

NEXTDC

NEXTDC S5

State Significant Development Application (SSDA) - Air Quality Report

Reference: S5-EN-00-000-REP-J-DVA-APP-EN REPORT

J | 26 September 2025



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Job number 296866-08

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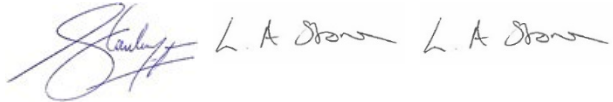



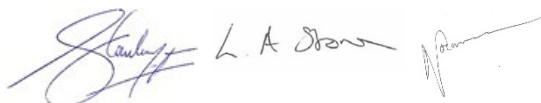
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Executive summary

This Air Quality Technical Report has been prepared by Arup on behalf of NEXTDC Limited to accompany a State Significant Development Application (SSDA) for the data centre development at 269 Lane Cove Road (The Proposal or the site). The legal description of the site is Lot 3 in Deposited Plan (DP) 1129811.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-63168959). This report concludes that the proposed data centre development is suitable and warrants approval subject to the implementation of the mitigation measures discussed in the report.

Existing Environmental Conditions

Sensitive receivers

The Proposal site is located in the City of Ryde Local Government Area (LGA) within the Macquarie Park corridor. The area around the Proposal is primarily commercially zoned. Commercial, active recreational, childcare, hotel and educational receivers are within the immediate vicinity. The nearest existing residential receivers are located to the south-west of the site, across Epping Road.

The area around the site is undergoing development; the proposed known approved and proposed future developments around the site have been reviewed and future receivers have been incorporated into the sensitive receivers assessed. The future receivers include a hotel to the west of the site and residential buildings to the north of the site.

Existing meteorology

Site-representative meteorological conditions were derived from a prognostic meteorological model. Analysis of meteorological data for the past five years indicated similar meteorological patterns, and therefore the most recent year at the outset of the assessment was selected, 2022, and correlated with background air quality data. Based on the meteorological data:

- Winds are most prevalent from the west-south-west, with average wind speed of 3.3 m/s.
- Winds are least prevalent from the south-south-west sector with annual winds of about 3%, and
- Light winds (< 0.5 m/s) are more prevalent from the north-west sectors.

Local background air quality

Data from the nearest Department of Planning, Housing and Industry air quality monitoring station (AQMS) located at Macquarie Park, approximately 2.5 km to the north-west of the Proposal site, has been used to establish background pollutant concentrations for the Proposal. The AQMS at Macquarie Park records all relevant pollutants, such as NO₂, SO₂, CO, O₃, PM₁₀ and PM_{2.5}. The maximum monitored pollutant concentrations for year 2022 at Macquarie Park AQMS show that the background concentrations are all below the NSW *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2022) (the 'Approved Methods') impact assessment criteria.

Pollutant Impact Assessment

Construction

Construction activities have the potential to generate short-term emissions of particulates, typically associated with uncontrolled or fugitive dust emissions. A quantitative construction dust impact assessment was undertaken using AERMOD based on the worst-case construction activity for dust-related impact during the construction phase, which is bulk excavation and piling activities. The dust emissions from the construction activity were modelled assuming that earthworks would occur across the entirety of the project area, with equipment operating every day, to ensure that the day of worst-case dispersion meteorology is covered by the modelling. Heavy construction work is assumed to occur during standard hours of work.

Some mitigation measures (50 per cent water spray to keep soil wet) have been allowed for haul trucks, light vehicles and vibrating rollers as these would be operating on material where water is applied as part of the process. Additional mitigation measures (75 to 80 per cent water spray to keep soil wet) have been allowed for earthmoving equipment, to minimise construction dust impact, given the close proximity of the nearby sensitive receivers. The above preliminary mitigation measures should be included when implementing a construction environmental management plan (CEMP) for the Proposal, to minimise the construction dust impact risk.

The results show that the cumulative PM₁₀ concentrations (i.e. inclusive of background concentrations) are predicted to meet the daily impact assessment criterion of 50 µg/m³ at all assessed sensitive receivers at ground as well as at elevated levels. This predicted concentration represents the highest possible concentrations during construction, with all dust-generated construction equipment operating concurrently, and coinciding with worst-case meteorological conditions. As the impact assessment criteria are met at the nearby receivers under worst-case conditions, the dust impact risk during construction is considered to be low with appropriate mitigation measures in place.

Operation

The primary source of emissions to air during the operational phase are the standby generators that are included for in the Proposal, as an insurance policy, to absolutely guarantee the need for 100% uptime if there was ever a failure of the primary and secondary power supply to the site. The proposal (as a data centre facility) is a mission critical facility that if not able to operate 100% of the time could lead to catastrophic impacts for the society, organizations, and businesses that it serves. The Proposal therefore as a minimum is supplied by dual redundant utility feeds using a 33kV highly reliable power utility supply arrangement. It is only in the event of both primary and secondary feeds failing, that back-up power generation would be required using the standby generators, which is highly unlikely.

A dispersion modelling assessment of the proposed 48 on-duty standby generators within the Proposal's site has been undertaken to ascertain the air quality impacts at nearby receivers due to a highly unlikely worst-case scenario where all generators would be operational (in the rare instance of a full loss of mains power), as well as routine maintenance/testing (realistic operations). The assessment was conducted to comply with requirements of the Secretary's Environmental Assessment Requirements (SEARs).

The assessment was undertaken using AERMOD. Emissions to air from the standby generators associated with this Proposal have been estimated using manufacturer's specification datasheets for indicative pieces of equipment. Predicted ground-level as well as elevated pollutant concentrations were assessed at identified nearby discrete sensitive receivers.

Hourly varying background concentration data were used to assess all relevant pollutants, which are nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO) and particulate matter. In addition, incremental ground-level concentrations were also assessed for toxic pollutants such as benzene and polycyclic aromatic hydrocarbons (PAH).

A photochemical conversion for short-term concentrations (i.e. hourly average) from nitrogen oxides (NO_x) to NO₂ were determined in accordance with the US EPA's Ozone Limiting Method¹ (OLM), which is recognised in the NSW Approved Methods.

Scenario 1: Highly unlikely worst-case scenario (peak emissions)

In the event of an interruption of mains power from the dual redundant feeds, the standby generators would switch on to provide power to each of the buildings. The S5 facility is designed to operate on the 33kV utility power supply, which has high reliability. The Macquarie Park Sub Transmission substation (132/33kV) is currently being upgraded by Ausgrid, with completion expected in December 2025. New 33kV feeders will be constructed, and it is assumed they will supply the S5 facility. The Macquarie Park Zone Substation is a highly reliable facility, and the proposed design for the S5 facility will also include a fully redundant 33kV

¹ Cole, H. S., & Summerhays, J. E. (1979). *A Review of Techniques Available for Estimating Short-Term NO₂ concentrations*. *J. Air Poll. Cont. Assoc.*, 29:8, 812-817. doi:10.1080/00022470.1979.10470866.

utility power supply to further reduce the likelihood of needing the backup generators. This redundant 33kV supply enhances the reliability of the utility power supply, offering additional security, minimizing downtime, and limiting disruption to only parts of the facility

Further, a review has been undertaken of the electricity supplier Ausgrid *Distribution and Transmission Annual Planning Report Summary* (DTAPR, December 2023)² to understand typical outages for conventional utilities in the wider area surrounding the Proposal. This shows an extremely low power outage occurrence of less than 0.01% in any year for a conventional utility. Noting Macquarie Park zone substation (132/33kV) supply and the 33kV utility power supply arrangement proposed for the Proposal, both have a higher reliability than a conventional utility, it is highly unlikely that the standby generators would ever need to be used in their capacity to provide back-up power generation, and even if they did the likelihood of this happening would be far lower than 0.01% of the year. In fact, Ausgrid have analysed the outage scenarios of other zone substations (132/33kV) in their network such as Homebush, Willoughby, Port Hacking and Alexandria, and stated in writing that there were no customer outages for customers, with similar, redundant supplies, in the last 10 years.

A dispersion modelling assessment under this scenario has been undertaken to determine the likely pollutant concentrations should all the proposed 48 on-duty standby generators be needed to operate during the highly unlikely power outage event, to comply with SEARs. The modelling results indicated that the predicted pollutants' impact concentrations from the generators generally meet the impact assessment criteria outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2022) (the 'Approved Methods') at identified nearby sensitive receivers. Emissions of 1-hour average oxides of nitrogen (NO_x), which convert to NO₂ in the atmosphere, exceed the impact assessment criteria at the nearby sensitive receivers.

Predicted exceedances of the impact assessment criteria for NO₂ are not uncommon for facilities including standby diesel generators, where all generators would be required to operate where a loss of mains power occurs. However, it is highly unlikely that the standby generators would ever need to be used in their capacity to provide back-up power generation, and even if they did the likelihood of this happening would be far lower than 0.01% of the year reported by Ausgrid above.

Therefore, the air quality impact risk from the highly unlikely worst-case scenario (power outage) activity would be very low.

Scenario 2: Realistic operations during routine maintenance

The on-duty standby generators would undergo routine maintenance and testing to make sure they are operational if required during a power outage. Routine maintenance follows a prescribed testing regime that sets the frequency and duration of testing to minimise emissions to air while undertaking all required maintenance. For the Proposal, it is proposed that up to one generator would be tested at any one time during the daytime, with a total cumulative testing duration of not more than 200-hours in a year.

Dispersion modelling has been undertaken to determine potential air quality impacts at nearby identified sensitive receivers as a result of routine maintenance. Predicted pollutant concentrations at nearby identified sensitive receivers during all maintenance or testing periods are below the impact assessment criteria for all assessed pollutants, due to less generators being operational, compared with the highly unlikely worst-case scenario. Therefore, the air quality impact risk from the routine maintenance activity would be negligible.

POEO (Clean Air) Regulation – Standard of Concentrations

Clause 73 of the POEO (Clean Air) Regulation 2022 exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities Standard of nitrogen dioxide and nitric oxide concentrations specified in Schedule 2, if the plant is used for a total of not more than 200 hours per year, and considered a non-scheduled premises. The Proposal would not be a scheduled premises as testing of generators would not be for more than a total of 200 hours per year, however the Proposal would

² Ausgrid, 2023. *Distribution and Transmission Annual Planning Report Summary*, December 2023.

still need to comply with the Schedule 2 Part 3 of the POEO and its solid particles Standard of Concentration limit for non-scheduled premises, which is 100 mg/m³.

The proposed indicative generator selection has particulate emissions below the Standard of Concentration of 100 mg/m³, when operating at all loads as provided in the generator specification, and therefore meet the relevant POEO (Clean Air) Standard of Concentration requirement.

Cumulative impact from nearby data centres

Existing data centres are located approximately 200 metres to the north-east and north-west of the Proposal site, respectively. These facilities contain standby generators that have the potential to contribute to cumulative impacts from the Proposal on local air quality. While these facilities are owned and operated by NEXTDC, they are designed as diverse sites with their own operational tolerances to run independently of the Proposal. As per the Proposal, the generators are installed as back up emergency generators with the intent to host the facilities power generation during emergency loss of mains power, all three facilities (S1, S2 and S5) are connected to diverse and redundant power feeds such as 33kV feeder, to ensure the highest level of resilience from mains power and to ensure generators are present as a final resort for business continuity only.

Further, Ausgrid analysed the outage scenarios of other sub-transmission substation (STS) in their network such as Homebush, Willoughby, Port Hacking and Alexandria. There were no 33kV busbar outages in these STS in the last 10 years. There were a few 33kV feeder outages at the commissioning stage with no outages to customers due to N-1 supply. While the infrastructure surrounding the Project site is relatively new to the above STS network, the analysed Ausgrid outage data has demonstrated the reliability of the 33kV feeder proposed for the Proposal site and the surrounding.

A qualitative cumulative impact review has been conducted, based on the following factors to evaluate the potential risk of cumulative impacts.

- The probability of potential simultaneous failure of multiple feeders.
- The probability of potential simultaneous maintenance testing at multiple facilities.
- The frequency of wind vectors giving rise to cumulative impacts from the contributing sources towards common receiver(s).

The review outcomes indicate that the probability of cumulative air quality impacts during emergency and routine maintenance testing scenarios are extremely low; 0.0012%-0.0017% and 0.019%-0.026% respectively, indicating that they are highly unlikely to occur in a typical year.

Environment Management Measures

General air quality mitigation and management measures recommended for the proposal have been provided in Section 8 of this Report. These include recommendations to control emissions to air and dust during construction, which can be incorporated in the Construction Environmental Management Plan (CEMP). These also include measures for the operator to minimise operation of the generators as far as practicable. Residual air quality impacts with these management measures in place are negligible to low.

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1. Introduction

This report has been prepared to accompany a detailed SSDA for the proposed data centre development at 269 Lane Cove Road, Macquarie Park (SSD-63168959) (the Proposal or the site).

The application seeks consent for construction and operation of a data centre development and includes site preparation works, bulk earthworks and infrastructure, and construction of the buildings, ancillary facilities, and associated site works. The application also includes the delivery of one internal road and an urban plaza adjacent to the Macquarie Park Metro Station entrance.

Specifically, the Proposal comprises the redevelopment of the site as summarised below:

- Site preparation works including demolition and removal of existing structures, tree removal and bulk earthworks.
- Staged construction and operation of two connected data centre buildings (Building A and Building B) with a maximum height of 65 metres and a combined total gross floor area (GFA) of 47,285m² comprising 33,142m² of technical data hall floor space and 14,143m² of office, retail and innovation hub floor space.
- Building A will be delivered in Stage 1 and will comprise the following:
 - Basement parking for 51 car spaces including two accessible spaces and 10 EV spaces.
 - Seven storeys of technical data floor space accommodating seven data houses: 16,571m².
 - Utilities including diesel generators (3MWe), above-ground water tanks for industrial water (600kL each), above-ground diesel storage tanks (100kL each) and an aboveground water tank for fire water (400kL each).
 - Business identification signage facing Waterloo Road and Lane Cove Road.
 - Integrated 'Building O' component within Building A, comprising:
 - Two retail tenancies at ground level: 326m².
 - Lobby and innovation hub including auditorium and training rooms: 3,186m².
 - NEXTDC and ancillary office floor space on upper levels: 10,631m².
 - Building B will be delivered in Stage 2 and will comprise the following:
 - Seven storeys of technical data floor space accommodating seven data halls: 16,571m².
 - Utilities including diesel generators (3MWe), above-ground water tanks for industrial water (600kL each), above-ground diesel storage tanks (100kL each) and an aboveground water tank for fire water (400kL each).
 - Business identification signage on the western and southern building facades.
- Landscaping across the site in accordance with the project staging, delivering a mix of native and endemic plant species, shrubs and grasses, including 139 additional trees within a total area of 4,959 m² deep soil and a resultant tree canopy cover of 5,707 m²
- Staged delivery of public domain works including:
 - Stage 1: construction of Road 13 within the subject site and urban plaza.
 - Stage 2: construction of Road 6 (half-width) within the subject site, including provision for a future pedestrian/cycle overbridge (to be delivered by others), and works along Lane Cove Road.

- Delivery of 90 megawatts of power with a 33kV switching station to be accommodated on site, as well as other site services, including stormwater infrastructure.

1.1 SEARs response

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 8 November 2023 issued for the SSDA (SSD-63168959). Specifically, this report has been prepared to respond to the SEARs requirement issued below in Table 1.

Table 1 – SEARs Compliance

Item	Description of Requirement	Section Reference (this Report)
Air Quality	A quantitative assessment of the potential air quality, dust and odour impacts of the development (construction and operation) on surrounding landowners, businesses and sensitive receptors, in accordance with relevant Environment Protection Authority guidelines. The assessment must address construction works and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) and a peak emission and air pollutant scenario, and outline the proposed mitigation, management and monitoring measures that would be implemented.	Sections 3.1, 3.2, 6, 7, 8, 9.

1.2 Purpose of this report

The purpose of this report is to examine and identify the potential impact from the construction and operation of the Proposal, on local air quality at nearby sensitive receivers. The air quality impact assessment in this report has been conducted in accordance with the following legislation, policy and guidelines:

- NSW Protection of the Environment Operations (Clean Air) Regulation 2022 (POEO)
- NSW EPA – Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (August 2022)
- NSW Protection of the Environment Operations Act 1997 – Section 128

This assessment characterises the local meteorological and air quality conditions at the Proposal and its surroundings, quantitatively assesses impact associated with the construction phase and provides a detailed dispersion modelling assessment of the proposed standby generators to be installed at the Proposal, as a worst-case scenario as well as considering a regular testing scenario.

It is unlikely that the equipment proposed for use during the construction and operation phase of the Proposal would be a significant source of odour emissions that would result in an adverse impact for the surrounding environment. Therefore, an assessment of odour impacts has not been undertaken as part of this technical report.

Recommendations for mitigation measures required to allow the Proposal to meet NSW air quality impact assessment criteria have also been included, where necessary.

1.3 The site

The Proposal site is located at 269 Lane Cove Road, Macquarie Park and is legally described at Lot 3 in Deposited Plan (DP) 1129811. It is located on the corner of Lane Cove Road and Waterloo Road and is made up of a single rectangular lot and is approximately 22,381m² in size. An aerial photograph of the site is provided at Figure 1.

The Proposal site is located in the City of Ryde Local Government Area (LGA) within the Macquarie Park corridor, an established employment precinct with a particular focus on innovation. Macquarie Park is a

nationally significant research and employment centre and includes the head offices for some of Australia's leading companies including Foxtel, Optus and Siemens. The site is approximately 2km southeast of Macquarie University, and 1.5km southeast of Macquarie Shopping Centre.

Existing development includes a two-storey office furniture store (Work Arena) at the northern end of the site and offices and studios associated with Foxtel in the southern portion of the site. Scattered trees exist along the site boundaries, particularly within the western setback to Lane Cove Road, along the southern boundary and the eastern boundary.

The site is well serviced by public transport with several bus routes operating along Lane Cove Road and Waterloo Road. The entrance to Macquarie Park Metro Station is immediately to the north of the site. The site includes a lengthy frontage to Lane Cove Road which provides access to the M2 Hills Motorway and Epping Road.



Figure 1 – Aerial photograph of site (Source: Urbis GIS 2023)

1.4 Detailed proposal description

The key components of the Proposal are listed in the following Table 2.

