B	Likely	2	Extensive but reversible (within 2 years) impact or irreversible local impact
C	Possible	3	Local, acceptable or reversible impact
D	Unlikely	4	Local, reversible, short term (<3 months) impact
E	Rare	5	Local, reversible, short term (<1 month) impact

The risk levels for likely and potential impacts were derived using the risk matrix shown in **Table 27**.

Table 27 Risk Matrix

Consequence	Likelihood				
	A	B	C	D	E
1	High	High	Medium	Low	Very Low
2	High	High	Medium	Low	Very Low
3	Medium	Medium	Medium	Low	Very Low
4	Low	Low	Low	Low	Very Low
5	Very Low	Very Low	Very Low	Very Low	Very Low

The risk assessment and mitigations measures are shown in **Table 28.**

Table 28 Risk Assessment and Mitigation Measures

Matter	Potential Impact	Likelihood	Consequence	Risk Level	Proposed Mitigation Measures
Air Quality	PM_{10} health impacts on nearby sensitive receptors from construction phase	E	4	Very Low	No mitigation required for PM_{10} specifically. Note that measures for dust soiling (below) will likely also reduce the potential impact of PM_{10}.
	Dust soiling (nuisance) impacts on nearby receptors from construction phase	D	4	Low	Develop a Construction Environmental Management Plan (CEMP) adopting appropriate and relevant measures from **Section 9.1.4** of the AQIA, including monitoring as proposed in **Section 10** of the AQIA.
	Health impacts on nearby sensitive receptors from operation of standby generators	E	4	Very Low	Undertaking routine maintenance of all generators and minimising storage of volatile chemicals on-site.

12 Conclusions

The main potential sources of air emissions were identified as suspended particulate matter and deposited dust during the construction stage and combustion gases and particulate matter during the operational stage of the Project.

The potential for off-site air quality impacts during the construction stage of the Project were assessed using a qualitative risk-based approach, concluding that given the nature of the operations proposed, the location of the site and the local meteorological conditions, exceedances of the relevant air quality criteria are unlikely..

The potential for off-site air quality impacts during the operational stage of the Project were assessed quantitatively through the use of dispersion modelling techniques in general accordance with the Approved Methods. The dispersion modelling study, which accounted for worst case testing conditions predicted no exceedance of the relevant ambient air quality as a result of the operation of the Project. To further reduce the risk of any exceedances of the relevant air quality criteria it is recommended that testing hours be revised to 9:00 am to 4:00 pm.

Based on the above, it is concluded that air quality issues do not pose a constraint for the Project.

13 References

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APPENDIX A

IAQM Construction Assessment Methodology

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located more than 350 m from the boundary of the Site, more than 50 m from the route used by construction vehicles on public roads and more than 500 m from the Site entrance. This step is noted as having deliberately been chosen to be conservative, and will require assessments for most projects.

Step 2a – Assessment of Scale and Nature of the Works

Step 2a of the assessment provides "dust emissions magnitudes" for each of four dust generating activities; demolition, earthworks, construction, and track-out (the movement of soils and dusty materials onto public roads by vehicles). The magnitudes are: *Large*; *Medium*; or *Small*, with suggested definitions for each category. The definitions given in the IAQM guidance for earthworks, construction activities and track-out, which are most relevant to this Project, are as follows:

Demolition *(Any activity involved with the removal of an existing structure [or structures]. This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time)*:

- ***Large***: Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level;
- ***Medium***: Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level; and
- ***Small***: Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

Earthworks *(Covers the processes of soil-stripping, ground-levelling, excavation and landscaping)*:

- ***Large***: Total site area greater than 10,000 m^2, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.
- ***Medium***: Total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (eg silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t.
- ***Small***: Total site area less than 2,500 m^2, soil type with large grain size (eg sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t, earthworks during wetter months.

Construction *(Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc)*:

- ***Large***: Total building volume greater than 100,000 m^3, piling, on site concrete batching; sandblasting.
- ***Medium***: Total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (eg concrete), piling, on site concrete batching.
- ***Small***: Total building volume less than 25,000 m^3, construction material with low potential for dust release (eg metal cladding or timber).