Table 2 – Proposal Details

Description	Proposal Details
Project Area	The site has a total area of approximately 22,381m ² . The entire site area will be disturbed as a result of the Project. The site does not contain any environmental constraints.
Proposed Use	Data centre with ancillary office and innovation space. Two retail premises at ground level.
Project Description	<ul style="list-style-type: none"> • Demolition of existing buildings and structures. • Site preparation works including tree removal, bulk earthworks, excavation and construction of retaining walls. • Staged construction of the data centre buildings including technical data hall floor space, ancillary office and innovation space and two ground floor retail premises. • Vehicle access via Waterloo Road with on-site car parking and loading within the building footprint. • Associated landscaping including extensive trees, shrubs and grasses. • Business identification signage. • Staged delivery of public domain works via a Planning Agreement, including construction of Road 13, Road 6 and an urban plaza between Building A and Waterloo Road. • Provision of required utilities, including an on-site switching station.
Gross Floor Area	Total GFA of 47,285m ² , broken down as follows: <ul style="list-style-type: none"> • Data halls/technical: 33,142m² • Lobby and innovation hub: 3,186m² • MCX office: 10,631m² • Retail including BOH: 326m² • Total number of data houses: 14 data houses
Building Height	<ul style="list-style-type: none"> • Building A: office and innovation hub – 49 metres over 10-storeys • Building A: data centre – 65 metres over nine-storeys • Building B: data centre – 60 metres over nine-storeys:
Proposed Floor Space Ratio	2.11:1
Deep Soil Area	4,959m ² of deep soil area (22.16% of total site area or 35.6% of future site area)
Car Parking	51 parking spaces, including 10 EV and 2 accessible spaces
Motorbike Spaces	17 spaces
Bicycle Spaces	20 spaces
Utilities	Provision of required utilities, combined for both buildings, including:

Description	Proposal Details
	<ul style="list-style-type: none"> • 48 x diesel generators (3MWe). • 16 x above-ground diesel storage tanks (100kL each). • Eight above-ground water tanks for industrial water (600kL each). • One 400kL above-ground water tank for fire water. • 33kV switching station.
Power Consumption	90 megawatts
Operations and Management	The facility will be constructed and operated by NEXTDC. The site will be operated on a 24-hour, 7 day a week basis.
Existing Services and Infrastructure	The site is fully serviced; however, existing services and infrastructure will be extended, adapted and augmented to meet the demands of the Project. A new 33kV switching station will be required to provide power to the site in the event of an emergency blackout to facilitate power to the generators.
Staging/Phasing	<p>The Project will be constructed in two stages:</p> <ul style="list-style-type: none"> • Stage 1 will include the early works for the entire site, construction of Building A, the urban plaza and Road 13 within the subject site. • Stage 2 will include construction of Building B and Road 6 (half-width) within the subject site, including provision for a future pedestrian/cycle overbridge (to be delivered by others), and works along Lane Cove Road.

The Proposal involves the construction of data centre building, comprising:

- Building A, comprising a 9-storey building hosting 40 MW IT load data centre with office block, located to the north side of the site; and
- Building B, comprising a 9-storey building hosting 40 MW IT load data centre, located to the south side of the site.

The design of the Proposal is based on the end-client's reference design as well as applicable Australian Standards and will deliver a total capacity for approximately 90 MW of IT equipment. Each building contains seven data halls (two Enterprise with 2.5MW per data hall IT and five Hyperscale with 7MW per data hall IT).

The nine (9) level (including basement carpark) building facility will reach a total building height of approximately 65m above ground floor, including any lift shaft, rooftop plant and equipment and any roof screening.

The facility will include seven (7) levels of data hall space building and supporting plantrooms, and supporting administrative spaces incorporating secure entry facilities, loading dock, storage, staff offices and the like. The standby generators will be located indoor, occupying six floors building, and some mechanical equipment will be located at roof level.

2. Policy and planning context

This Chapter presents relevant regulation, legislation and policy governing management of Air Quality it relates to the Proposal.

2.1 State Legislation

2.1.1 Protection of the Environment Operations Act 1997

The NSW Protection of the Environment Operations (POEO) Act 1997 is administered by the New South Wales (NSW) Department of Planning and Environment (DPE), under the Environment and Heritage group. The Act is formed to protect, restore and enhance the environment in NSW and to promote public access to information and involvement in environment protection. The Act designates the NSW EPA (Environment Protection Authority) as the regulatory authority.

The following sections from Part 5.4 of the Act provide general protection conditions for air quality are relevant to the Proposal:

- *Section 124*: The occupier of any premises who operated any plant in or on those premises shall operate as well as maintain the plant in a proper and efficient manner, such that it minimises the potential for air pollution.
- *Section 125*: The occupier of any premises who carries out maintenance work on any plant in or on those premises shall conduct the work in a proper and efficient manner, such that it minimises the potential for air pollution.
- *Section 128*: The occupier of any premises must not carry on any activity, or operate any plant, in or on the premises in such a manner as to cause or permit the emission at any point specified in or determined in accordance with the regulations of air impurities in excess of the standard of concentration and/or the rate prescribed by the regulations in respect of any such activity or any such plant.
- The occupier of any premises must carry on any activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.
- Schedule 1, Clause 17 of the Act³ applies scheduled premises status to electricity generation by means of internal combustion engine in a metropolitan area with capacity to produce more than 30 to 32.5 MW of electrical power and burn rate of more than 3 MJ of fuel per second. However, Clause 17 (1A) of the Act notes that scheduled premises status does not apply if the electricity generation is utilised for emergency standby plant operating for less than 200 hours per year.

2.1.2 Protection of the Environment Operations (Clean Air) Regulation 2022

The NSW Protection of the Environment Operations POEO (Clean Air) Regulation 2022 is specifically regulated to manage air quality issues associated with various sources, such as burning activities, motor vehicles fuels, fuel usage and transfer, air impurities from activities and plant, storage of volatile organic liquids and many others.

Part 5 of the POEO (Clean Air) Regulation specifically addresses air impurities from activities and plant, and refers to Schedule 2 Part 2 Division 3 to set the *Standard of concentrations for scheduled premises of general activities and plant* and Schedule 2 Part 3 to set the *Standard of concentrations for non-scheduled premises*. However, Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities

³ Part 9.7, Section 327, Schedule 1, Part 1 (Premises-based activities), Clause 17 (1A) of the POEO Act 1997.

Standard of nitrogen dioxide and nitric oxide concentrations specified in Schedule 2 in relation to that plant, if the plant is used for a total of not more than 200 hours per year.

Table 3 and Table 4 below set out the standard of concentrations under the Schedule 4 and Schedule 6 of the POEO (Clean Air) Regulation.

Table 3 – Schedule 2, Part 2 Division 3 – Standards of concentration for (Group 6) scheduled premises

Air impurity	Activity or plant	Concentration
Solid Particles (Total)	Any activity/ plant	50 mg/m ³
Nitrogen dioxide (NO₂) or Nitric oxide (NO) or both nitrogen dioxide and nitric oxide, as NO₂ equivalent	Stationary reciprocating internal combustion engines	450 mg/m ³

Note: Concentration level based on reference condition of dry, 273 K, 101.3kPa and 7% O₂ content

Table 4 – Schedule 2 Part 3 – Standards of concentration for (Group C) non-scheduled premises

Air impurity	Activity or plant	Concentration
Solid particles	Any activity/ plant	100 mg/m ³
Smoke	Any activity or plant in connection with which liquid or gaseous fuel is burnt	Ringelmann 1 or 20% opacity

Note: Concentration level based on reference condition of dry, 273 K, 101.3kPa and 7% O₂ content

Part 5, Subdivision 3 of the POEO (Clean Air) Regulation makes exemptions of standards of concentration for plant during *start-up* or *shutdown* periods. The *start-up* or *shutdown* periods are defined by the regulation as below:

- “*Start-up period – that is, while the plant is being brought up to normal operation following a period of inactivity.*”
- “*Shutdown period – that is, while the plant is being taken out of service from normal operation to inactivity.*”

2.1.3 The EPA Approved Methods 2022

As the Regulatory Authority designated by the POEO Act 1997, EPA NSW has published the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (August 2022), hereafter referred to as the Approved Methods, to provide detailed statutory methods in modelling and assessing air pollutants in the state of NSW. The Approved Methods provides methods and impact assessment criteria for assessing emissions of air pollutants from stationary sources in NSW.

2.1.4 Impact assessment criteria

Section 7.1 of the Approved Methods outlines the air pollutant impact assessment criteria. Predicted pollutant concentrations (including background air quality concentrations) for a proposal should where possible comply with these criteria. If they do not, further mitigation may be required.

Table 5 presents the relevant air quality impact assessment criteria applicable for the Proposal’s standby generators.

The Approved Methods set standards for various averaging periods, including annual averages. As the generators are to be used for standby purposes only and would only run for a short period or intermittently, the assessment has focussed on short-term averaging periods only. Pollutant criteria with averaging periods of longer than 24 hours have therefore been excluded from this assessment.

Table 5 – Applicable Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Maximum Concentration, $\mu\text{g}/\text{m}^3$
Carbon Monoxide (CO)	15 minutes	100,000
	1 hour	30,000
	8-hour	10,000
Sulfur dioxide (SO ₂)	1 hour	215
	24-hour	57
Nitrogen dioxide (NO ₂)	1 hour	164
Benzene (representative of VOCs)	1 hour	29
Polycyclic Aromatic Hydrocarbon (PAH)	1 hour	0.4
Particulate matter with aerodynamic diameter of 10 microns or less (PM₁₀)	24 hours	50
Particulate matter with aerodynamic diameter of 2.5 microns or less (PM_{2.5})	24 hours	25

The impact assessment criteria in Table 5 must be applied at the nearest existing or likely future off-site sensitive receiver (with the exceptions of benzene and PAH, which are to be applied at and beyond the site boundary), compared against both the incremental impact from modelled sources as well as the cumulative impact, including background pollutant concentrations.

3. Identification of potential emissions sources

3.1 Construction phase

Construction activities have the potential to generate short-term emissions of particulates, typically associated with uncontrolled or fugitive dust emissions. This is generally experienced by nearby receivers as amenity impacts rather than health-related impacts, however health impacts can be experienced if dust impacts are unmanaged for an extended period of time. Below are construction activities that may be applicable to the Proposal and have the potential for dust generation:

- Activity 1: Site establishment and demolition of existing structures
- Activity 2: Bulk excavation and piling
- Activity 3: Construction of structure and superstructure
- Activity 4: Internal fit-out and installation of building services.

Typical construction equipment with major dust generation used for the Proposal are likely to be:

- Front end loader
- Backhoe
- Excavators
- Vibratory rollers
- Heavy vehicles/trucks

The above-mentioned construction equipment will emit combustion emissions (particularly NO₂, PM₁₀ and PM_{2.5}) to the atmosphere, however given the minor scale of the proposed works, fugitive dust emissions such as PM₁₀ would have the greatest potential for downwind air quality impacts. The assessment of construction dust impact has been discussed in Sections 5.3 and 6.

3.2 Operational phase

The primary source of emissions to air during the operational phase are the standby generators that are included in the Proposal, as an insurance policy, to absolutely guarantee the need for 100% uptime if there was ever a failure of the primary and secondary power supply to the site. The proposal (as a data centre facility) is a mission critical facility that if not able to operate 100% of the time could lead to catastrophic impacts for the society, organizations, and businesses that it serves. The Proposal therefore as a minimum is supplied by dual redundant utility feeds using a 33kV highly reliable power utility supply arrangement. The purpose of these generators is to support the buildings' power requirement for critical IT systems and other site infrastructure in the event of mains power loss or damage of electrical infrastructure on site.

Diesel storage tanks within the Proposal site may have the potential to emit low levels of fugitive emission to air, due to breathing and working losses.

No other emissions to air are to be discharged from the facility. Whilst there are louvres proposed across the southern elevation of the data centre building, these will not discharge emissions to air.

Potential emissions associated with the standby generators as well as on-site diesel storage tanks are discussed throughout this report.

3.2.1 Standby generator

Standby generators arrangement

The Proposal's standby generators will be located indoor, occupying six-floor building, with eight generators per floor. There would be a total of 48 generators within the Proposal site. At this stage, the locations of the generators are indicative, however the locations assessed are expected to be largely consistent with the final developed design. The generator exhaust stacks are channelled along the eastern building façade, discharging vertically at approximately 1m from the top of the building (being at 65m for Building A, and at 60m for Building B).

The masterplan drawing in Figure 2 shows the proposed data centre buildings and the standby generator stack locations.

The diesel generator specification sheets are presented in Appendix B.

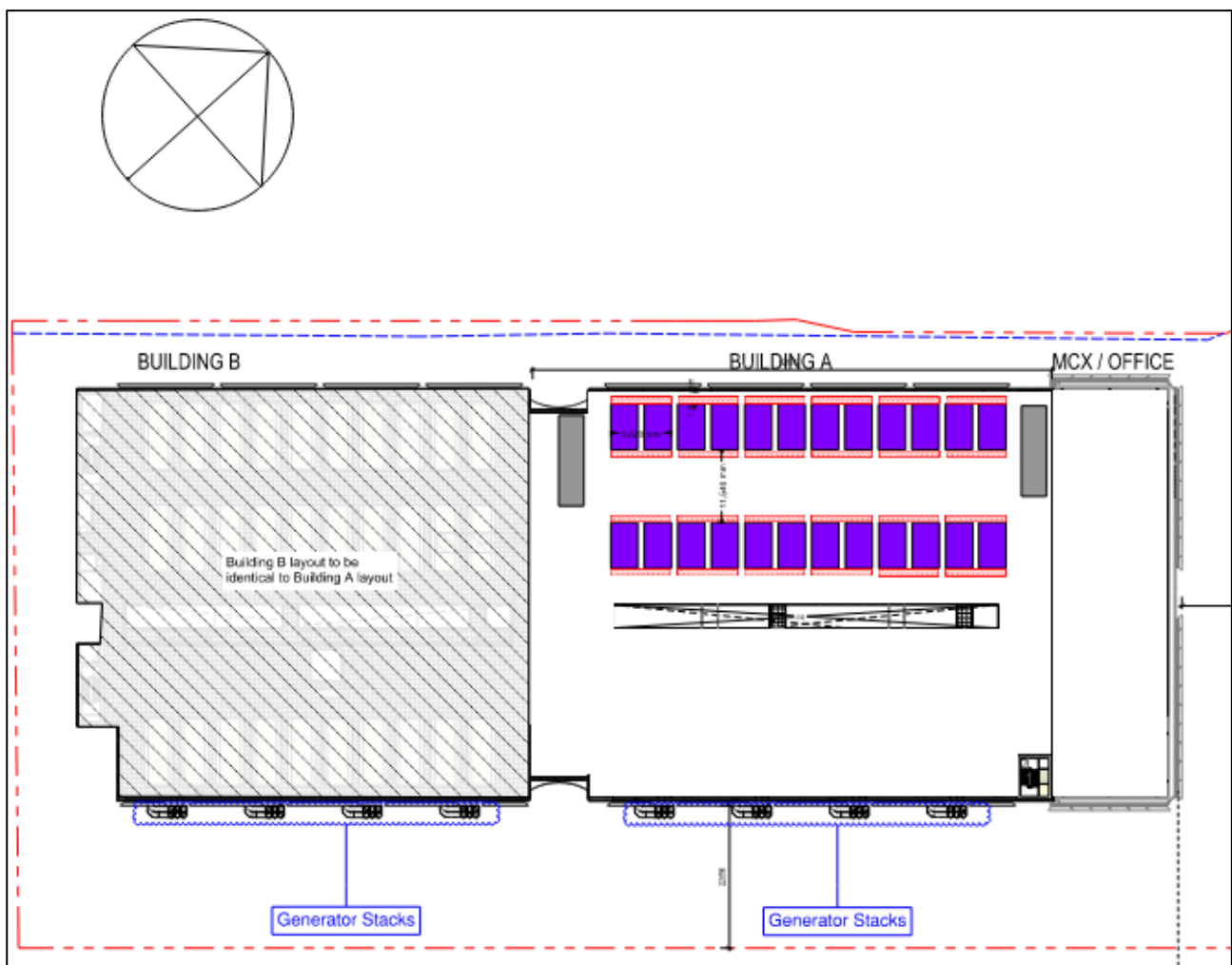


Figure 2 – The Proposal's standby generator stack locations

Grid reliability and likelihood of an event where the standby generators are required to provide backup power generation

In the event of an interruption to mains power from the dual redundant feeds, standby generators will provide power to each building. The S5 facility is designed to operate on the 33kV utility power supply, which has high reliability. The Macquarie Park Sub Transmission substation (132/33kV) is currently being upgraded by Ausgrid, with completion expected in December 2025. New 33kV feeders will be constructed, and it is assumed they will supply the S5 facility. The Macquarie Park Zone Substation is a highly reliable facility,

and the proposed design for the S5 facility will also include a fully redundant 33kV utility power supply to further reduce the likelihood of needing the backup generators. This redundant 33kV supply enhances the reliability of the utility power supply, offering additional security, minimizing downtime, and limiting disruption to only parts of the facility

Further, a review has been undertaken of the electricity supplier Ausgrid *Distribution and Transmission Annual Planning Report Summary* (DTAPR, December 2023)⁴ to understand typical outages for conventional utilities in the wider area surrounding the Proposal. This shows an extremely low power outage occurrence of less than 0.01% in any year for a conventional utility, based on the average unplanned actual system average interruption duration index (SAIDI)⁵ of power outage incident over the past 10 years. Noting Macquarie Park zone substation (132/33kV) supply and the 33kV utility power supply arrangement proposed for the Proposal, both have a much more reliability than conventional utility, it is highly unlikely that the standby generators would ever need to be used in their capacity to provide back-up power generation, and even if they did the likelihood of this happening would be far lower than 0.01% of the year. In fact, Ausgrid have analysed the outage scenarios of other zone substations (132/33kV) in their network such as Homebush, Willoughby, Port Hacking and Alexandria, and stated in writing that there were no customer outages for customers, with similar, redundant supplies, in the last 10 years.

Maintenance routine

For standby generators to be ready to operate should an unexpected interruption to mains power occur, a regular maintenance schedule is required. The proposed standby generator testing schedule is provided in Table 6. It is understood that the testing schedule in Table 6 excludes plant cooldown period considered to be exempted from the POEO (Clean Air) Regulation Standard of Concentrations, as part of the *start-up/shutdown* period exemption (refer to Section 2.1.2).

Maintenance testing of standby generators is anticipated to occur during the daytime period (the period from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm (Sundays and public holidays⁶).

Table 6 – The proposed standby generator maintenance testing regime

Test	Run Time (Minutes)	Cooldown (excluded from Runtime)	No of Gens	Generator Per Test	Number of Test	Total Run Times (Minutes)	Description
Quarter 1	40	10	48	1	1	1920	Operational Run – Tested under 55% minimum load
Quarter 2	40	10	48	1	1	1920	Maintenance Run – Tested under 50% load
Quarter 3	40	10	48	1	1	1920	Operational Run –

⁴ Ausgrid, 2023. *Distribution and Transmission Annual Planning Report Summary*, December 2023.

⁵ The SAIDI is a measure in minutes the average duration of an incident weighted by the number of customers affected by each incident. That is, if 10 customers suffer a 10-minute interruption and there are 100 customers in the region, then this would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then that would be added to the first incident and equal a SAIDI of 2.5 minutes.

⁶ NSW EPA, 2017. Noise Policy for Industry.

Test	Run Time (Minutes)	Cooldown (excluded from Runtime)	No of Gens	Generator Per Test	Number of Test	Total Run Times (Minutes)	Description
							Tested under 55% minimum load
Quarter 4	90	10	48	1	1	4320	Maintenance – Tested under 100% load
Total						10080	168 hours

Based on the proposed maintenance testing schedule in Table 6, there would be up to one generator tested at any given time in either Building A or Building B. Generators will be tested under a load where emissions comply with the Standard of Concentrations requirements for non-scheduled premises under the POEO (Clean Air) Regulations, as discussed in Section 2.1.2, and assessment undertaken in Section 7.3.

The preliminary generator testing schedule in Table 6 shows a proposed cumulative total hours of testing of 168 hours, not more than the 200-hour exemption limit in Schedule 1 Clause 17 of the NSW POEO Act 1997 (refer to Section 2.1.1), as well as Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation 2022 (refer to Section 2.1.2), and therefore generator emissions are exempt from Schedule 2 Part 2 of the Standard of Concentrations in the POEO (Clean Air) Regulation 2022.

Potential impacts

While in use, standby generators produce a range of pollutants including total unburned hydrocarbons (HC), nitrogen oxide (NO_x), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO₂) and volatile organic compounds (VOC). The release of these emissions has the potential to impact local air quality in the surrounding area. Due to the fuel type proposed e.g. diesel, the pollutant of greatest concern in relation to the use of generators is typically NO_x, as NO_x emissions are orders of magnitude greater than for other pollutants.

Emission data for this Proposal has been assessed based on indicative equipment selection as below:

- Building A and B: MTU 20V4000G94LF generator (refer to Appendix B).

All other emission data for the assessed pollutants not provided in the generator specification has been based on emission information provided in Table 43 of the National Pollutant Inventory (NPI 2008)⁷.

3.2.2 Diesel storage tank

Diesel storage tanks will be required at the Proposal site, which also have the potential to emit fugitive emissions to air. Storage and handling will be conducted in full compliance with Australia Standard (AS) 1940: *The storage and handling of flammable and combustible liquids, ensuring adherence to industry standards and environmental best practices*.

There is proposed to be 16 x 100 kL bulk fuel storage tanks to store fuel for the standby generators, that will be located on the ground level of the data centre building.

The two types of emissions from tanks are breathing and working losses. A breathing loss is the expulsion of vapour from a tank through vapour expansion and contraction that result from changes in ambient temperature and barometric pressure. This loss occurs without any liquid level change in the tank. The combined loss from filling and emptying tanks is called the working loss. Evaporation during filling

⁷ National Pollution Inventory (NPI) – *Emission estimation technique manual for Combustion engines*, Version 3.0, June 2008.

operations results from an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure, and vapours are expelled from the tank. Evaporative emissions during the emptying process occur when air, drawn into the tank during liquid removal, becomes saturated with organic vapour and expands, expelling vapour through the vapour relief valve.

4. Existing environment

4.1 Local meteorology

Local meteorology conditions which can affect the dispersal of pollutants in the local area were determined. Meteorological conditions are not monitored at the Proposal site with the nearest Bureau of Meteorology (BoM) meteorological station at Sydney Olympic Park, approximately 7 km south-east of the Proposal site.

To provide site representative meteorological data and all parameters required by the dispersion model, meteorological data was purchased from Lakes Environment based on the WRF prognostic model with 1km grid resolution. The prognostic data was interpolated from nearby forecasted and monitored data. Analysis of meteorological data for the past five years indicated similar meteorological patterns, and therefore the most recent year 2022 was selected for this assessment, and correlated with background air quality data discussed in Section 4.2.

4.1.1 Windrose

Annual average

The annual average wind rose between 1 January 2022 and 31 December 2022 is shown in Figure 3 with wind class frequency distribution in Figure 4. Based on Figure 3 and Figure 4, the following features can be observed:

- Winds are most prevalent from the west-south-west.
- The average wind speed is 3.3 m/s.
- Winds are least prevalent from the south-south-west sector with annual winds of about 3%.
- Light winds (< 0.5 m/s) are more prevalent from the north-west sectors.
- Due to the infrequent occurrence of calm winds (1.9%), meteorological conditions are favourable for dispersion.

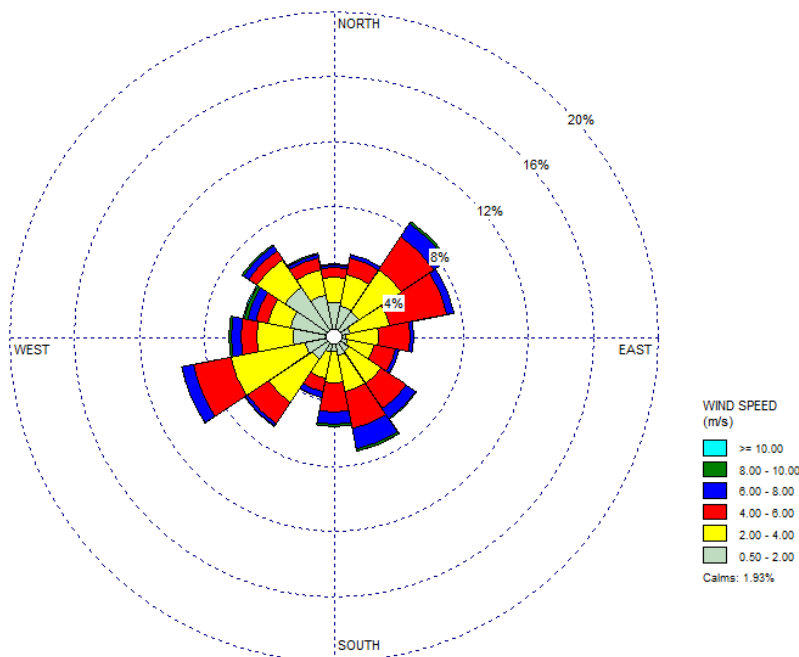


Figure 3 – Wind Rose for 2022 data

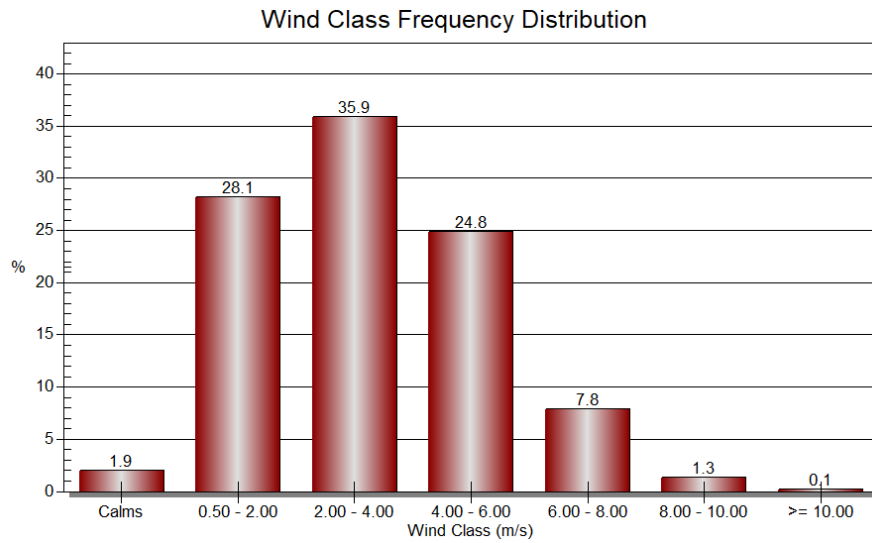
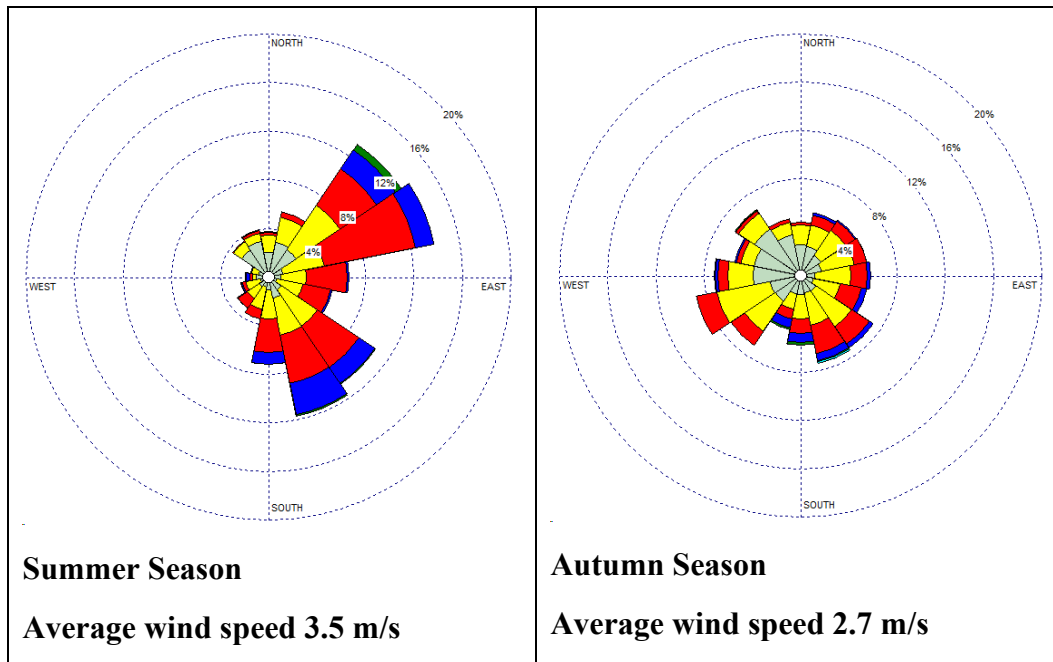


Figure 4 – Wind Class Frequency Distribution for 2022 data

Seasonal variation

The seasonal variation wind roses for 2022 are shown in Figure 5. Based on Figure 5, the following features can be observed:

- Prevailing wind direction varies seasonally. Autumn and winter seasons are dominated by west-south-west prevailing wind, whereas summer and spring seasons are dominated by north-east prevailing wind.
- The incident of light wind is greatest in autumn season with a north-west direction.



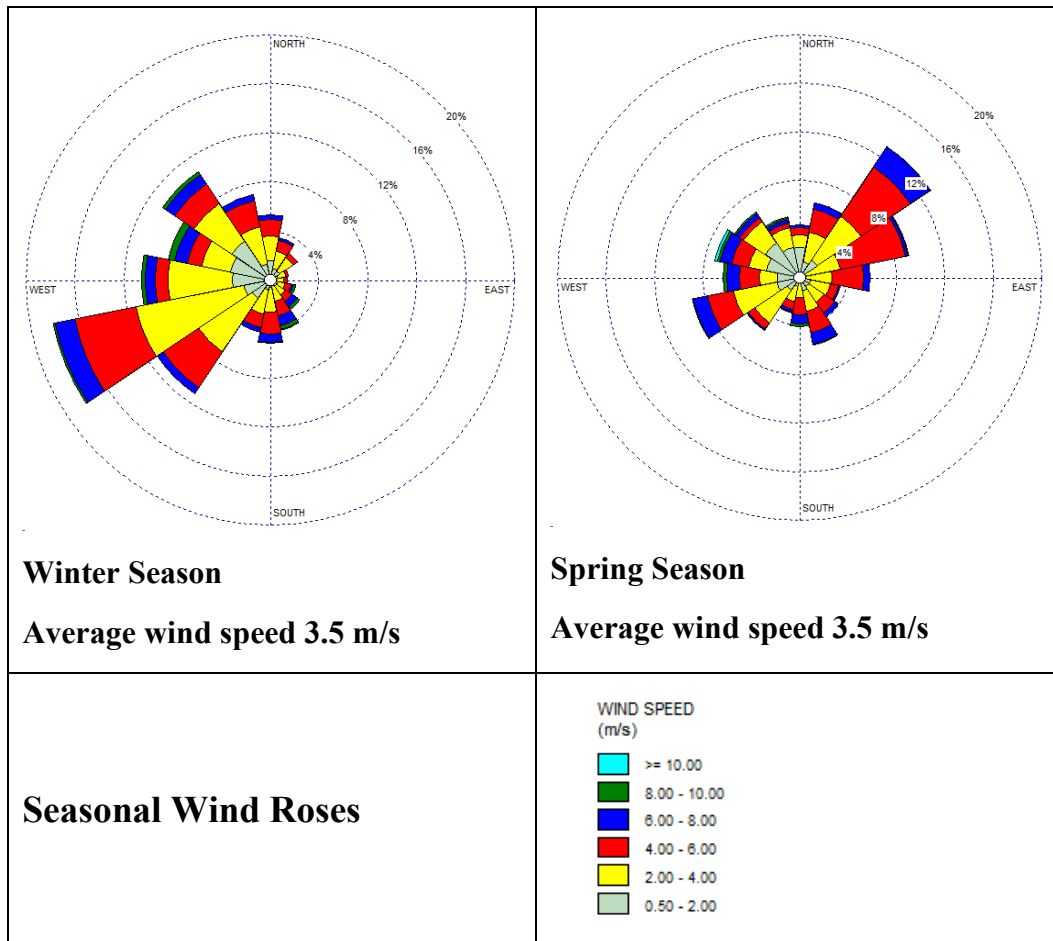


Figure 5 – Seasonal Wind Rose for 2022

4.2 Background air quality

Existing background air quality refers to the concentration of relevant substances that are already present in the environment from various sources that may include industrial processes, commercial and domestic activities, traffic and natural sources.

The Approved Methods requires at least one year of continuous background air quality data to be used, contemporaneous with meteorological data. Upon review of recent background air quality data, 2022 was selected due to the absence of extreme events that would have influenced monitored pollutant concentrations, such as major bush fires in late 2019 and early 2020, as well as lockdowns associated with the COVID-19 pandemic, reducing transport and some industrial emissions, in early to mid-2020 and late 2021. Background air quality data from these years is considered to be atypical. On this basis, background air quality data for 2022 is considered to be most representative of typical conditions and has been adopted for this assessment.

The assessment of air quality impacts can be undertaken using two options of background air quality data:

- Background Option 1: Using the maximum background concentration of the pollutant being assessed for each relevant averaging period, or
- Background Option 2: Using the addition of the corresponding measured background concentration to each individual dispersion model prediction (e.g. add the first hourly average dispersion model prediction to the first hourly average background concentration).

For air emissions from diesel combustion engines, typically NO₂ and particulate matter are considered to be the major pollutants of concern, over and above other pollutants such as CO, SO₂, PAH and VOC that are also generated by standby generators in smaller quantities. Background method Option 2 has been used to

predict ground level concentrations of NO₂, CO, SO₂ and particulate matter. Background monitoring of VOCs and PAHs is not undertaken in NSW, however concentrations of these pollutants are expected to be minimal (refer to Section 4.2.4).

4.2.1 Air quality monitoring station

The nearest air quality monitoring station (AQMS) is located at Macquarie Park, approximately 2.5 km to the north-west of the Proposal site. The AQMS at Macquarie Park records all relevant pollutants, such as NO₂, SO₂, CO, O₃, PM₁₀ and PM_{2.5}. The AQMS at Macquarie Park is located within a relatively close proximity to commercial premises, which is similar to the Proposal site. Background air quality at Macquarie Park is considered representative and has been adopted for this assessment.

Table 7 shows the relevant data capture for each of relevant pollutants from Macquarie Park AQMS year 2022. It can be seen that the data capture for all of the relevant pollutants are greater than 93% and are therefore acceptable.

Table 7 – 2022 background air quality data capture (Macquarie Park)

Pollutant	Data Capture
CO	94.0%
SO ₂	97.5%
NO ₂	93.7%
O ₃	95.0%
PM ₁₀	96.5%
PM _{2.5}	97.6%

4.2.2 Hourly missing data interpolation

The assessment of particulate matter as well as the OLM method (conversion of NO_x to NO₂ - refer to Section 5.4.3) requires hourly background data for CO, O₃, SO₂, NO₂, PM₁₀ and PM_{2.5}. Although data capture was above 93% for each of these pollutants, any missing data periods were interpolated using the following methodology:

- Where less than six consecutive hours of missing data occurred, the nearest valid data point was used (i.e. the first three missing hours would be replaced with the nearest preceding value, and the last three missing values would be replaced with the following value).
- Where there was more than six consecutive hours of missing data, an average hourly value was used for the corresponding hour of missing data (i.e. the average value for a given hour of day was calculated, using the entire existing dataset, and subsequently used to fill the respective missing hour of day).

4.2.3 Adopted background air quality

The maximum monitored air quality concentrations for 2022 are summarised in Table 8, which show that the background concentrations are all below the NSW Approved Methods' impact assessment criteria. The hourly data are presented in Figure 6 to Figure 11 for CO, O₃, NO₂, SO₂, PM₁₀ and PM_{2.5}, which have been used to provide a contemporaneous cumulative assessment.