Track-out *(The transport of dust and dirt from the construction / demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network)*:

- ***Large***: More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length.
- ***Medium***: Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.
- ***Small***: Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

In order to provide a conservative assessment of potential impacts, it has been assumed that if at least one of the parameters specified in the 'large' definition is satisfied, the works are classified as large, and so on.

Step 2b – Risk Assessment

Assessment of the Sensitivity of the Area

- Step 2b of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:
- The specific sensitivities that identified sensitive receptors have to dust deposition and human health impacts
- The proximity and number of those receptors
- In the case of PM_{10}, the local background concentration
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Individual receptors are classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors are not addressed using this approach). The IAQM method provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in **Table A-1**. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

Table A-1 IAQM Guidance for Categorising Receptor Sensitivity

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

According to the IAQM methods, the sensitivity of the identified individual receptors (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors. Additional factors to consider when determining the sensitivity of the area include:

- Any history of dust generating activities in the area
- The likelihood of concurrent dust generating activity on nearby sites

- Any pre-existing screening between the source and the receptors
- Any conclusions drawn from analysing local meteorological data which accurately represent the area and if relevant, the season during which the works will take place
- Any conclusions drawn from local topography
- The duration of the potential impact (as a receptor may be willing to accept elevated dust levels for a known short duration, or may become more sensitive or less sensitive (acclimatised) over time for long-term impacts)
- Any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in **Table A-2**. The sensitivity of the area should be derived for each of activity relevant to the project (i.e. construction and earthworks).

Table A-2 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

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

Note: Estimate the total number of receptors within the stated distance. Only the *highest level* of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors < 20m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total of number of receptors < 50 m is 102. The sensitivity of the area in this case would be high.

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table A-3**. For high sensitivity receptors, the IAQM methods takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM_{10} in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (i.e. an annual average of 25 µg/m^3 for PM_{10}) the IAQM method has been modified slightly.

- This approach is consistent with the IAQM guidance, which notes that in using the tables to define the *sensitivity of an area*, professional judgement may be used to determine alternative sensitivity categories, taking into account the following factors:
- Any history of dust generating activities in the area
- The likelihood of concurrent dust generating activity on nearby sites
- Any pre-existing screening between the source and the receptors
- Any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place
- Any conclusions drawn from local topography
- Duration of the potential impact
- Any known specific receptor sensitivities which go beyond the classifications given in this document.

Table A-3 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Receptor sensitivity	Annual mean PM_{10} conc.	Number of receptors [a,b]	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
	21-25 μg/m³	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	17-21 μg/m³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<17 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
	21-25 μg/m³	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	17-21 μg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<17 μg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Notes: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m); noting that only the highest level of area sensitivity from the table needs to be considered.

(b) In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

Risk Assessment

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table A-4** (demolition), **Table A-5** (earthworks and construction) and **Table A-6** (track-out) to determine the risk category with no mitigation applied.

Table A-4 Risk Category from Demolition Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table A-5 Risk Category from Earthworks and Construction Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table A-6 Risk Category from Track-out Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 3 - Site-Specific Mitigation

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

Step 4 – Residual Impacts

Following Step 3, the residual impact is then determined after management measures have been considered.

APPENDIX B

SELECTION OF REPRESENTATIVE METEOROLOGICAL DATA

Once emitted to atmosphere, the emissions will:

- Rise according to the momentum and buoyancy of the emission at the discharge point relative to the prevailing atmospheric conditions;
- Be advected from the source according to the strength and direction of the wind at the height which the plume has risen in the atmosphere;
- Be diluted due to mixing with the ambient air, according to the intensity of turbulence; and
- (Potentially) be chemically transformed and/or depleted by deposition processes.

Dispersion is the combined effect of these processes. Dispersion modelling is used as a tool to simulate the air quality effects of specific emission sources, given the meteorology typical for a local area together with the expected emissions. Selection of a year when the meteorological data is atypical means that the resultant predictions may not appropriately represent the most likely air quality impacts. Therefore, in dispersion modelling, one of the key considerations is the representative nature of the meteorological data used.