Table 8 – Maximum monitored air quality concentrations

Pollutant	Averaging Period	Maximum Monitored Concentrations, µg/m ³	Impact Assessment Criteria, µg/m ³
CO	1-hour	2645.0	30,000
	8-hour	805.0	10,000
NO ₂	1-hour	43.2	164

Pollutant	Averaging Period	Maximum Monitored Concentrations, $\mu\text{g}/\text{m}^3$	Impact Assessment Criteria, $\mu\text{g}/\text{m}^3$
SO ₂	1-hour	81.2	286
	24-hour	8.5	57
O ₃	1-hour	139.2	n/a
PM ₁₀	24-hour	25.9	50
PM _{2.5}	24-hour	17.6	25

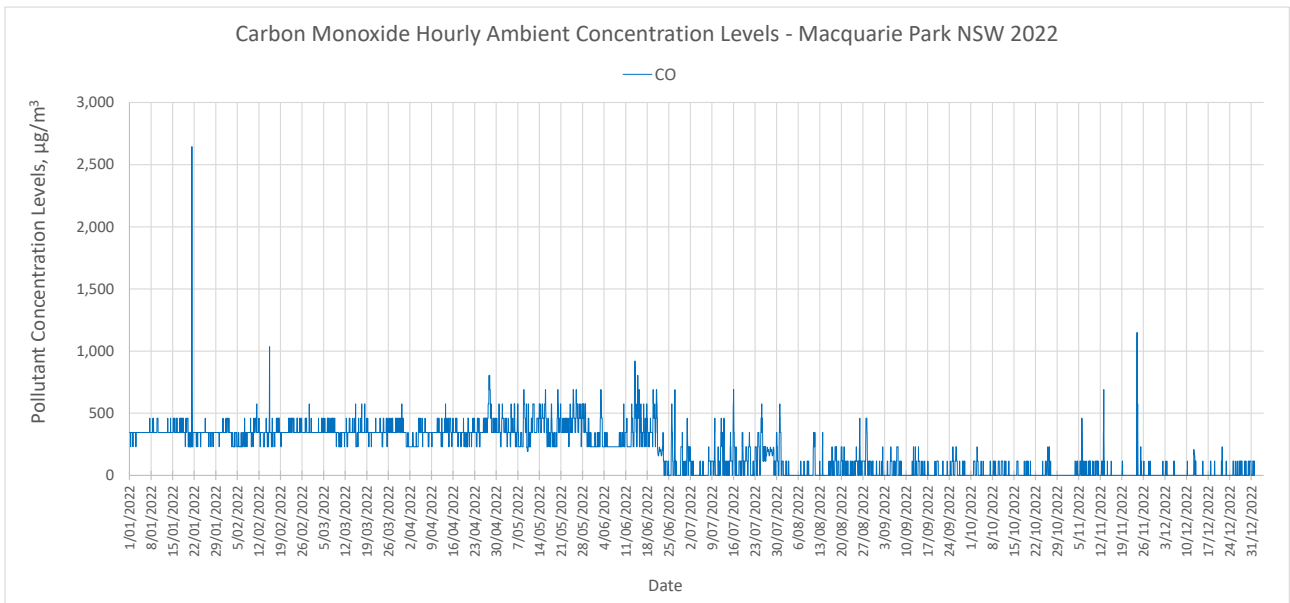


Figure 6 – Adopted hourly carbon monoxide background air quality chart

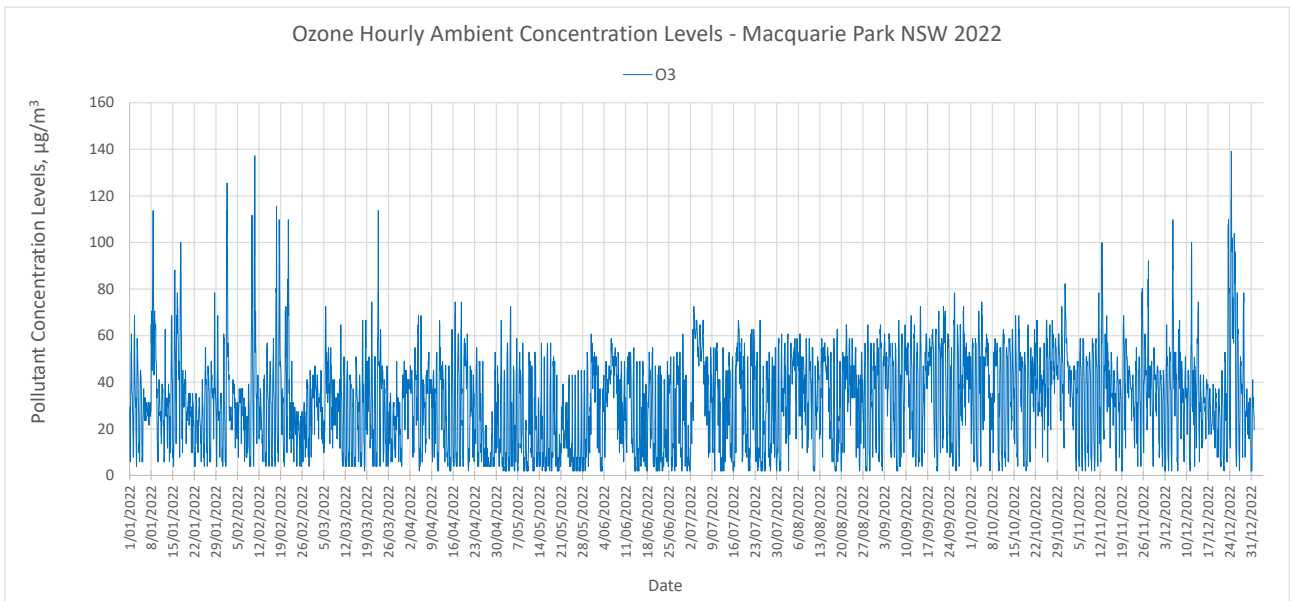


Figure 7 – Adopted hourly ozone background air quality chart

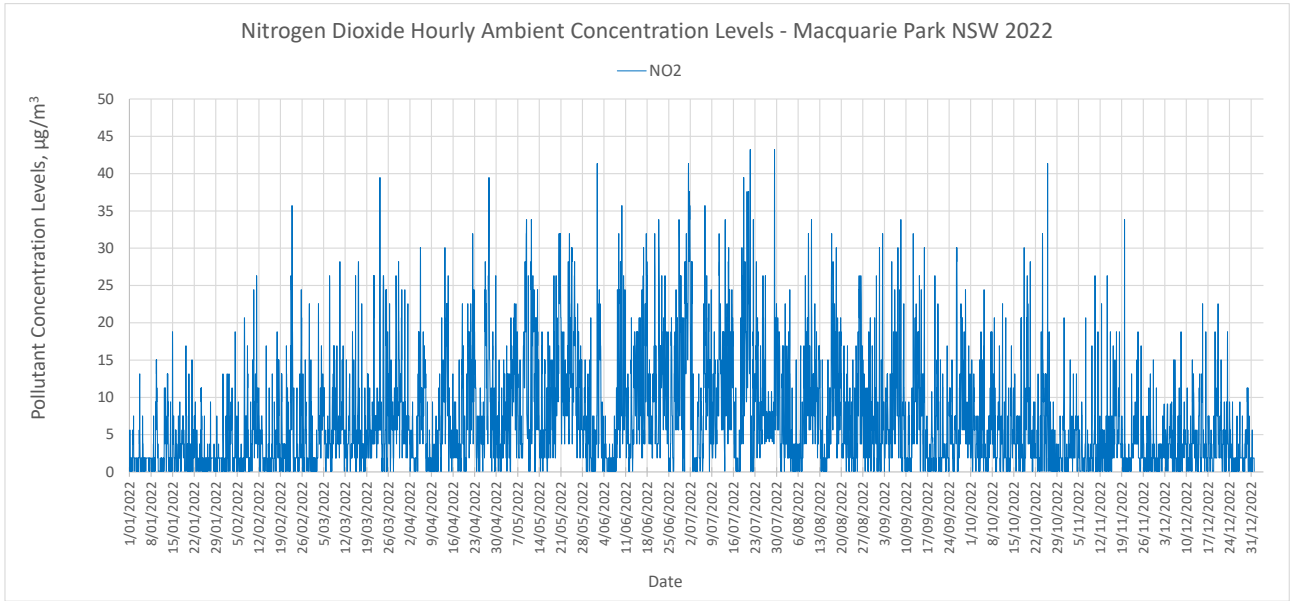


Figure 8 – Adopted hourly nitrogen dioxide background air quality chart

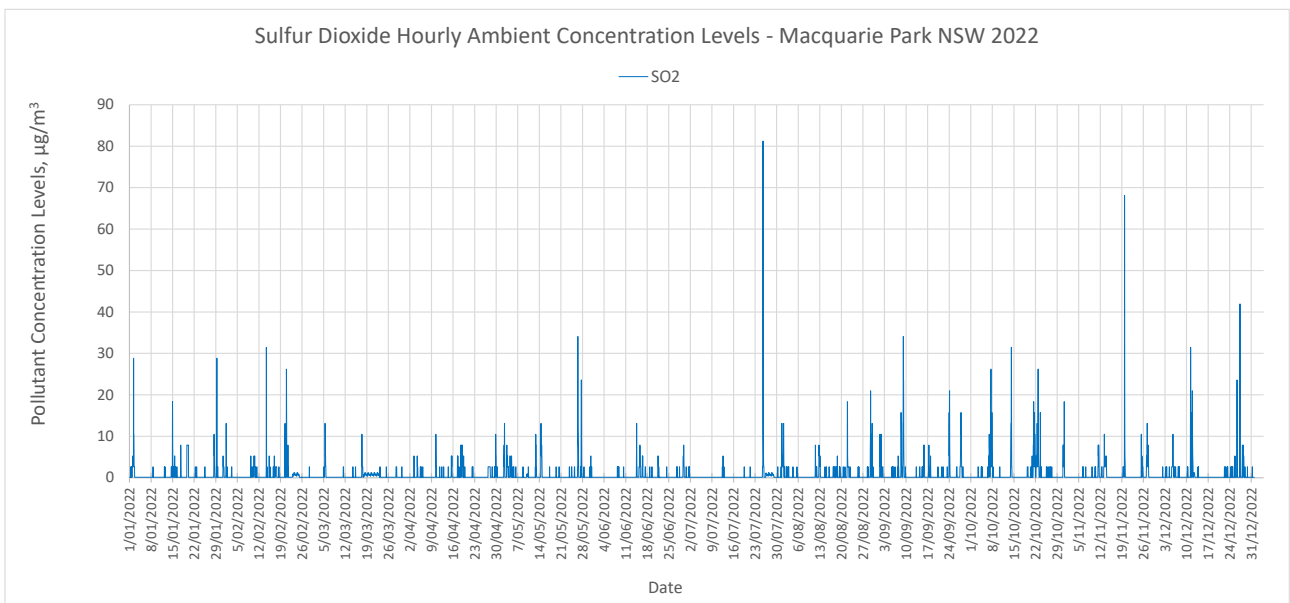


Figure 9 – Adopted hourly sulfur dioxide background air quality chart

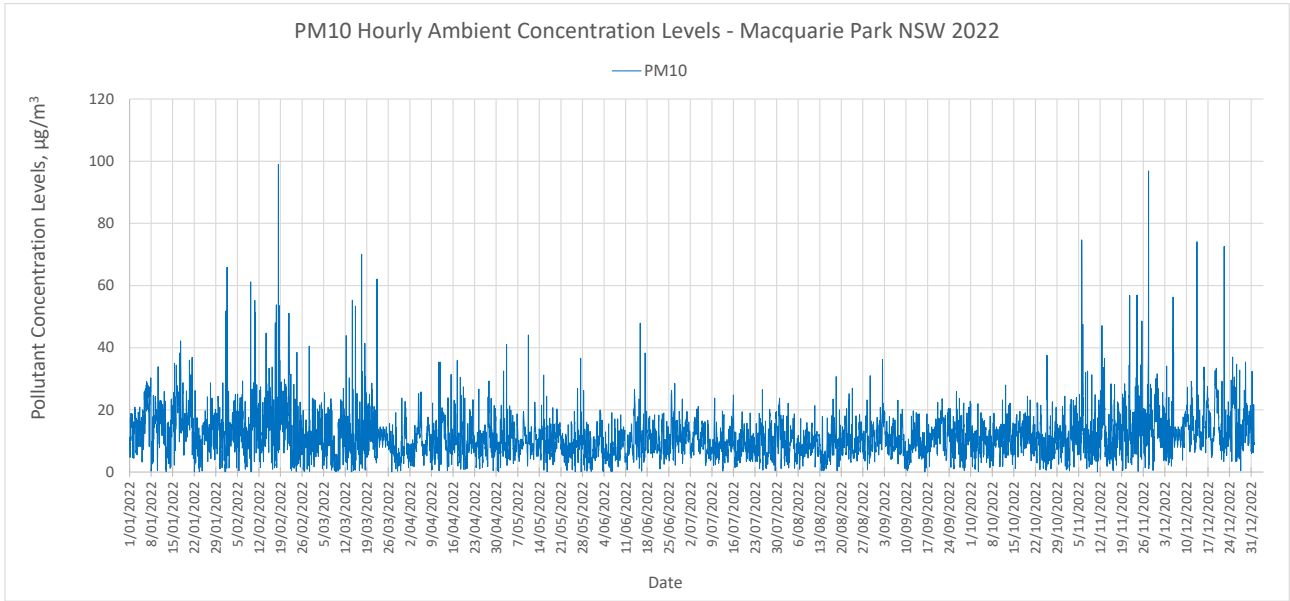


Figure 10 – Adopted hourly PM₁₀ background air quality chart

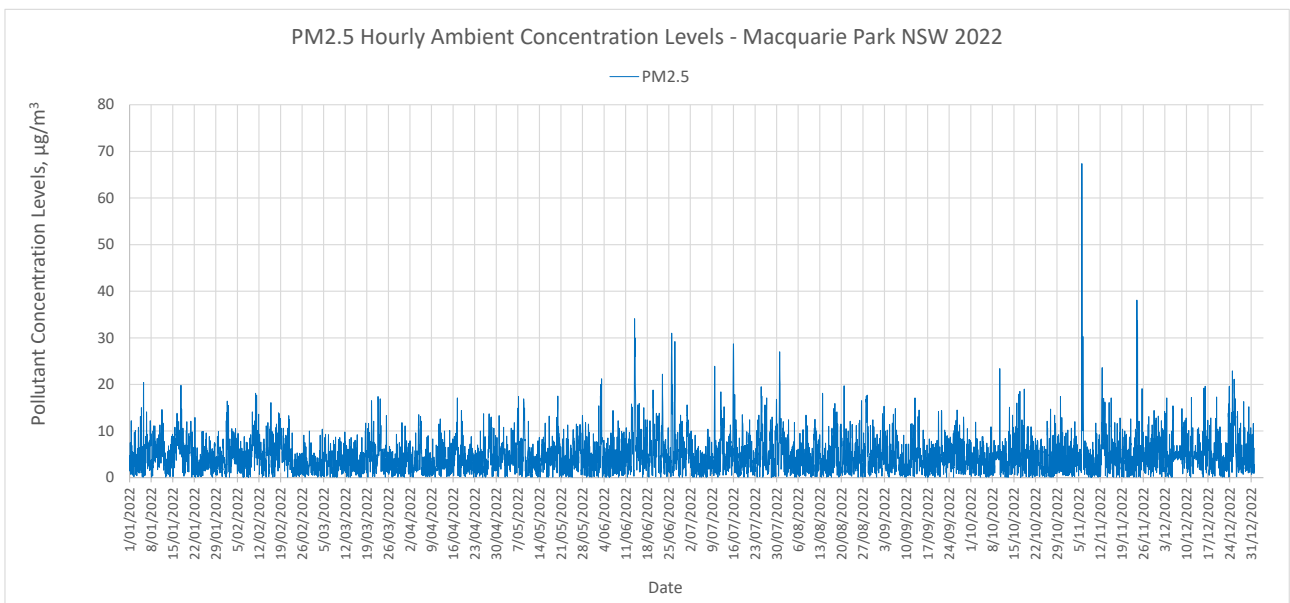


Figure 11 – Adopted hourly PM_{2.5} background air quality chart

Note that in the absence of publicly available 15-minute local background concentration for the assessed CO pollutant, 1-hour background concentrations have been used. Whilst it is noted that 15-minute background concentration may be higher than the 1-hour concentration, given the predicted cumulative assessment for CO is generally well below the impact assessment criteria (refer to Section 7.1.3), it is unlikely that adopting the 15-minute background concentrations would result in a significant increase to cause exceedances for the 15-minute impact assessment criteria for this pollutant.

4.2.4 Air quality contribution from nearby industries

National Pollutant Inventory

A review of the National Pollutant Inventory (NPI) database was undertaken to identify any industrial sites with potentially significant emissions to air within the proximity of the Proposal site.

There are several NPI registered industries surrounding the Proposal site, as well as in the wider Ryde area, located mainly to the south-east of the Proposal site (refer to Figure 12). The contribution of these sources to local air quality in the area is expected to be captured in the air quality monitoring data from the AQMS at Macquarie Park discussed above.

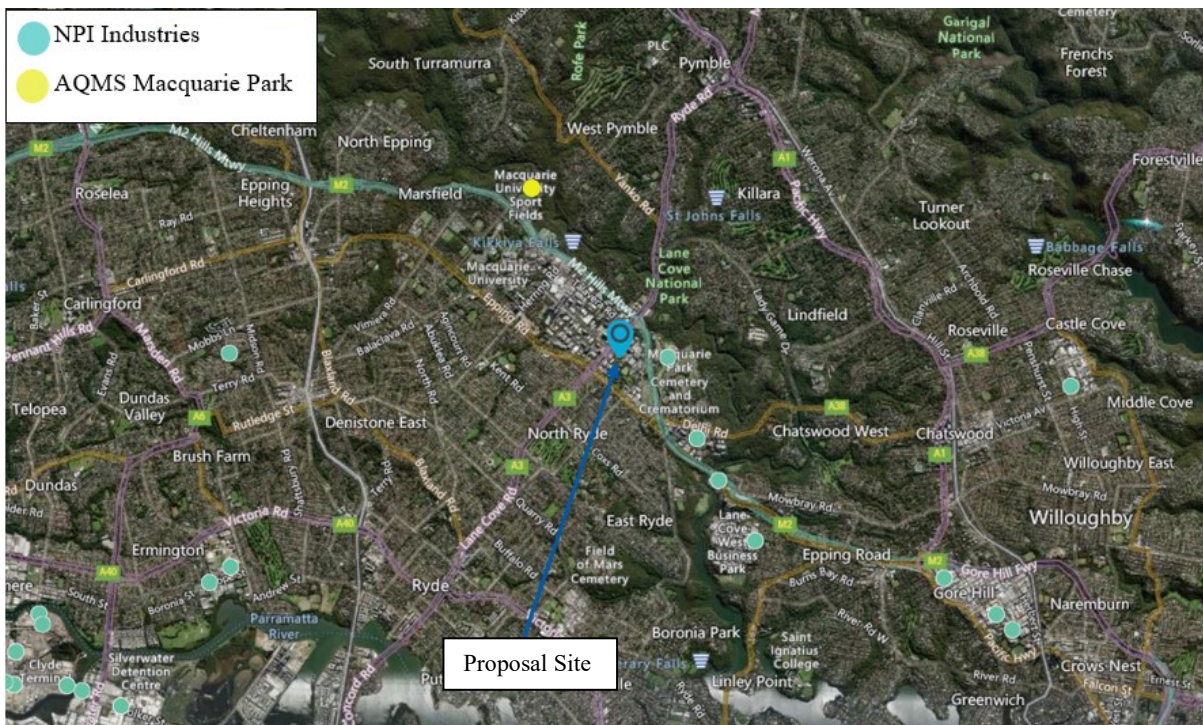


Figure 12 – Map locations of surrounding NPI listed industries

Emissions from nearby data centre facilities

The proposal is situated in an area with nearby data centres, which would also contribute emissions to the local air shed periodically, during routine maintenance and in the unlikely event of a loss of mains power. Investigation has been conducted to determine any other data centres within 250 m from the proposal site boundary. There are two data centres (NEXTDC owned and operated S1 and S2) located approximately 200 metres to the north-east and north-west of the proposal site, respectively (refer to Figure 13). These facilities have the potential to contribute to cumulative impacts alongside the proposal on local air quality. While these facilities are owned and operated by NEXTDC, they are designed as diverse sites with their own operational tolerances to run independently of the proposal. As per the proposal, the generators are installed as back up emergency generators with the intent to host the facilities power generation during emergency loss of mains power. Each of the three facilities (S1, S2 and S5) has multiple electrical supplies installed or proposed with the highest level of resilience for mains power whereby in the event of a single failure, the full site load can be maintained through other feeder(s) to prevent running the generators long term. The diverse and redundant power feeds arrangement of the three facilities are further discussed below:

- S1 data centre:
 - Site is fed via 3 x 11kV supplies from Ausgrid's upstream 11kV Macquarie Park substation via underground reticulation between the substation and the site. Each supply is laid via individual conduit routes.

- Ausgrid’s substation arrangement is such that 4 Transformer / feeders can be switched to support the 3 supplies to the S1 site.
- The upstream Ausgrid substation includes +1 redundancy in the transformers and feeder arrangement to be able to minimise any outage duration (and hence generator run) in the event of transformer and associated feeder failure.
- S2 data centre:
 - Site is fed from 2 x 33kV supplies from Ausgrid’s purpose built 33kV Macquarie Park substation via underground reticulation between the substation and the site. Each supply is laid via individual conduit routes.
 - Utility transformers and switchgears are configured in a redundant manner such that in the event of an incoming failure or transformer failure at the substation, Ausgrid can switch to restore power through the redundant infrastructure.
 - Each of the two Ausgrid supplies to the site are designed such that they can support the full design capacity load of the site without the other.
 - The upstream Ausgrid substation is arranged such that any single failure of transformer, feeder or switchgear within the substation would mean that the site load can be maintained online after switching activities (minimised outage conditions) via the alternate feeder to the site.
 - On site NEXTDC HV infrastructure also allows for the failure of any one of the incoming HV supplies, NEXTDC’s Facility Management team can also switch to the alternate feeder to also minimise outage duration (and hence generator run).
- S5 data centre:
 - The S5 facility is designed to operate on the 33kV utility power supply, which has high reliability. The Macquarie Park Sub Transmission substation (132/33kV) is currently being upgraded by Ausgrid, with completion expected in December 2025. New 33kV feeders will be constructed, and it is assumed they will supply the S5 facility. The Macquarie Park Zone Substation is a highly reliable facility, and the proposed design for the S5 facility will also include a fully redundant 33kV utility power supply to further reduce the likelihood of needing the backup generators. This redundant 33kV supply enhances the reliability of the utility power supply, offering additional security, minimizing downtime, and limiting disruption to only parts of the facility
 - The transformers and switchgears at Ausgrid Macquarie Park Sub-transmission Substation are configured with N-1 redundancy. In the event of any single transformer, feeder or switchgear failure, Ausgrid can perform remote switching to reconfigure the network and restore the power supply, minimizing outages .
 - The two Ausgrid feeders supplying the Building A or Building B are designed to have the full redundancy, ensuring that either feeder can supply the building load without the other. In the event of a feeder failure, NEXTDC’s Facility Management team can perform switching on site to restore the power supply , minimizing outage duration and generator runtime.

The above Ausgrid 132/11kV Macquarie Park Zone Substation and 132/33kV Macquarie Park Sub-transmission Substation are supplied via a 132kV ring network designed with N-1 redundancy. In the event of a 132kV feeder failure, Ausgrid can perform remote switching to reconfigure the network and restore the power supply, minimizing outage duration and generator runtime.

Ausgrid analysed the outage scenarios of other sub-transmission substation (STS) in their network such as Homebush, Willoughby, Port Hacking and Alexandria. There were no 33kV busbar outages in these STS in the last 10 years. There were a few 33kV feeder outages at the commissioning stage with no outages to customers due to N-1 supply.



Figure 13 – Map locations of nearby NEXTDC S1 and S2 facilities

The likelihood of cumulative air quality impacts at nearby sensitive receivers from the Proposal and these facilities in close proximity is discussed in Section 7.4.

4.3 Sensitive receivers

Nearby sensitive receivers were identified through a review of aerial mapping.

Air quality sensitive receivers are defined under the Approved Methods as:

“A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors.”

The area around the Proposal is primarily commercially zoned. Commercial, active recreational, childcare, hotel and educational receivers are within the immediate vicinity. The nearest existing residential receivers are located to the south-west of the site, across Epping Road.

The area around the site is undergoing development; the proposed known approved and proposed future developments around the site have been reviewed and future receivers have been incorporated into the sensitive receivers assessed as identified in Table 9, Table 10 and Figure 14. The future receivers include a hotel to the west of the site and residential buildings to the north of the site.

Table 9 presents potentially affected residential receivers identified within the nearby vicinity, while Table 10 presents the nearby non-residential sensitive receivers. These receivers are presented in Figure 14. Discrete sensitive receivers have been selected to represent the nearest receivers in all directions to assist in assessing air quality impacts from the Proposal.

The modelled discrete receivers’ locations are discussed in Section 5.2.5.

In addition, the assessment has considered a 1000 m x 1000 m grid to assess the location of predicted maximum ground level concentration that may not coincide with a sensitive receiver (refer to Section 5.2.2).

Table 9 – Identified nearby residential sensitive receivers

Receiver ID (Figure 14)	Address	Description	No of Floors	Building Height (m)	Approximate Distance from Proposal site boundary (m)
R1	370A Lane Cove Rd, North Ryde	Existing residential dwellings representative of residential properties to the south west of the site	1	5	218
R2	1-9 Allengrove Cr, North Ryde	Existing residential dwellings representative of residential properties to the south west of the site	3	12	168
R3	35 Waterloo Rd, Macquarie Park	Future residential dwellings representative of residential properties to the north of the site	16	65	90
R4	16 Allengrove Crescent, North Ryde	Existing residential dwellings representative of residential properties to the south west of the site	2	7.5 ^a	325
R5	34 Lorna Avenue, North Ryde	Existing individual residential dwelling along Lorna Avenue	2	9 ^a	420
R6	114 Epping Road, North Ryde	Existing residential dwellings representative of residential properties to the south west of the site	1	3.5 ^a	200
R7	10 Cam Street, North Ryde	Existing individual residential dwelling representative of residential properties to the south of the site	2	6.5 ^a	345
R8	12 Paul Street, North Ryde	Existing individual residential dwelling representative of residential properties to the west of the site	2	7.5 ^a	345

Note:

a. Building not included in the model due to insignificant building wake effect.

Table 10 – Identified nearby non-residential sensitive receivers

Receiver ID (Figure 14)	Name	Address	No of Floors	Building Height (m)	Approximate Distance from Proposal site boundary (m)
Commercial					
C1	Aristocrat Technologies	2 Drake Ave, Macquarie Park	8	34	55
C2	Macquarie Veterinary Hospital & Doggy Daycare	384 Lane Cove Rd, Macquarie Park	1	4	41
C3	n/a	386 Lane Cove Rd, Macquarie Park	1	6	41
C4	Scientia Medical Heart Clinic	376 Lane Cove Rd, North Ryde	1	6	174

Receiver ID (Figure 14)	Name	Address	No of Floors	Building Height (m)	Approximate Distance from Proposal site boundary (m)
C5	Hyundai	394 Lane Cove Rd, Macquarie Park	7	33	40
C6	Rohde & Schwarz Building	75 Epping Rd, Macquarie Park	2	9	Adjacent to site
C7	KIA Motors	67 Epping Rd, Macquarie Park	5	27	60
C8	Foxtel Building	5 Thomas Holt Dr, North Ryde	8	30	Adjacent to site
C9	n/a	33 Waterloo Rd, Macquarie Park	2	11	26
C10	ORIX	27 Waterloo Rd, Macquarie Park	6	28	90
C11	Magenta Technologies	3 Thomas Holt Dr, North Ryde	9	37	43
C12	Philips	61-65 Epping Rd, Macquarie Park	6	27	159
Childcare Centre					
CC1	Rise and Early Running Childcare	61-65 Epping Rd, Macquarie Park	First floor of the 5-storey building	27	159
CC2	Nought to Five Early Childhood Centre	16 Waterloo Rd, Macquarie Park	1	4	335
Active Recreation					
AR1 ^a	Ryde Hunters Hill District Hockey Club	18 Waterloo Rd, Macquarie Park	1	n/a	281
Hotel					
H1	The Quest apartment	71 Epping Rd, Macquarie Park	6	21	75
H2(future) ^b	n/a	388 Lane Cove Road, Macquarie Park	19	65	38
<p>Note:</p> <ol style="list-style-type: none"> This recreational area is located a considerable distance from the proposal site, and risk of pollutant impact concentrations at this location could be determined by assessing closer identified sensitive receivers, as well as receiver C2. Therefore, this receiver location has not been assessed further. Receiver currently under construction at time of this assessment, refer to LDA 2015/0484. 					



Figure 14 – Assessed nearby sensitive receiver locations

5. Methodology

This Chapter outlines the methodology used to define the existing environment and undertake the assessment of potential impacts of the Proposal on air quality, including definition of the study area used as the basis of the assessment.

The overall approach to the air quality impact assessment comprises:

- A review of the existing air quality conditions at, and in the vicinity of, the Proposal site;
- A review of the potential changes in air quality arising from the construction and operation of the Proposal; and
- Formulation of mitigation measures, where appropriate, to ensure any adverse effects from air pollutants are minimised.

5.1 Study area

The study area for the air quality assessment extends approximately 375m from the Proposal site in all directions. The assessment has focussed on those modelled discrete sensitive receivers closest to the Proposal site, however a modelling domain of 1000 m x 1000 m has been included to ensure that the area of maximum impact is understood and the impact for the surrounding area can be shown.

5.2 Dispersion modelling

The assessment of potential construction dust (PM₁₀) impacts and the operation of standby generator emissions from the Proposal was undertaken using AERMOD. AERMOD has been accepted in Australia for use in a variety of regulatory applications⁸, and is estimated to be the most widely used dispersion model internationally⁹. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain, such as the case of the Proposal.

The terrain within the immediate vicinity of the Proposal site is relatively flat and air quality impacts from the standby generators are considered to be relatively localised due to the stack characteristics (including plume depression due to building downwash), together with sensitive receivers being located near to the Proposal. Due to these factors, change in plume directions due to meteorological or terrain variations are not considered to be critical, compared to 'line-of-sight' plume impaction. On balance, AERMOD has been selected, rather than other common dispersion model such as CALPUFF that simulates the effects of time and space varying conditions.

The NSW Approved Methods Section 4 requires one-year of site-specific meteorological data or site-representative meteorological data, in the absence of site-specific data, to be used for AERMOD dispersion modelling. The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data. AERMET requires surface and upper air meteorological data input. The meteorological data used in this assessment is for the period of 1st January 2022 – 31st December 2022 (refer to Section 4.1).

AERMOD was configured as per Table 11 to assess the impact of construction dust as well as generator emissions from the Proposal.

⁸ Pacific Environment, 2016. *Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment*: Department of Infrastructure and Regional Development, ID. 9417F. Doc no. AQU-NSW-001-9417E. Rev. R2. Sydney, NSW.

⁹ Pacific Environment, 2016. *Energy from Waste Facility – Air Quality and Greenhouse Gas Assessment*: The Next Generation, ID. 21292C. Doc no. AQU-NS-001-21292C. Rev. 5. Eastern Creek, NSW.

Table 11 – General inputs for AERMOD dispersion modelling

Parameter	Input
Meteorological Data	2022 – refer to meteorological data section below
Terrain Topography	Obtained using Shuttle Radar Topography Mission (SRTM3/SRTM1) data from AERMAP at a range of 100 metres.
Grid Domain Size	1000 metres x 1000 metres
Grid Spacing	5 metres

The 100th percentile¹⁰ was modelled to determine the average concentration impact for comparison against the impact assessment criteria.

5.2.1 Prediction of less than 1-hour average concentrations

In the absence of NSW specific guidelines to convert modelled hourly concentrations to a less than 1-hour averaging period, reference was made to the EPA Victoria Draft Publication 1551 – *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* (October 2013), which provides conversion from hourly average concentrations to 3-minute average concentration. This has been used in this case to convert hourly average concentrations to 15-minute average concentrations.

$$c(t) = c(t_0) (t_0/t)^{0.2}$$

Where:

(*t*) is the averaging time (minutes) of interest, and

(*t*₀) is the averaging time consistent with the dispersion rates (60 minutes in this case).

¹⁰ The maximum possible concentrations over the relevant averaging period taking into account emission source and meteorological data.

5.2.2 Model extent

The model was run for a grid (1000 m x 1000 m) with 5 m spacing, at a level of the most impacted receiver height. This covers all potentially impacted nearby sensitive land uses. The extent of the model is shown in Figure 15.



Figure 15 – AERMOD model extent

5.2.3 Terrain effects

The Proposal site is located in slightly sloped terrain. The gradient is sloping down from south to north direction with a difference in elevation of approximately 10 m, reducing from approximately 70 m to 60 m AHD.

Terrain data was sourced from NASA's Shuttle Radar Topography Mission (SRTM) Data (3 arc second (~30m) resolution) and processed within AERMAP to create the necessary input files for the model. The topography of the local area used in the model is shown in Figure 16.



Figure 16 – Modelled AERMOD topography

5.2.4 Building wake effects

Buildings can have a significant effect on dispersion. If buildings are close to a stack, the plume can be entrained in the cavity zone downwind of the building. The ratio of the stack height vs. the building height can affect the magnitude of building downwash, such that if the stack extends well above the roof of the building, the downwash effect is expected to be insignificant. The Approved Methods notes that “*A point source is wake-affected if stack height is less than or equal to 2.5 times the height of buildings located within a distance of $5L$ (where L is the lesser of the height or width of the building) from each release point.*”

For the operational phase (generator emissions) assessment, Building A and B both have a height of 65 m and 60m above ground respectively, including any roof-top mechanical plant, equipment and screening.

The generators are proposed to be located within the main buildings, with stack discharge height at 1m above the building height.

Based on the above, the standby generator stacks are considered wake-affected sources. As a result, the building downwash effect can lead to higher ground concentrations than would be expected in the absence of buildings, therefore buildings that may contribute to a downwash effect have been included in the dispersion model.

The surrounding buildings were also modelled as deemed relevant in potentially creating wake effect on the dispersion. The surrounding building heights have been identified based on visual desktop inspection (Google©), with 3 m floor-to-floor height assumed. The identified surrounding building heights are shown in Figure 17.

The modelled 3-D view of the above surrounding buildings is shown in Figure 18.

Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) uses heights and corner locations of buildings in the vicinity of the stack release to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to ten-degree intervals. AERMOD then calculates the impact of these buildings on plume dispersion and consequently on ground level concentrations. Although a simplified building geometry is used, it should provide a reasonable indication of how the building may disrupt wind flow in the immediate vicinity.

It should be noted that Building A and B (the Proposal buildings, shown as the taller buildings within the centre of Figure 18) have not been included in the construction phase assessment, however all other buildings shown in Figure 18 were included.



Figure 17 – Modelled surrounding building heights

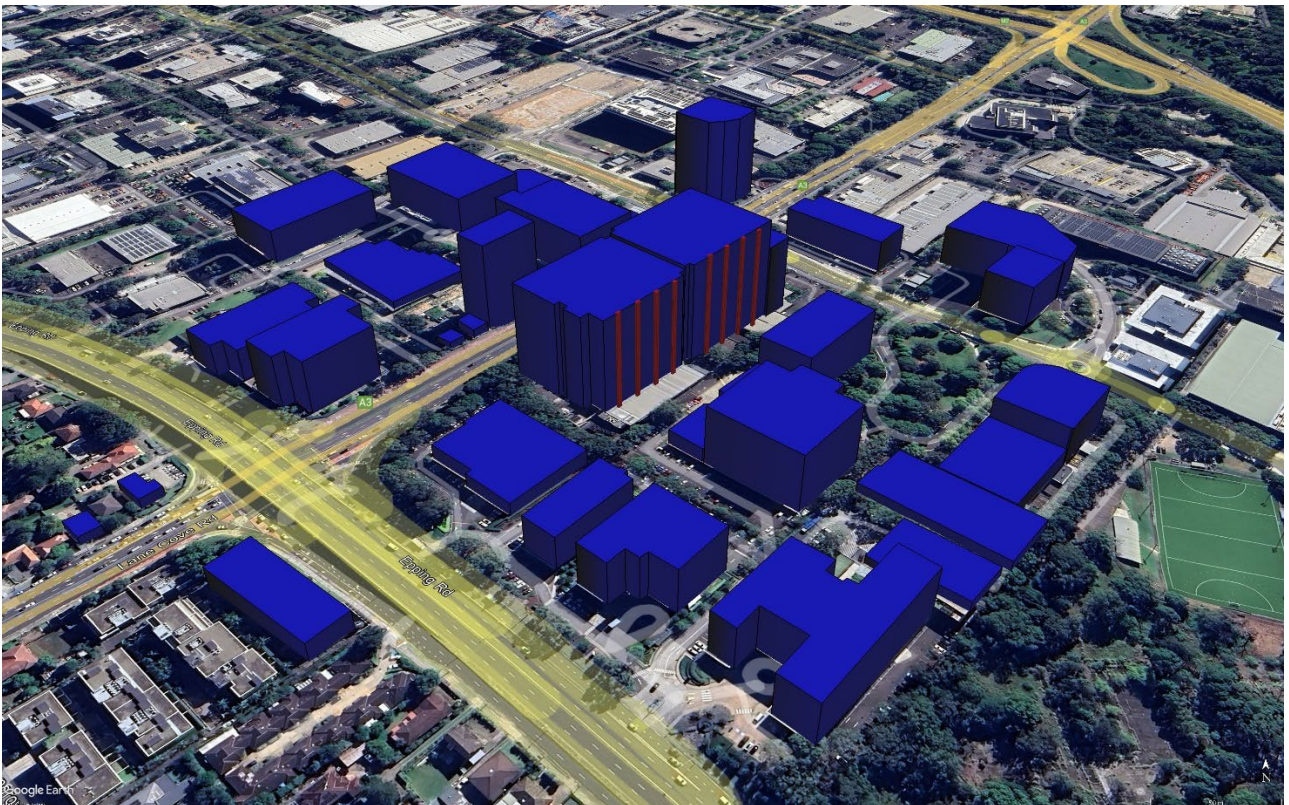


Figure 18 – Modelled AERMOD surrounding buildings (stacks marked in red)

5.2.5 Modelled discrete receivers

The assessed discrete sensitive receivers have been modelled at the nearby sensitive receivers' (Section 4.3) building facade, closest to the proposal site and as well as at individual floors, with 4 m floor-to-floor height being assumed (e.g. for a 10 storey building height, there will be 10 receiver points vertically at a particular discrete receiver location). This is aimed to capture the potential air quality impact at the elevated receivers, which is expected to be greater than at ground level, due to the elevated stack sources.

There was a total of 182 discrete sensitive receiver points modelled.

5.3 Construction phase

Potential dust impacts from the Proposal's construction activity can be estimated by modelling likely dust-generating sources and equipment across the construction work area.

The construction stages proposed in Section 3.1 were reviewed and it was determined that the earthwork activity during the excavation and piling activities (Activity 2) is anticipated to be the largest source of potential dust impacts. A list of construction equipment to be used for the Proposal with the potential for major dust-related sources have been identified based on experience from similar construction projects, provided by the Client.

5.3.1 Assessment scenarios

A construction dust impact assessment was undertaken using AERMOD based on the worst-case construction activity for dust-related impact during the construction phase, which is bulk excavation and piling activities. The dust emissions from the construction activity were modelled assuming that earthworks would occur across the entirety of the project area, with equipment operating every day, to ensure that the day of worst-case dispersion meteorology is covered by the modelling. Heavy construction work is assumed to occur during standard hours of work (from 7:00 am to 6:00 pm (11 hours) Monday to Friday, and from 8:00 am to 1:00 pm (5 hours) Saturday).

5.3.2 Modelling configuration

The following modelling settings were assumed:

- Meteorological date: 1 January 2022 to 31 December 2022.
- Output type: PM₁₀ dust concentration with dry depletion.
- Backhoe (on overburden) area source initial vertical spread: 2m.
- Excavator (on overburden) area source initial vertical spread: 2m.
- Front end loader (on overburden) area source initial vertical spread: 2m.
- Vibratory roller area source initial vertical spread: 1m.
- Haul truck (on unpaved roads) area source initial vertical spread: 3m.
- Light vehicle (on unpaved roads) area source initial vertical spread: 2m.
- Wind erosion area source initial vertical spread: 1.5m.
- 24-hour averaging period.