The year of meteorological data used for the dispersion modelling was selected by reviewing the most recent five years of historical surface observations at Horsley Park Equestrian Centre AWS (2015 to 2019 inclusive) to determine the year that is most representative of average conditions. Wind direction, wind speed and ambient temperature were compared to 5-year averages for the region to determine the most representative year.

Data collected from 2015 to 2019 is summarised in **Figure A1** to **Figure A3**. Examination of the data indicates the following:

- **Figure A1** indicates a higher frequency of winds from the north-northwest quadrant in 2016 which would blow emissions from the Project towards the nearest sensitive receptors.
- **Figure A2** indicates that average monthly wind speeds during 2016 typically below the 5-year average wind speeds which would lead to less effective dispersion of pollutants (ie more conservative).
- **Figure A3** shows that temperatures for all years with the exception of 2015 closely reflect the 5-year average.

Given the above, the year 2016 was selected as the representative year of meteorology.

Figure A1 Frequency of Winds at Horsley Park Equestrian Centre AWS for 2015 – 2019

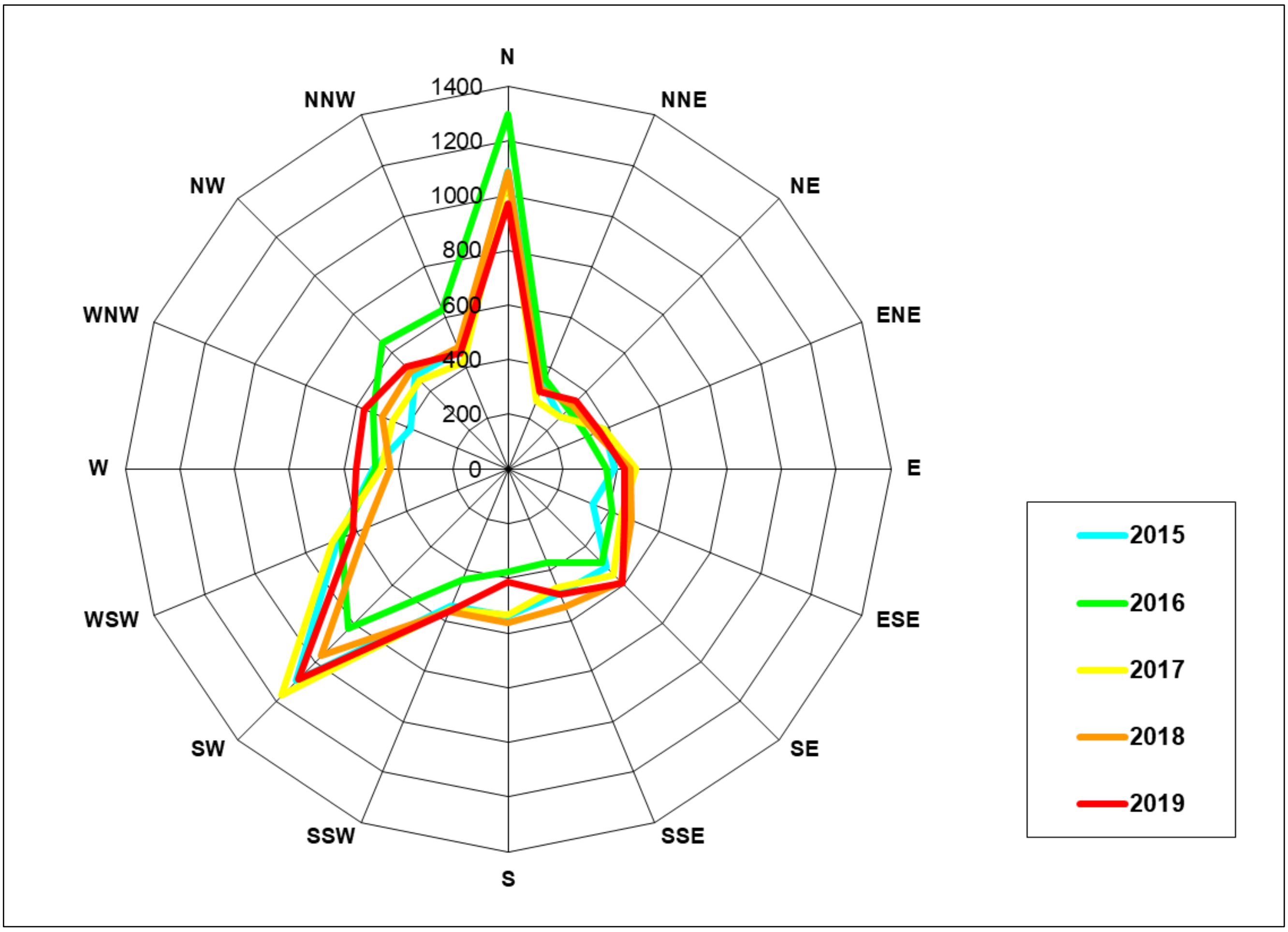


Figure A2 Monthly Average Wind Speed at Horsley Park Equestrian Centre AWS for 2015 – 2019