In modelling the construction dust emissions from the Proposal in AERMOD, the source release geometry was taken to be area sources representing various construction activities at ground level. The adopted area sources representing each of the construction activities are based on the overall Proposal site boundary, which is approximately 22,540m².

5.3.3 Modelling assumptions

The following assumptions were made in modelling the construction dust impact from the construction activity:

- The predicted dust emissions from the construction components were modelled for a worst case scenario (meteorological conditions coincident with construction activity).
- It is assumed that construction work for the Proposal would be undertaken during the recommended standard hours of work from 7:00 am to 6:00 pm (11 hours) Monday to Friday and from 8:00 am to 1:00 pm (5 hours) Saturday. Thus, the heavy construction equipment would operate during these hours only, while the wind erosion from the site has the potential to occur during all hours.
- **Backhoe** – A total of one backhoe was assumed to be in operation across the construction area. The backhoe was assumed to have a loading productivity rate of 20 tonnes per hour.
- **Excavator (30t)** – A total of two excavators were assumed to be in operation across the construction area. The excavators were assumed to have loading productivity rate of 60 tonnes per hour.
- **Front-end loader** – A total of two front-end loaders were assumed to be in operation across the construction area. The front-end loaders were assumed to have a loading productivity rate of 30 tonnes per hour.
- **Vibrating rollers** – The PM₁₀ emission factor for vibrating rollers was assumed to be the average between the heavy and light vehicles emission factors (i.e. 0.785 kg/VKT). A total of one roller/compactor was assumed to be in operation across the construction area. The rollers/compactors have the operating condition of 5 trips per hour over the total length of the modelled construction area.
- **Haul truck** on unpaved road – A total of three haul trucks were assumed to do two circuits of the total length of the modelled construction area per day.
- **Light vehicle** on unpaved road – A total of two light vehicles (4WD) were assumed to do two trips over the total length of the modelled construction area per day.

5.3.4 Emission rates

An emission inventory for the identified dust sources have been determined based upon wind erosion and mechanically induced sources of dust. The relevant emissions rates were characterised using emissions factors published in the National Pollutant Inventory – Emission Factor Estimation Techniques Manual (NPI-EETM) for Mining V 3.1, January 2012.

Table 12 summarises the NPI-EETM emission factors, and the calculated emission rates for each item of equipment proposed during construction. The default emission factors addressed by NPI assumed only for dry conditions, however dust control methods and emission reduction techniques were proposed, as those indicated in the NPI-EETM Section 5.3, and have been applied to these sources.

Note that some mitigation measures have been allowed for haul trucks, light vehicles and vibrating rollers as these would be operating on material where water is applied as part of the process. Additional mitigation measures have been allowed for earthmoving equipment, such as backhoe, excavator and loader to minimise construction dust impact, given the close proximity of the nearby sensitive receivers.

Table 12 – Summary of dust emission inventory

Operation/Activity	PM ₁₀ Default Emission Factor	Unit	Control Method	Total Number of Equipment	PM ₁₀ Emission Rate (kg/hr)
Backhoe (on overburden)	0.012	kg/t	50 per cent water spray to keep soil wet	1	0.12
Excavator (30t) (on overburden)	0.012	kg/t	80 per cent water spray to keep soil wet	2	0.29

Operation/Activity	PM ₁₀ Default Emission Factor	Unit	Control Method	Total Number of Equipment	PM ₁₀ Emission Rate (kg/hr)
Unpaved haul roads - trucks (>20t)	1.25	kg/VKT	75 per cent for level 2 watering (>2 L/m ² /hr)	3	0.11
Unpaved haul roads - light vehicles	0.33	kg/VKT	50 per cent for level 1 watering (>2 L/m ² /hr)	2	0.01
Front end loader (23t) (on overburden)	0.012	kg/t	50 per cent water spray to keep soil wet	2	0.18
Roller (vibratory)	0.785 ^a	kg/VKT	75 per cent for level 1 watering (>2 L/m ² /hr)	1	0.21

Note:

a. The PM₁₀ emission factor for vibrating rollers and compactors is assumed to be the average between the heavy and light vehicles emission factors (i.e. 0.785 kg/VKT).

The PM₁₀ dust emission resulting from wind erosion was modelled based on the NPI Default Emission Factor of 0.2 kg/ha/hr over an exposed surface area source. Then using the identified meteorological data in Section 4.1, the dust emission rates of the wind erosion has been adjusted for each hour based on the cubed¹¹ of the wind speed relation of that hour of the meteorological data, to determine the hourly wind strength, which were then used to calculate the emission rates for each wind speed category to be used for the modelling assessment. The rates per wind speed category are shown in Table 13, which have been corrected to account for 50% water sprays on soil mitigation measures.

Table 13 – Dust emission rates for wind erosion

Wind Category (m/s)	PM ₁₀ Emission Rates (kg/hr/m ²)
0 > 1.54	0.0000001
1.55 > 3.09	0.0000009
3.10 > 5.14	0.0000045
5.15 > 8.23	0.0000160
8.24 > 10.80	0.0000461
> 10.80	0.0000990

5.4 Operational phase

The impact assessment for the operation of standby generators has been carried out using dispersion modelling to predict pollutant concentrations at nearby sensitive receivers, as well as over a larger grid domain.

5.4.1 Assessment scenarios

The following assessment scenarios were undertaken to determine the potential impact under the anticipated operational conditions of the standby generators:

- **Scenario 1:** A highly unlikely worst-case scenario (peak emission scenario) where all generators are in operation (100% load) to provide back-up power generation under a full loss of mains power scenario (refer to Section 3.2).

¹¹ Agriculture Victoria, 2020. *Shelterbelts for Control of Wind Erosion*. Department of Energy, Environment and Climate Action. (<https://agriculture.vic.gov.au/farm-management/soil/erosion/shelterbelts-for-control-of-wind-erosion#:~:text=The%20quantity%20of%20soil%20carried,significant%20reduction%20in%20soil%20erosion.>)

- **Scenario 2:** Realistic operations during regular or routine maintenance testing of the Proposal, where individual generator testing is undertaken, it has been assumed that up to one (1) generator would be tested at any given hour during the daytime, as described in Section 3.2.

5.4.2 Emission sources

Generator stack parameters

Modelled stack parameters were developed for this assessment using information provided by the Client and manufacturer specifications for the indicative generator equipment selection. Stack design parameters per generator are summarised in Table 14.

The manufacturer's specification datasheet is provided in Appendix B, which provides the emissions for particulate matter, NO_x, CO and hydrocarbon.

Particulate matter

The emission data taken from the manufacturer's specification datasheet refers only to "particulate matter", with no reference to the size of the particulate matter. Table 43 of the National Pollutant Inventory (NPI 2008)¹² shows that emission factors of PM₁₀ and PM_{2.5} from large stationary diesel engines are the same. On this basis, it has been assumed that the particulate matter emission rate applies to both PM₁₀ and PM_{2.5} size components.

Volatile Organic Compounds

Hydrocarbons are organic compounds composed primarily of carbon and hydrogen atoms. Many of these compounds are volatile, which can easily vaporise into the atmosphere at normal atmospheric conditions (room temperature and atmospheric pressure) and are typically referred to as volatile organic compounds (VOCs). The proportion of VOCs within the hydrocarbon emission has not been provided in the generator's specification datasheet in Appendix B. Therefore, it is assumed that 100% of the hydrocarbon emission from the generator would be VOCs, which is expected to provide a level of conservatism.

For internal combustion engines, VOCs are often associated with primary toxic air pollutants such as benzene, ethylbenzene, toluene and xylene (BTEX). Among these pollutants, benzene is one of the major components within VOCs discharged from a diesel combustion engine. In this case, compliance with Benzene would typically result in compliance with all other VOC pollutants. The proportion of benzene or all other pollutants has not been provided in the manufacturer's specification datasheet. Reference to the NPI 2008 has therefore been made to approximate Benzene emission concentration from the Proposal's diesel generator, as a proportion relative to the total VOCs.

Stack Characteristics and Emission Inventory

The generator exhaust stack characteristics and the associated emission inventory are summarised in Table 14.

¹² National Pollution Inventory (NPI) – *Emission estimation technique manual for Combustion engines*, Version 3.0, June 2008.

Table 14 – Standby generator stack design parameters and emission inventory

Stack Parameter	MTU 20V4000G94LF				
	100% Load	75% Load	50% Load	25% Load	10% Load
Number of generators	48				
Stack Discharge Height above ground level (m)	66m (Building A) or 61 m (Building B)				
Exit internal diameter (mm)	600				
Actual discharge rates (m ³ /s) ^c	11.9				
Exit temperature (°C)	482				
Calculated exit velocity (m/s)	42.1				
CO emission (g/s)	0.505	0.462	0.891	0.664	0.512
SO ₂ emission (g/s) ^b	0.093	0.074	0.054	0.035	0.016
NO _x emission (g/s)	7.882	5.318	2.861	1.518	1.582
Benzene emission (g/s)	0.000827	0.000758	0.000735	0.000758	0.001922
PAH emission (g/s) ^a	0.0000000433	0.0000000343	0.0000000253	0.0000000164	0.0000000074
PM emission (PM ₁₀ and PM _{2.5}) (g/s)	0.028	0.032	0.067	0.061	0.018
Stack location coordinates	Refer to Appendix C.				
<p>Note:</p> <ul style="list-style-type: none"> a. The PAH emission is based on emission factor from Table 43 of the NPI Emission Technique Manual for Combustion Engines and generator's fuel consumption specification. b. Emission values were estimated with reference from the NPI 2008. c. Constant flow rate under different engine loads has been assumed, in the absence of detailed information. 					

5.4.3 NO_x to NO₂ conversion

The air quality model predicts concentrations of nitrogen oxides which is a mixture of NO₂ and nitric oxide (NO). Both gases react in the atmosphere, particularly with ozone. In general, the nitrogen oxides are mainly emitted as nitric oxide and this converts to NO₂ in the atmosphere. The Approved Methods impact assessment criteria have been set for NO₂, as this is the pollutant most impactful to human health, and therefore it is important that an appropriate conversion rate is used to calculate NO₂ from modelled NO_x concentrations.

For this assessment, a photochemical conversion for short-term concentrations (i.e. hourly average) from NO_x to NO₂ were determined in accordance with the US EPA's Ozone Limiting Method¹³ (OLM), as per Section 8.1.2 of the Approved Methods.

OLM assumes NO conversion to NO₂ by reaction with ambient ozone. The reaction is assumed to be instantaneous and irreversible and can be applied on an hourly basis. Several studies have been undertaken to evaluate the accuracy of the OLM method, and show that OLM has a tendency to overpredict the NO₂/NO_x ratios^{14, 15}, which adds a level of conservatism to the assessment.

The OLM equation for calculating NO₂ is provided below:

$$NO_2 (total) = [ISR \times NO_x (predict)] + Minimum[\{(1 - ISR) \times NO_x (predict)\} \text{ or } \{(46/48) \times O_3 (bckgnd)\}] + NO_2 (bckgnd)$$

Where,

ISR = In-stack NO₂/NO_x ratio

The OLM assumes a default 10% of the NO_x was initially NO₂ upon release, equating to an in-stack NO₂/NO_x ratio of 0.1. This ISR is generally appropriate for combustion sources¹⁶. On this basis, the simplified OLM equation is:

$$NO_2 (total) = [0.1 \times NO_x (predict)] + Minimum[\{0.9 \times NO_x (predict)\} \text{ or } \{(46/48) \times O_3 (bckgnd)\}] + NO_2 (bckgnd)$$

The adopted NO₂ and ozone background concentrations for the OLM method are detailed in Sections 4.2.3.

5.4.4 Cumulative impacts

As discussed in Section 4.2.4, standby generator emissions from nearby NEXTDC S1 and S2 data centres may have the potential to result in cumulative air quality impacts alongside the Proposal site. However, the resilience of the power supply to each of the three facilities (S1, S2 and S5) means that the operation of emergency backup generators in parallel at all three facilities due to a power outage is an unrealistic scenario. Operationally, having visibility of the maintenance schedule of all three facilities enables NEXTDC to manage generator maintenance separately across the three sites to ensure generator operation for maintenance purposes is minimised in parallel.

While dispersion modelling is the most robust method for assessing cumulative impacts, its application in this case would be difficult due to the intermittent and sporadic nature of emissions from data centres, which may only emit pollutants for brief periods each year. Given these constraints, a qualitative approach of

¹³ Cole, H. S., & Summerhays, J. E. (1979). *A Review of Techniques Available for Estimating Short-Term NO₂ concentrations*. *J. Air Poll. Cont. Assoc.*, 29:8, 812-817. doi:10.1080/00022470.1979.10470866.

¹⁴ Hendrick, E., Tino, V., Hanna, S., & Egan, B. (2013). *Evaluation of NO₂ predictions by the plume volume molar ratio method (PVMRM) and ozone limiting method (OLM) in AERMOD using new field observations*. *J. Air & Waste Mgt. Assoc.*, 844-854. doi:10.1080/10962247.2013.798599

¹⁵ Podrez, M. (2015). *An update to the ambient ratio method for 1-h NO₂ air quality standards dispersion modelling*. *Atm. Env.*, 163-170.

¹⁶ AGL (2019). *Newcastle Power Station – Air Quality Impact Assessment*. Project No.: 0468623/AQIA/R4. Version 7.0. Revision R4. 30 October 2019.

cumulative impact has been conducted, considering the following factors to evaluate the potential risk of impact.

- The probability of potential simultaneous failure of multiple feeders.
- The probability of potential simultaneous maintenance testing at multiple facilities.
- The frequency of common wind direction whereby potential cumulative impact at receiver(s) located within the common 1-hour average wind vectors.

Probability of emergency (power outage) scenario

The probability of power outage affecting multiple feeders simultaneously could be estimated as a product of the average unplanned actual SAIDI of power outage incident for each feeder – refer to the equation below.

$$P(A \cap B) = P(A) \times P(B)$$

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

Where:

$P(A \cap B)$ = Probability of power outage at facility A and facility B occurring simultaneously in a given year

$P(A)$ = Probability of power outage at facility A occurring in a given year

$P(B)$ = Probability of power outage at facility B occurring in a given year

SAIDI = System average interruption duration index

Note that in the case where both data centre facilities are connected to a common feeder, the probability will be the common SAIDI.

Probability of realistic worst-case maintenance testing scenario

The probability of simultaneous routine maintenance testing from multiple facilities could be estimated as a product of the probability of the testing plans from those facilities – refer to the equation below.

$$(A \cap B) = P(A) \times P(B)$$

$$(A \cap B) = \left(\frac{n_A}{h_A} \right) \times \left(\frac{n_B}{h_B} \right)$$

Where:

$P(A \cap B)$ = Probability of maintenance testing at facility A and facility B occurring simultaneously in a given year

$P(A)$ = Probability of routine maintenance testing at facility A occurring in a given year

$P(B)$ = Probability of routine maintenance testing at facility B occurring in a given year

n = Number of testing hours in a given year

h = Number of available testing hour in a given year. For instance, if the testing period is proposed during 7am to 6pm (Monday to Saturday) and 8 am to 6 pm (Sundays), then $h = 3963$

Wind frequency

Cumulative impacts may arise when emissions from multiple facilities are transported to a shared sensitive receptor due to specific wind patterns over a given averaging period. Given the short operational duration of the generators, the 1-hour average wind vectors that direct emissions from both facilities to the common receiver are most relevant and should be determined. To estimate the overall likelihood of cumulative impact, the wind vector frequency statistics leading to such impacts would be multiplied by the probabilities of the relevant scenarios.

5.4.5 Diesel storage tank emissions

Bulk fuel tanks are not considered to be a significant source of emission to air, however an estimation of the annual total emissions (breathing and working losses) from bulk fuel tanks can be obtained using the United States Environmental Protection Agency (US EPA) TANKS application¹⁷. Some assumptions were used for the emissions estimation, as the diesel tank design is not fully finalised:

- Shell length = 12.2 m.
- Shell width = 2.4 m.
- Shell height = 3.7 m.
- Maximum liquid height = 3.5 m.
- Shell colour = white.

The results of the US EPA TANKS application are discussed in Section 7.5.

¹⁷ <https://tanks.app.cloud.gov/tank-data>

6. Assessment of potential construction impacts

The construction dust (PM₁₀) impact concentrations at the modelled discrete receivers have been predicted. The predicted highest 100th percentile 24-hour average PM₁₀ concentrations are summarised in Table 15.

The predicted cumulative Ground Level Concentrations (GLCs) of construction dust (PM₁₀) across the modelled domain are shown as a contour plot in Figure 19.

The results show that the cumulative PM₁₀ concentrations (i.e. inclusive of background concentrations) are predicted to meet the impact assessment criterion of 50 µg/m³ at all assessed sensitive receivers at ground level. As the most dust-generating construction activities (e.g. Earthworks) will happen at ground level, the largest impact to receivers is also at ground level. There are no exceedances of the impact assessment criteria at any elevated receivers modelled during the construction phase.

The highest predicted PM₁₀ ground level concentration (GLC) is located at the adjacent commercial receiver ID C6 (Rhode & Schwarz) at ground level, with a GLC of 49 µg/m³, which is marginally below the impact assessment criteria. It is to note that this predicted concentration represents the highest possible concentrations during construction, with all dust-generated construction equipment operating concurrently, and coinciding with worst-case meteorological conditions. As the impact assessment criteria are met at the assessed nearby receivers, the dust impact risk during construction is considered to be low with appropriate mitigation measures in place.

It is to note that the predicted concentrations in Table 15 considered the inclusion of preliminary mitigation measures discussed in Section 5.3.4. These mitigation measures are as follows:

- Backhoe, unpaved roads for haul trucks and light vehicle: 50 per cent water spray to keep soil wet.
- Excavator, loader and roller: 75 to 80 per cent water spray to keep soil wet.
- Wind erosion: 50 per cent water spray on soil across the construction boundary.

The above preliminary mitigation measures should be included when implementing a construction environmental management plan (CEMP) for the Proposal, to minimise the construction dust impact risk.