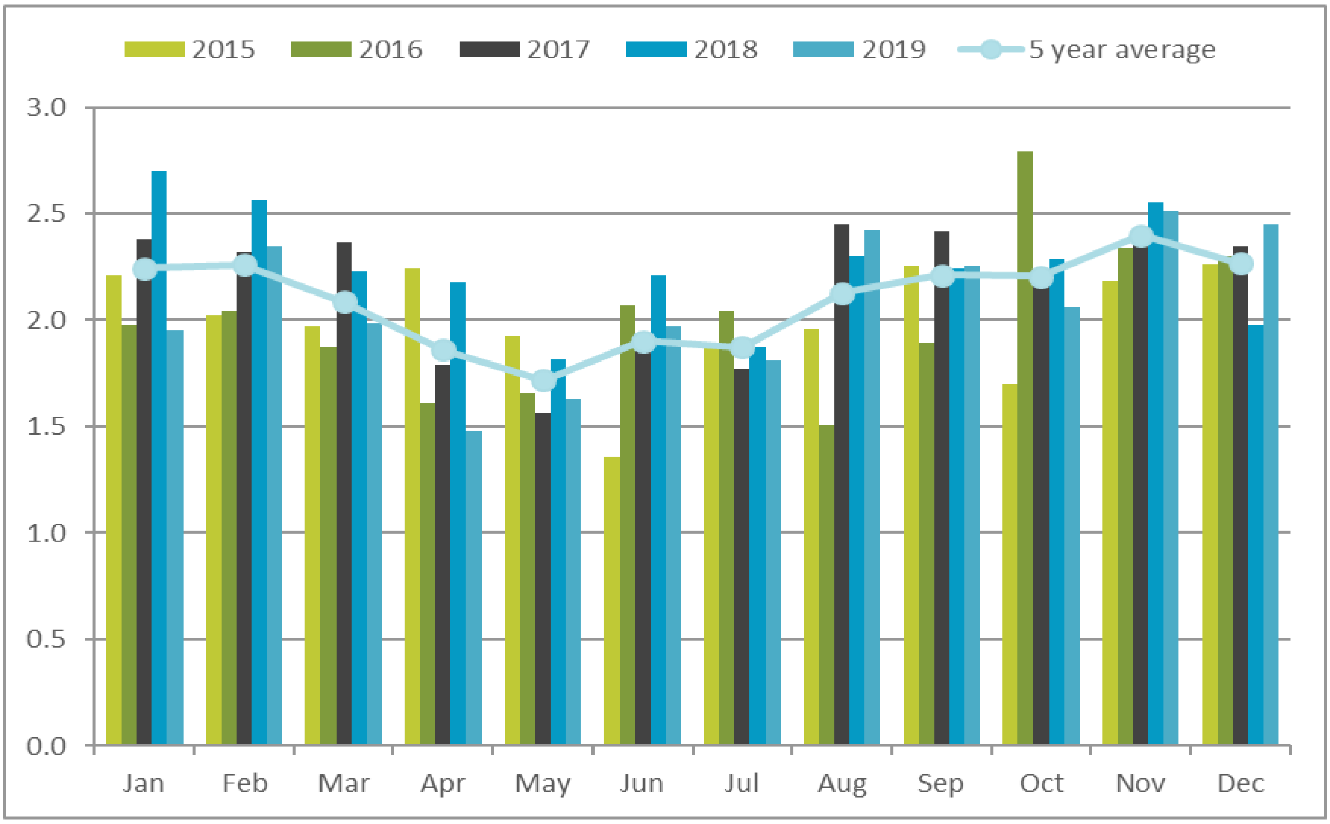