Table 15 – Predicted highest 100th percentile 24-hour PM₁₀ GLCs (Construction Scenario)

Receiver ID	24-Hour PM ₁₀ Concentration (µg/m ³)		Criteria	Comply
	Incremental	Cumulative		
R1	3.6	25.9	50	Yes
R2	4.5	25.9		Yes
R3	4.1	28.1		Yes
R4	1.0	25.9		Yes
H2	12.5	28.3		Yes
H1	14.4	26.3		Yes
C1	10.1	26.8		Yes
C2	13.1	27.0		Yes
C3	13.3	27.4		Yes
C4	4.2	25.9		Yes
C5	13.2	29.8		Yes
C6	35.7	49.4		Yes
C7	8.7	25.9		Yes
C8	25.3	37.2		Yes
C9	35.7	49.4		Yes
C10	4.6	25.9		Yes
C11	10.9	25.9		Yes
CC1	3.3	25.9		Yes
CC2	1.0	25.9		Yes

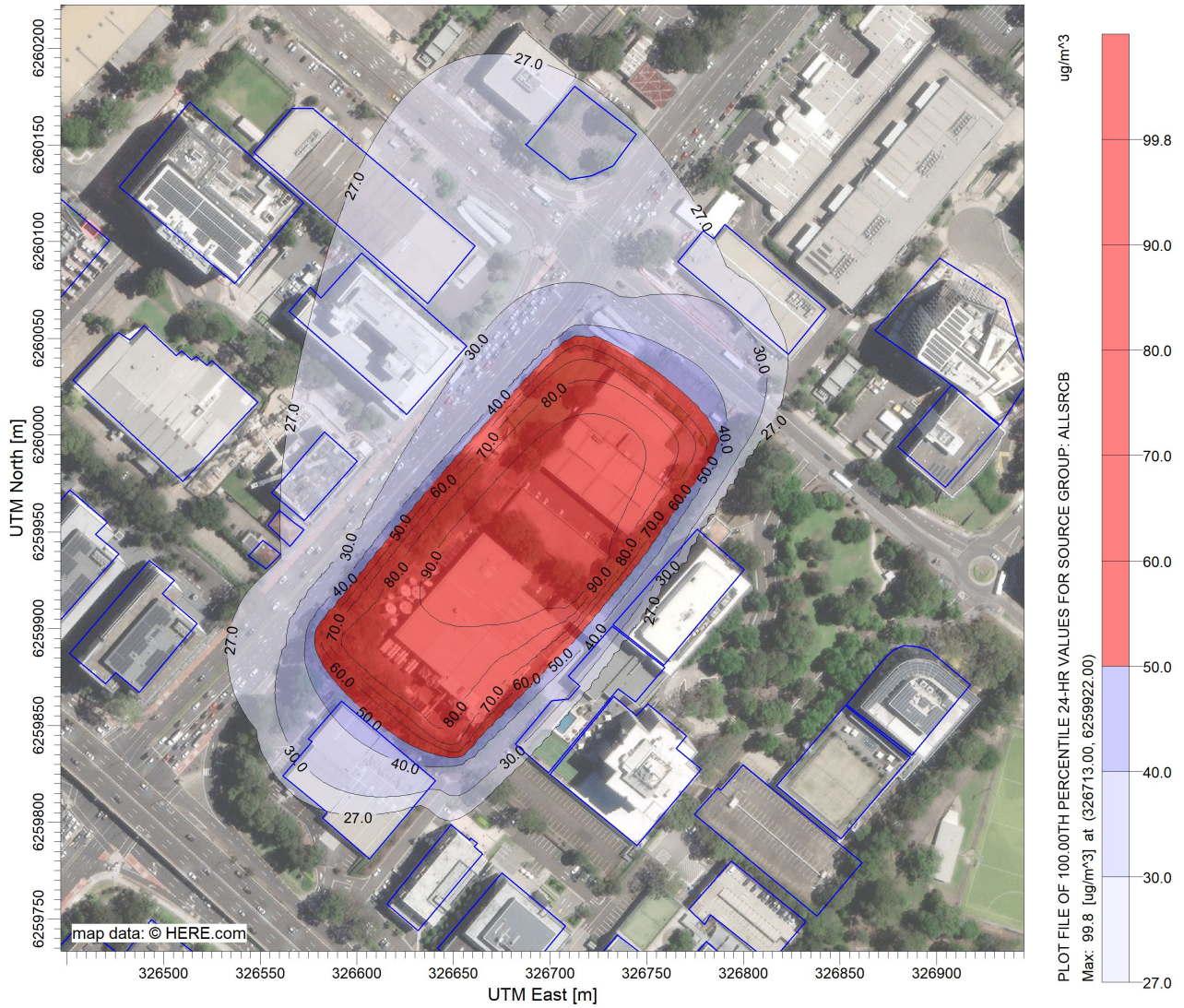


Figure 19 – Predicted 24-hour average construction dust (PM₁₀) GLC contours

7. Assessment of potential operational impacts

7.1 Scenario 1 – Highly unlikely worst-case scenario (all generators operating in a full loss of mains power situation)

This section addresses the potential air quality impact from a highly unlikely scenario where all generators would run simultaneously (peak emissions) to provide the full back up power required. As discussed in Section 3.2, this scenario has a very low likelihood of occurring and would only happen if both the primary and secondary power supplies failed.

7.1.1 Nitrogen dioxide

The highest 1-hour average concentrations for NO₂ have been predicted at each of the assessed sensitive receivers at both ground level and elevated floors. The results are shown in Table 16, which indicate that the cumulative NO₂ concentrations (i.e. inclusive of background concentrations) are predicted to exceed the impact assessment criterion at the nearby commercial and residential receivers, with the highest concentration predicted at receiver ID C2, Macquarie Veterinary Hospital & Doggy Daycare (at ground level).

The concentrations shown in Table 16 represent the highest possible concentrations during a loss of mains power, with all generators operating and coinciding with worst-case meteorological conditions, which provides conservatism in the assessment. The likelihood of this scenario occurring is expected to be extremely rare at the Proposal site (refer to Sections 3.2.1 and 7.1.4). In-principle mitigation measures have been discussed in Section 8 to assist in minimising the need for standby generators to operate and therefore reducing the impact from NO_x emissions.

Table 16 – Predicted highest 100th percentile 1-hour NO₂ concentrations (Scenario 1)

Receiver ID	Floor Level	1-Hour Highest Nitrogen Dioxide (NO ₂) Concentration (µg/m ³)			Comply
		Incremental	Cumulative	Criteria	
R1	Ground	322.9	330.5	164	No
R2	Level 2	319.1	322.9		No
R3	Level 15	468.3	490.8		No
R4	Level 1	265.5	267.4		No
R5	Level 1	292.5	298.2		No
R6	Ground	249.2	249.3		No
R7	Level 1	257.5	257.6		No
R8	Level 1	307.2	325.0		No
C1	Ground	670.7	676.3		No
C2	Ground	795.5	799.2		No
C3	Ground	744.3	746.2		No
C4	Ground	343.7	353.1		No
C5	Ground	711.1	723.6		No
C6	Level 1	421.4	425.2		No
C7	Ground	302.7	306.4		No
C8	Level 7	753.7	757.5		No
C9	Level 1	422.5	424.4		No

Receiver ID	Floor Level	1-Hour Highest Nitrogen Dioxide (NO ₂) Concentration (µg/m ³)			Comply
		Incremental	Cumulative	Criteria	
C10	Level 5	270.1	272.0		No
C11	Level 8	591.2	595.0		No
C12	Level 5	227.2	234.7		No
CC1	Ground	201.6	205.4		No
CC2	Ground	167.2	171.0		No
H1	Level 4	369.9	373.6		No
H2	Ground	703.0	703.1		No

The predicted cumulative concentrations at ground level and across the modelled domain are shown as contour plots in Appendix D.

7.1.2 Particulate matter

The highest 100th percentile 24-hour averaged concentrations for PM₁₀ and PM_{2.5} have been predicted at each of the assessed sensitive receivers, which are shown in Table 17.

The results show that the cumulative PM₁₀ concentrations (i.e. inclusive of background concentrations) are predicted to meet the impact assessment criterion of 50 µg/m³ at all assessed sensitive receivers at ground as well as at elevated levels. The cumulative PM_{2.5} concentrations are predicted to meet the impact assessment criterion of 25 µg/m³ at all assessed sensitive receivers.

Table 17 – Predicted highest 100th percentile 24-hour PM₁₀ and PM_{2.5} concentrations (Scenario 1)

Receiver ID	24-Hour Highest Level Concentrations (µg/m ³)					Comply
	PM ₁₀ /PM _{2.5}		PM ₁₀ Criteria	PM _{2.5} Criteria		
	Incremental	Cumulative		Cumulative	Criteria	
R1	2.8	26.8	50	20.0	25	Yes
R2	2.6	25.9		18.9		Yes
R3	4.4	29.0		17.7		Yes
R4	1.6	25.9		17.9		Yes
R5	1.6	25.9		17.9		Yes
R6	1.7	25.9		17.9		Yes
R7	1.9	25.9		17.7		Yes
R8	2.5	26.2		19.3		Yes
C1	7.1	30.0		23.6		Yes
C2	7.9	29.8		23.4		Yes
C3	7.9	29.8		23.4		Yes
C4	7.9	29.8		23.4		Yes
C5	6.6	30.5		19.2		Yes
C6	2.8	26.4		20.0		Yes
C7	1.1	25.9		17.8		Yes
C8	2.6	25.9		17.6		Yes

Receiver ID	24-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)					Comply
	PM ₁₀ /PM _{2.5}		PM ₁₀ Criteria	PM _{2.5}		
	Incremental	Cumulative		Cumulative	Criteria	
C9	4.7	26.2		17.6		Yes
C10	2.4	25.9		17.6		Yes
C11	1.6	25.9		17.8		Yes
C12	2.0	25.9		17.7		Yes
CC1	1.1	25.9		17.6		Yes
CC2	1.1	25.9		17.6		Yes
H1	1.3	25.9		18.0		Yes
H2	8.7	28.9		22.3		Yes

7.1.3 All other pollutants

The predicted highest 100th percentile highest concentrations for all other assessed pollutants (CO, SO₂, Benzene and PAH) are summarised in Table 18 to Table 20. The results show that CO, SO₂, Benzene and PAH are all predicted to be below the relevant impact assessment criteria at the assessed sensitive receivers, at both ground as well as elevated levels and therefore no significant impact is anticipated.

Table 18 – Predicted highest 100th percentile concentrations for 15-minutes,1-hour and 8-hour CO (Scenario 1)

Receiver ID	15-Minute Highest Level Concentrations (µg/m ³)			1-Hour Highest Level Concentrations (µg/m ³)			8-Hour Highest Level Concentrations (µg/m ³)			Comply
	CO			CO			CO			
	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	
R1	215	3490	100,000	163	2645	30,000	114	733	10,000	Yes
R2	176	3490		133	2645		104	733		Yes
R3	370	3490		281	2645		179	733		Yes
R4	184	3490		140	2645		59	733		Yes
R5	194	3490		147	2645		61	733		Yes
R6	157	3490		119	2645		62	733		Yes
R7	183	3490		139	2645		65	733		Yes
R8	240	3490		182	2645		92	733		Yes
C1	519	3490		393	2645		284	754		Yes
C2	652	3490		494	2645		349	743		Yes
C3	591	3490		448	2645		355	735		Yes
C4	248	3490		188	2645		127	733		Yes
C5	577	3490	437	2645	266	733	Yes			
C6	275	3490	208	2645	114	733	Yes			
C7	178	3490	135	2645	47	733	Yes			
C8	571	3490	433	2645	131	733	Yes			
C9	329	3490	249	2645	190	733	Yes			
C10	193	3490	147	2645	98	733	Yes			
C11	406	3490	308	2645	87	733	Yes			
C12	154	3490	117	2645	78	733	Yes			
CC1	124	3490	94	2645	45	733	Yes			

Receiver ID	15-Minute Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			8-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	CO			CO			CO			
	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	
CC2	135	3490		102	2645		56	733		Yes
H1	223	3490		169	2645		56	733		Yes
H2	559	3490		424	2645		336	733		Yes
Note:										
a. The predicted uniformity of the cumulative concentration levels is due to low predicted project pollutant contribution levels, compared to the background concentration levels which dominate.										

Table 19 – Predicted highest 100th percentile concentrations for 1-hour and 24-hour SO₂ (Scenario 1)

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			24-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	SO ₂			SO ₂			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
R1	30.0	86.9	215	9.4	14.1	57	Yes
R2	24.6	93.5		8.8	14.3		Yes
R3	51.7	83.0		14.6	15.4		Yes
R4	25.7	91.4		5.3	11.6		Yes
R5	27.1	88.7		5.4	10.9		Yes
R6	21.9	95.0		5.7	12.3		Yes
R7	25.6	86.9		6.3	10.5		Yes
R8	33.5	82.8		8.2	11.5		Yes
C1	72.4	90.7		23.7	25.6		Yes
C2	91.0	91.1		26.4	26.5		Yes
C3	82.5	88.0		26.6	26.7		Yes
C4	34.7	85.8		10.6	14.4		Yes

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			24-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	SO ₂			SO ₂			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
C5	80.5	83.6		21.8	22.1		Yes
C6	38.3	90.9		9.5	14.6		Yes
C7	24.9	90.3		3.8	11.1		Yes
C8	79.8	83.5		8.5	11.5		Yes
C9	45.9	82.2		15.6	15.7		Yes
C10	27.0	82.4		7.9	10.6		Yes
C11	56.7	90.0		5.4	10.4		Yes
C12	21.5	83.8		6.6	9.6		Yes
CC1	17.3	83.1		3.7	9.4		Yes
CC2	18.9	82.3		4.8	8.6		Yes
H1	31.2	96.9		4.2	10.7		Yes
H2	78.1	87.8		28.8	28.9		Yes

Table 20 – Predicted highest 100th percentile 1-hour concentrations for benzene and PAH (Scenario 1)

Receiver ID	1-Hour Highest Level Concentrations (µg/m ³)			1-Hour Highest Level Concentrations (µg/m ³)			Comply
	Benzene		Criteria	PAH		Criteria	
	Incremental	Cumulative		Incremental	Cumulative		
R1	0.3	0.3	29	0.000010	0.000010	0.4	Yes
R2	0.2	0.2		0.000010	0.000010		Yes
R3	0.5	0.5		0.000020	0.000020		Yes
R4	0.2	0.2		0.000010	0.000010		Yes
R5	0.2	0.2		0.000010	0.000010		Yes
R6	0.2	0.2		0.000010	0.000010		Yes
R7	0.2	0.2		0.000010	0.000010		Yes
R8	0.3	0.3		0.000020	0.000020		Yes
C1	0.6	0.6		0.000030	0.000030		Yes
C2	0.8	0.8		0.000040	0.000040		Yes
C3	0.7	0.7		0.000040	0.000040		Yes
C4	0.3	0.3		0.000020	0.000020		Yes
C5	0.7	0.7		0.000040	0.000040		Yes
C6	0.3	0.3		0.000020	0.000020		Yes
C7	0.2	0.2		0.000010	0.000010		Yes
C8	0.7	0.7		0.000040	0.000040		Yes
C9	0.4	0.4		0.000020	0.000020		Yes
C10	0.2	0.2		0.000010	0.000010		Yes
C11	0.5	0.5	0.000030	0.000030	Yes		
C12	0.2	0.2	0.000010	0.000010	Yes		
CC1	0.2	0.2	0.000010	0.000010	Yes		

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	Benzene			PAH			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
CC2	0.2	0.2		0.000010	0.000010		Yes
H1	0.3	0.3		0.000010	0.000010		Yes
H2	0.7	0.7		0.000040	0.000040		Yes
Maximum at and beyond site boundary	0.8	0.8		0.000040	0.000040		Yes

7.1.4 Likelihood of highly unlikely worst-case scenario and exceedances of the impact assessment criteria

The failure rates for a supply in the high reliability utility supply arrangement at the Proposal site are expected to be significantly low, as discussed in Section 3.2.1. Therefore, despite predicted exceedances of the NO₂ 1-hour impact assessment criterion being possible during operation of all standby generators concurrently, it is highly unlikely that this worst-case scenario would occur in a typical year. If it did occur, the standby generators are likely to only operate for far less than 0.01% of the year due to power outages.

7.2 Scenario 2 – Realistic operations (routine maintenance)

The on-duty standby generators would undergo routine maintenance and testing to make sure they are operational if required during a power outage. Routine maintenance follows a prescribed testing regime as shown in Section 3.2.1. For the Proposal, it is anticipated that a maximum of one generator would be tested at any one time on a quarterly basis. All testing to be undertaken during the daytime period.

The emission rates for relevant pollutants under different loads are presented in Section 5.4.2, Table 14. Based on the available emission data, the engine load with the worst emission rates have been adopted in this assessment, which are:

- NO₂, SO₂, Benzene, and PAH at 100% load
- CO and particulate matter at 50% load.

During testing and maintenance operations, the order of generator testing is likely to be conducted to align with the most efficient testing regime, which could vary each testing period. Noting that the generator stack arrangement has eight clusters with six stacks per cluster (Refer to Appendix C), to determine the likely realistic ‘worst-case’ scenario of air quality impact during routine maintenance scenario, one stack representing each cluster were assessed, as per below:

- Test 1: Stack 2;
- Test 2: Stack 8;
- Test 3: Stack 14;
- Test 4: Stack 20;
- Test 5: Stack 26;
- Test 6: Stack 32;
- Test 7: Stack 38; and
- Test 8: Stack 44.

Refer to Appendix C for the generator stack ID.

The highest concentrations of the above test arrangement at the discrete sensitive receivers were then assessed against the impact assessment criteria.

7.2.1 Nitrogen dioxide

The highest 100th percentile 1-hour NO₂ concentrations under routine maintenance at each of the assessed sensitive receivers (both at ground as well as elevated floor levels) have been predicted in Table 21.

The results show the cumulative NO₂ concentrations (i.e. inclusive of background concentrations) are all predicted to be below the impact assessment criterion under all routine maintenance conditions.

Table 21 – Predicted highest 100th percentile 1-hour NO₂ concentrations (Scenario 2)

Receiver ID	Highest 1-Hour Nitrogen Dioxide (NO ₂) Concentration (µg/m ³)		Criteria	Comply
	Incremental	Cumulative		
R1	9.0	43.6	164	Yes
R2	9.2	44.9		Yes
R3	20.0	50.7		Yes
R4	7.3	43.6		Yes
R5	6.4	43.6		Yes
R6	8.1	43.6		Yes
R7	7.7	43.6		Yes
R8	8.7	43.6		Yes
C1	19.9	47.3		Yes
C2	22.1	54.6		Yes
C3	21.1	53.6		Yes
C4	9.3	43.6		Yes
C5	23.0	56.1		Yes
C6	17.9	44.7		Yes
C7	10.6	43.7		Yes
C8	21.2	51.3		Yes
C9	20.7	54.2		Yes
C10	12.8	48.4		Yes
C11	18.8	43.8		Yes
C12	8.3	43.6		Yes
CC1	8.2	43.6	Yes	
CC2	7.7	43.6	Yes	
H1	14.7	43.7	Yes	
H2	20.6	56.6	Yes	

7.2.2 Particulate matter

The highest 100th percentile 24-hour particulate matter (PM₁₀ and PM_{2.5}) concentrations under routine maintenance at each of the assessed sensitive receivers (both at ground as well as elevated floor levels) have been predicted in Table 22.

The results show the cumulative PM₁₀ and PM_{2.5} concentrations (i.e. inclusive of background concentrations) are all predicted to be below the impact assessment criteria under all routine maintenance conditions.