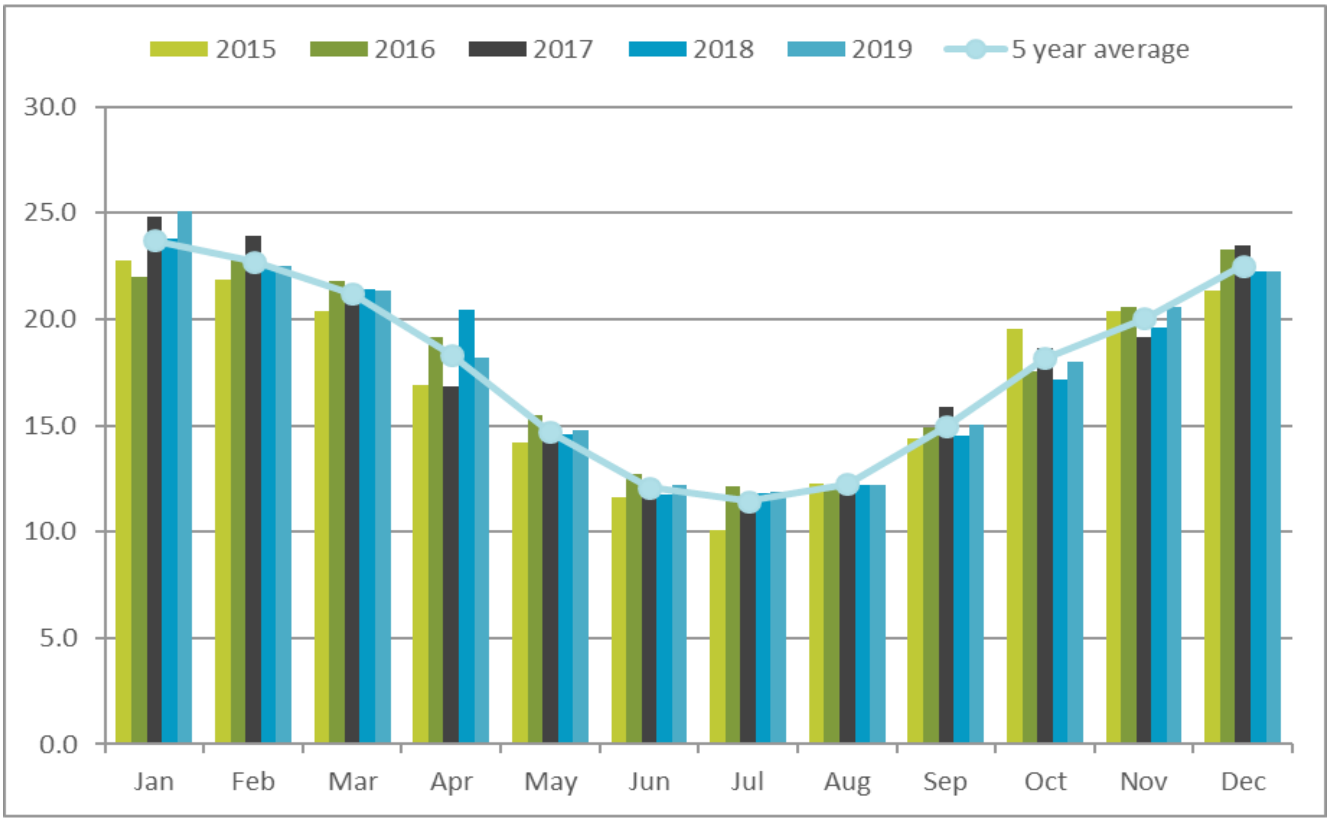


Figure A3 Monthly Average Temperature at Horsley Park Equestrian Centre AWS for 2015 – 2019



APPENDIX C

Diesel Generator Specifications Sheet

Exhaust emission data sheet
C3750 D5
50 Hz Diesel generator set

Engine Information:

Model:	Cummins Inc. QSK95-G4	Bore:	7.48 in. (190 mm)
Type:	4 Cycle, VEE, 16 cylinder diesel	Stroke:	8.27 in. (210 mm)
Aspiration:	Turbocharged and Aftercooled	Displacement:	5816 cu. in. (95.3 liters)
Compression Ratio:	15.5:1		
Emission Control Device:	Turbocharged and Aftercooled		
Emission Level:	Stationary emergency		

Performance Data	**1/4 Standby**	**1/2 Standby**	**3/4 Standby**	**Full Standby**	**Full Prime**	**Full Continuous**
Engine BHP @ 1500 RPM (50 Hz)	1145	2185	3225	4308	3822	3433
Fuel Consumption L/Hr (US Gal/Hr)	216 (57)	371 (98)	537 (142)	723 (191)	636 (168)	575 (152)
Exhaust Gas Flow m³/min (CFM)	205 (7251)	317 (11195)	443 (15664)	560 (19765)	510 (18022)	473 (16705)
Exhaust Gas Temperature °C (°F)	331 (627)	378 (713)	383 (722)	413 (776)	391 (763)	384 (723)
Exhaust Emission Data						
HC (Total Unburned Hydrocarbons)	0.19 (81)	0.09 (46)	0.08 (40)	0.06 (31)	0.06 (33)	0.08 (41)
NOx (Oxides of Nitrogen as NO_2)	9.1 (3990)	9.3 (4540)	7.6 (3800)	7.4 (3700)	7.3 (3670)	7 (3500)
CO (Carbon Monoxide)	0.3 (150)	0.2 (110)	0.1 (30)	0.1 (40)	0.1 (30)	0.1 (30)
PM (Particulate Matter)	0.05 (18)	0.01 (6)	0.01 (3)	0.01 (4)	0.01 (3)	0.01 (3)
SO_2 (Sulfur Dioxide)	0.005 (1.8)	0.004 (1.8)	0.004 (1.8)	0.004 (1.7)	0.004 (1.7)	0.004 (1.8)
Smoke (FSN)	0.35	0.16	0.08	0.11	0.08	0.08

All values (except smoke) are cited: g/BHP-hr (mg/Nm³ @ 5% O_2)

Test Conditions

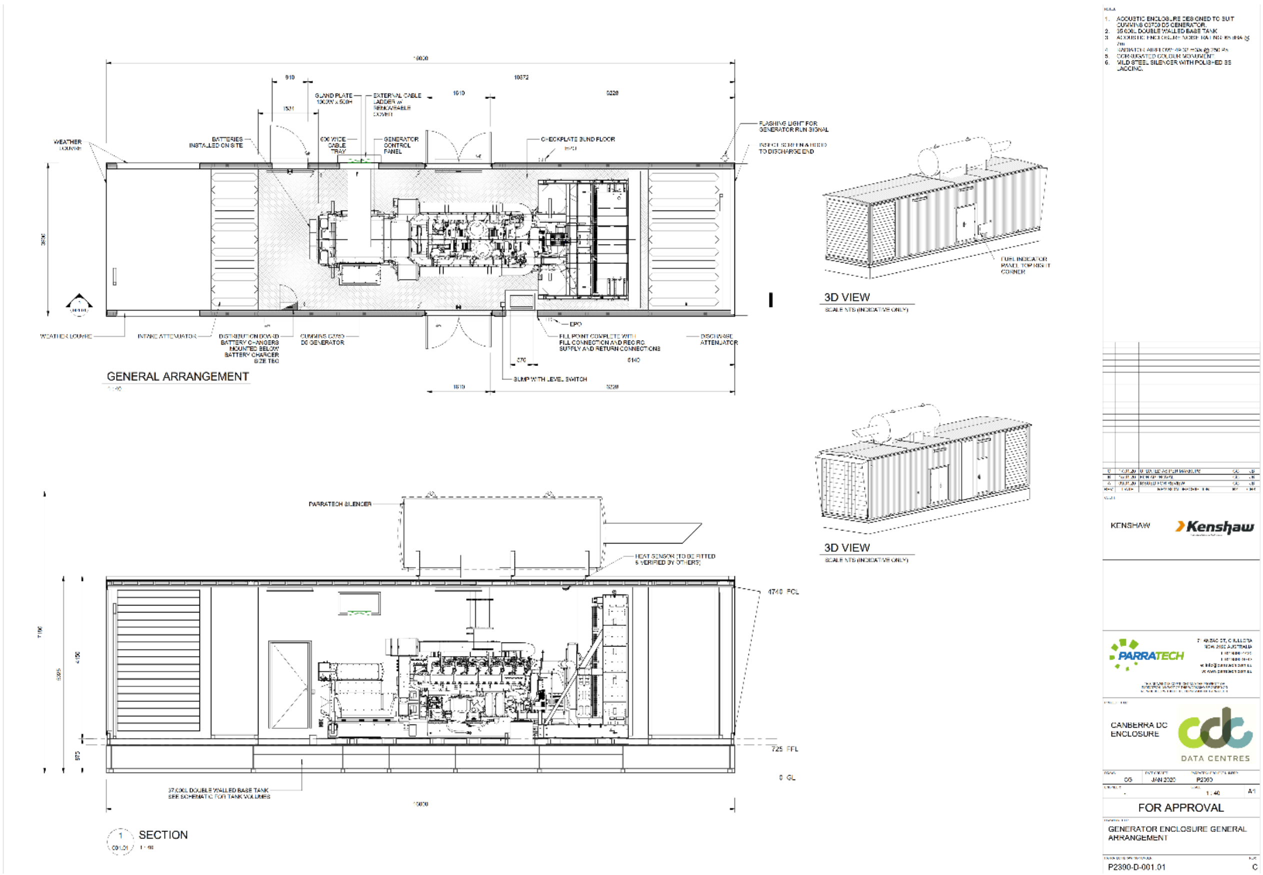
Steady-state emissions recorded per ISO8178-1 during operation at rated engine speed (+/-2%) and stated constant load (+/-2%) with engine temperatures, pressures and emission rates stabilized.

Fuel Specification:	40-48 Cetane Number, 0.0015 Wt.% Sulfur; Reference ISO8178-5, 40 CFR 86, 1313—98 Type 2-D and ASTM D975 No. 2-D. Fuel Density at 0.85 Kg/L (7.1 lbs/US Gal)
Air Inlet Temperature	25 °C (77 °F)
Fuel Inlet Temperature:	40 °C (104 °F)
Barometric Pressure:	100 kPa (29.53 in Hg)
Humidity:	NOx measurement corrected to 10.7 g/kg (75 grains H_2O/lb) of dry air
Intake Restriction:	Set to 18 in of H_2O as measured from compressor inlet
Exhaust Back Pressure:	Set to 1.5 in Hg
Note:	mg/m³ values are measured dry, corrected to 5% O_2 and normalized to standard temperature and pressure (0°C, 101.325 kPa)

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 result in elevated emission levels.

APPENDIX D

Generator Enclosure – General Arrangement



GENERAL ARRANGEMENT
3D VIEW
3D VIEW
SECTION
PARRATECH SILENCER
1. ACOUSTIC ENCLOSURE DESIGNED TO SUIT CUMMINS C3750 D5 GENERATOR.
2. 35,000L DOUBLE WALLED BASE TANK
5. CORRUGATED COLOUR MONUMENT.
6. MILD STEEL SILENCER WITH POLISHED SS LAGGING.
KENSHAW
Kenshaw
PARRATECH
CANBERRA DC ENCLOSURE
DATA CENTRES
OG
JAN 2020
P2390
1 : 40
A1
FOR APPROVAL
GENERATOR ENCLOSURE GENERAL ARRANGEMENT
P2390-D-001.01
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