Table 22 – Predicted highest 100th percentile 24-hour PM₁₀ and PM_{2.5} concentrations (Scenario 2)

Receiver ID	Highest 24-Hour Concentration (µg/m ³)					Comply
	Incremental	Cumulative	Criteria	Cumulative	Criteria	
	PM ₁₀ /PM _{2.5}	PM ₁₀		PM _{2.5}		
R1	0.2	25.9	50	17.7	25	Yes
R2	0.2	25.9		17.6		Yes
R3	0.3	26.1		17.6		Yes
R4	0.1	25.9		17.6		Yes
R5	0.1	25.9		17.6		Yes
R6	0.1	25.9		17.6		Yes
R7	0.1	25.9		17.6		Yes
R8	0.1	25.9		17.7		Yes
C1	0.5	25.9		18.0		Yes
C2	0.5	25.9		17.9		Yes
C3	0.5	25.9		17.9		Yes
C4	0.2	25.9		17.7		Yes
C5	0.4	26.1		17.7		Yes
C6	0.2	25.9		17.8		Yes
C7	0.1	25.9		17.6		Yes
C8	0.2	25.9		17.6		Yes
C9	0.4	25.9		17.6		Yes
C10	0.2	25.9		17.6		Yes
C11	0.3	25.9		17.6		Yes
C12	0.1	25.9		17.6		Yes
CC1	0.1	25.9	17.6	Yes		
CC2	0.1	25.9	17.6	Yes		
H1	0.1	25.9	17.6	Yes		
H2	0.5	26.0	17.9	Yes		

7.2.3 All other pollutants

The 100th percentile highest concentrations for all other pollutants (CO, SO₂, Benzene, and PAH) during routine maintenance testing period have been predicted and summarised in Table 23 to Table 25. The prediction results show that the cumulative concentrations (inclusive of background concentrations) for all assessed pollutants are below impact assessment criteria under all routine maintenance conditions and are therefore acceptable.

Table 23 – Predicted highest 100th percentile concentrations for 15-minutes, 1-hour and 8-hour CO (Scenario 2)

Receiver ID	15-Minute Highest Level Concentrations (µg/m ³)			1-Hour Highest Level Concentrations (µg/m ³)			8-Hour Highest Level Concentrations (µg/m ³)			Comply
	CO			CO			CO			
	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	
R1	9.7	3490	100,000	7.4	2645	30,000	4.4	733	10,000	Yes
R2	9.1	3490		6.9	2645		5.3	733		Yes
R3	24.4	3490		18.5	2645		8.3	733		Yes
R4	8.9	3490		6.7	2645		2.6	733		Yes
R5	7.9	3490		6.0	2645		2.4	733		Yes
R6	9.6	3490		7.2	2645		3.3	733		Yes
R7	9.2	3490		7.0	2645		2.7	733		Yes
R8	10.6	3490		8.1	2645		3.7	733		Yes
C1	28.3	3490		21.4	2645		14.0	733		Yes
C2	31.9	3490		24.2	2645		16.2	733		Yes
C3	29.6	3490		22.5	2645		16.4	733		Yes
C4	10.6	3490		8.0	2645		5.2	733		Yes
C5	25.3	3490	19.2	2645	12.0	733	Yes			
C6	20.8	3490	15.7	2645	7.1	733	Yes			
C7	10.3	3490	7.8	2645	3.8	733	Yes			
C8	29.5	3490	22.4	2645	8.3	733	Yes			
C9	26.4	3490	20.0	2645	12.2	733	Yes			
C10	14.5	3490	11.0	2645	5.9	733	Yes			
C11	20.3	3490	15.4	2645	8.5	733	Yes			
C12	8.0	3490	6.1	2645	3.8	733	Yes			

Receiver ID	15-Minute Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			8-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	CO			CO			CO			
	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	Incremental	Cumulative ^a	Criteria	
CC1	6.9	3490		5.2	2645		3.3	733		Yes
CC2	11.4	3490		8.6	2645		2.9	733		Yes
H1	15.4	3490		11.7	2645		3.7	733		Yes
H2	30.1	3490		22.8	2645		15.7	733		Yes

Note:

a. The predicted uniformity of the cumulative concentration levels are due to low predicted project pollutant contribution levels, compared to the background concentration levels which dominate.

Table 24 – Predicted highest 100th percentile concentrations for 1-hour and 24-hour SO₂ (Scenario 2)

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			24-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	SO ₂			SO ₂			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
R1	0.8	81	215	0.2	8.4	57	Yes
R2	0.7	82		0.3	8.3		Yes
R3	1.9	81		0.4	8.2		Yes
R4	0.7	82		0.1	8.3		Yes
R5	0.6	81		0.1	8.3		Yes
R6	0.8	82		0.2	8.3		Yes
R7	0.7	81		0.1	8.2		Yes
R8	0.8	81		0.2	8.3		Yes
C1	2.2	82		0.7	8.5		Yes
C2	2.5	82		0.7	8.5		Yes
C3	2.3	82		0.7	8.5		Yes

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			24-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	SO ₂			SO ₂			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
C4	0.8	81		0.2	8.4		Yes
C5	2.0	81		0.6	8.3		Yes
C6	1.6	82		0.3	8.4		Yes
C7	0.8	82		0.2	8.3		Yes
C8	2.3	81		0.3	8.3		Yes
C9	2.1	81		0.5	8.2		Yes
C10	1.1	81		0.2	8.2		Yes
C11	1.6	82		0.4	8.3		Yes
C12	0.6	81		0.2	8.3		Yes
CC1	0.5	81		0.2	8.3		Yes
CC2	0.9	81		0.1	8.2		Yes
H1	1.2	82		0.2	8.3		Yes
H2	2.4	82		0.7	8.5		Yes

Table 25 – Predicted highest 100th percentile 1-hour concentrations for benzene and PAH (Scenario 2)

Receiver ID	1-Hour Highest Level Concentrations (µg/m ³)			1-Hour Highest Level Concentrations (µg/m ³)			Comply
	Benzene		Criteria	PAH		Criteria	
	Incremental	Cumulative		Incremental	Cumulative		
R1	0.007	0.007	29	0	0	0.4	Yes
R2	0.006	0.006		0	0		Yes
R3	0.017	0.017		0	0		Yes
R4	0.006	0.006		0	0		Yes
R5	0.006	0.006		0	0		Yes
R6	0.007	0.007		0	0		Yes
R7	0.006	0.006		0	0		Yes
R8	0.007	0.007		0	0		Yes
C1	0.020	0.020		0	0		Yes
C2	0.022	0.022		0	0		Yes
C3	0.021	0.021		0	0		Yes
C4	0.007	0.007		0	0		Yes
C5	0.018	0.018	0	0	Yes		
C6	0.015	0.015	0	0	Yes		
C7	0.007	0.007	0	0	Yes		
C8	0.021	0.021	0	0	Yes		
C9	0.019	0.019	0	0	Yes		
C10	0.010	0.010	0	0	Yes		
C11	0.014	0.014	0	0	Yes		
C12	0.006	0.006	0	0	Yes		
CC1	0.005	0.005	0	0	Yes		

Receiver ID	1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			1-Hour Highest Level Concentrations ($\mu\text{g}/\text{m}^3$)			Comply
	Benzene			PAH			
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
CC2	0.008	0.008		0	0		Yes
H1	0.011	0.011		0	0		Yes
H2	0.021	0.021		0	0		Yes
Maximum at and beyond site boundary	0.020	0.020		0	0		Yes

7.3 POEO (Clean Air) Regulation – Standard of Concentrations

Clause 73 of the POEO (Clean Air) Regulation 2022 exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities Standard of nitrogen dioxide and nitric oxide concentrations specified in Schedule 2, if the plant is used for a total of not more than 200 hours per year.

Based on the maintenance schedule in Section 3.2.1, the Proposal is considered as non-scheduled premises as plant would not be used for more than 200 hours per year, the Proposal therefore should comply with the Schedule 2 Part 3 of the Standard of Concentrations for non-scheduled premises.

Table 26 below shows that the generator emissions for particles associated with the Proposal are all below the Standard of Concentration for solid particles of 100 mg/m³, when operating between 10% and 100% loads.

Table 26 – POEO (Clean Air) Regulation Schedule 2 Part 3 – Standards of concentrations assessment for non-scheduled premises

Air impurity	Activity or plant	Standard of Concentration, mg/m ³	The Proposal's per-Generator Emissions ^a , mg/m ³				
			100% load	75% load	50% load	25% load	10% load
Solid particles	Any activity/ plant	100 ^b	9	14	43	72	44
Note:							
a. The Proposal's generator emissions above are based on the mg/Nm ³ generator emission data of MTU 20V4000G94LF in Appendix B, assumed as dry, 273K, 101.3kPa and 5% O ₂ content, which were then converted into 7% O ₂ content as per the POEO (Clean Air) Regulation requirements.							
b. Standard of emission concentration under dry, 273K, 101.3kPa, 7% O ₂ conditions.							

7.4 Cumulative impacts

The methodology in Section 5.4.4 has been adopted to assess the likelihood of cumulative impacts from the nearby S1 and S2 facilities with the Proposal (S5), during simultaneous events of emergency (power outage) scenario or routine maintenance testing scenario.

The assessed wind rose in Section 4.1 has been analysed to determine the representative prevailing wind patterns in the area. Figure 20 shows the wind vectors linking potential sources at both S1 and S5 (the Proposal) data centres to the common receivers, and Figure 21 for the wind vectors linking potential sources at both S2 and S5 data centres to the common receivers. Note that additional receivers (C13 to C17) have been added in Figure 20 and Figure 21 for determining the likelihood of cumulative impact.

Table 27 – Potential cumulative impacts of NEXTDC S1, and S2 and S5 data centres

Conditions	Incident Wind Vectors	Description of Cumulative Impacts	Potentially Affected Receivers
1	52.5°-82.5°	Emissions from S1 giving rise to cumulative impact with S5	R1, R2, C1, C4, C6
2	232.5°-262.5°	Emissions from S5 giving rise to cumulative impact with S1	C13, C14, C15
3	97.5°-142.5°	Emissions from S5 giving rise to cumulative impact with S2	C16, C17
4	277.5°-322.5°	Emissions from S2 giving rise to cumulative impact with S5	C8, C11, C12, CC1

Based on Figure 20 and Figure 21, cumulative impacts during Condition 1, with prevailing winds within 52.5° and 82.5° wind vector range, could potentially affect receivers R1, R2, C1, C4 and C6, located south-west of S5 data centre. According to historical wind frequency statistics, wind vectors within this range could occur for 10.1% of the year.

Cumulative impact during Condition 2, with prevailing winds within 232.5° and 262.5° wind vector range, could potentially affect receivers C13, C14 and C15, located north-east of S1 data centre. According to historical wind frequency statistics, wind vectors within this range could occur for 12.4% of the year.

Cumulative impact during Condition 3, with prevailing winds within 97.5° and 142.5° wind vector range, could potentially affect receivers C16 and C17, located north-west of S2 data centre. According to historical wind frequency statistics, wind vectors within this range could occur for 9.9% of the year.

Cumulative impact during Condition 4, with prevailing winds within 277.5° and 322.5° wind vector range, could potentially affect receivers C8, C11, C12 and CC1, located south-east of S5 data centre. According to historical wind frequency statistics, wind vectors within this range could occur for 8.7% of the year.

7.4.1 Probability of cumulative impact during emergency scenario

The probability of both S1 and S5 data centres operating simultaneously under an emergency scenario depends on the reliability of the power feeders supplying the facilities. It is understood that both facilities are served by the same power distributor, Ausgrid. According to the Ausgrid DTAPR (December 2023)¹⁸, the normalised SAIDI for a typical customer in the past 10 years (2013 to 2023) averages 73.9 minutes, corresponding to a probability of 0.014% in a year. Similarly to the probability of both S2 and S5 data centres operating simultaneously under an emergency scenario.

Assuming that a power outage affects both S1 and S5 data centre simultaneously, the probability of cumulative impacts occurring at the affected common receivers under Conditions 1 to 4 can be estimated by multiplying the probability of a power outage occurring in a given year (P=0.014%) by the probability of the favourable wind vector associated with the corresponding condition. The probabilities of cumulative impact during emergency scenario are summarised in Table 28.

Table 28 – Probability of cumulative impact during emergency scenario

Conditions	Probability of power outage	Probability of favourable wind vector	Calculated Probability of Cumulative Impact
1	0.014%	10.1%	0.0014%
2	0.014%	12.4%	0.0017%
3	0.014%	9.9%	0.0014%

¹⁸ Ausgrid, 2023. *Distribution and Transmission Annual Planning Report Summary*, December 2023.

Conditions	Probability of power outage	Probability of favourable wind vector	Calculated Probability of Cumulative Impact
4	0.014%	8.7%	0.0012%

From Table 28, the probability of cumulative impact during emergency scenario is extremely low (0.0012%-0.0017%), indicating that it is highly unlikely to occur in a typical year.

7.4.2 Probability of cumulative impact during routine maintenance scenario

The probability of both S1 and S5 data centres having simultaneous maintenance testing under the same hour during favourable wind conditions towards a common receivers could be estimated by multiplying the probability of maintenance testing at S1 and S5 occurring at the same hour by the probability of the favourable wind vector associated with the corresponding condition. The probabilities of cumulative impact during routine maintenance testing scenario are summarised in Table 29.

Table 29 – Probability of cumulative impact during routine maintenance testing scenario

Conditions	Probability of Maintenance Testing	Probability of favourable wind vector	Calculated Probability of Cumulative Impact
1	S1 = 0.0127% ^a S5 = 0.0076%	10.1%	0.021%
2	S1 = 0.0127% ^a S5 = 0.0076%	12.4%	0.026%
3	S2 = 0.0127% ^a S5 = 0.0076%	9.9%	0.021%
4	S2 = 0.0127% ^a S5 = 0.0076%	8.7%	0.019%

Note:

a. NEXTDC S1 and S2 data centres maintenance testing is assumed to be undertaken during daytime period (the period from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm (Sundays and public holidays), with total number of testing hours of 199 hours (less than 200 hours) in a year.

From Table 29, the probability of cumulative impact during routine maintenance testing scenario is extremely low (0.019%-0.026%), indicating that it is highly unlikely to occur in a typical year.

7.5 Diesel storage tank emissions

The US EPA TANKS (Section 5.4.5) application estimated that each tank would emit around 0.12 kg/year (0.09 kg/year being from annual standing losses and 0.03 kg/year from annual breathing losses). Assuming all emissions are vented to the atmosphere from the data centre building, the 16 bulk fuel storage tanks are estimated to emit around 1.9 kg of hydrocarbons throughout the course of a year. Any local air quality impacts associated with this are considered to be negligible.

8. Environmental management measures

This section describes the measures to mitigate against, monitor and manage any potential adverse air quality impacts described in Sections 6 and 7.

The dust emitting activities assessed above can be greatly reduced or eliminated by applying mitigation and management measures. It is anticipated that with the implementation of effective management measures, the environmental effect would not be significant in most cases. Table 30 outlines the air quality mitigation and management measures recommended for the Proposal site. These measures should be included in the Construction Environmental Management Plan (CEMP) as a specific air quality management sub-plan.

Operation of the Proposal is not anticipated to significantly impact local air quality, however specific mitigation or management measures are proposed for the operational phase to minimise the air quality impact during maintenance.

Table 30 – Environmental management measures for air quality impacts

ID	Impacts	Mitigation	Responsibility	Timing
Construction				
AQ1	Risks to air quality during construction from fugitive dust	<p>A dust and air quality management plan shall be prepared and implemented as part of the Proposal's CEMP:</p> <ul style="list-style-type: none"> • Potential sources of air pollution (such as dust, vehicles, odour transporting waste, plant and equipment) during construction • Air quality management objectives consistent with any relevant published EPA guidelines • Mitigation and suppression measures to be implemented, such as spraying or covering exposed surfaces, provision of vehicle clean down areas, covering of loads, street cleaning, use of dust screens, maintenance of plant in accordance with manufacturer's instructions • Consideration of water suppression methods on soil and overburden, when using: <ul style="list-style-type: none"> • Backhoe, unpaved roads for haul trucks and light vehicle: 50 per cent water spray to keep soil wet. • Excavator, loader and roller: 75 to 80 per cent water spray to keep soil wet. 	Contractor	Pre-construction/Construction

ID	Impacts	Mitigation	Responsibility	Timing
		<ul style="list-style-type: none"> • Maintain sufficient water content on the soil across the general construction footprint boundary to minimise dust impact from wind erosion • Methods to manage works during strong winds or other adverse weather conditions • A progressive rehabilitation strategy for exposed surfaces • Explanation of when the air quality, suppression and management measures need to be applied, who is responsible, and how effectiveness will be assessed • Community notification and complaint handling procedures, as required. 		
AQ2	Risks to air quality during construction from vehicle and machinery emissions	<p>The following management measures shall be included as part of the Proposal's CEMP to minimise emissions to air from construction vehicles and site machinery:</p> <ul style="list-style-type: none"> • Implementation of a high standard of engine maintenance to minimise vehicle emissions • A requirement for completion of pre-start vehicle checklists to make sure construction vehicles are in good working order. 	Contractor	Pre-construction/construction
Operation				
AQ3	Risks to air quality during maintenance of standby generators	<ul style="list-style-type: none"> • Operation of standby generators during testing and maintenance should be minimised as far as practicable, and should follow the prescribed testing regime assessed in this report. • generator testing during routine maintenance should be undertaken under a load where emissions comply with the emission concentration limit for solid particles outlined in the relevant POEO (Clean Air) Standard of Concentration requirement for non-scheduled premises. 	Operator	Operation
AQ4	Risks to air quality during the highly unlikely operation of standby generators in the event of a full loss of mains power	<ul style="list-style-type: none"> • In the event of a loss of mains power, all practical measures should be taken to reduce the duration of the outage to ensure that standby generators operate for the least amount of time possible. <p>It is worth noting that measures included in the current design of the Proposal also mitigate the need for the standby generators to operate to provide back-up power generation. These include:</p> <ul style="list-style-type: none"> • The adoption of high voltage utility power supply to provide much higher reliability than a conventional utility. 	Operator	Operation

ID	Impacts	Mitigation	Responsibility	Timing
		<ul style="list-style-type: none"><li data-bbox="618 288 1516 414">• The adoption of dual redundant utility feeds to provide a secondary feed in the event of a primary power supply failure. These should be maintained, or even optimised, during the late stages of project design.		

9. Summary of residual impacts

This section provides a summary of the construction and operational risks both pre-mitigation and any residual impacts remaining after the implementation of the management measures describe in Section 8. Pre-mitigation and residual impacts are summarised in Table 31.

Table 31 – Summary of pre-mitigation and residual impacts

Potential pre-mitigation adverse impact	Relevant management measures	Potential residual impact after implementation of management measures	Comment on how any residual impacts would be managed
Construction			
Low risk of dust-generation during construction effecting local air quality	Refer to AQ1 Impact Mitigation in Table 30. Best practice dust management measures included in a dust and air quality management plan developed as part of the CEMP.	Negligible	N/A
Low risk of emissions from equipment, traffic and machinery effecting local air quality	Refer to AQ2 Impact Mitigation in Table 30. Best practice emission control management measures included in an Air Quality Management Plan developed as part of the CEMP.	Negligible	N/A
Operation			
Risks to air quality during maintenance of standby generators	Refer to AQ3 Impact Mitigation in Table 30.	Negligible	N/A
Risks to air quality during the highly unlikely operation of standby generators in the event of a full loss of mains power	Refer to AQ4 Impact Mitigation in Table 30.	Low	N/A

10. References

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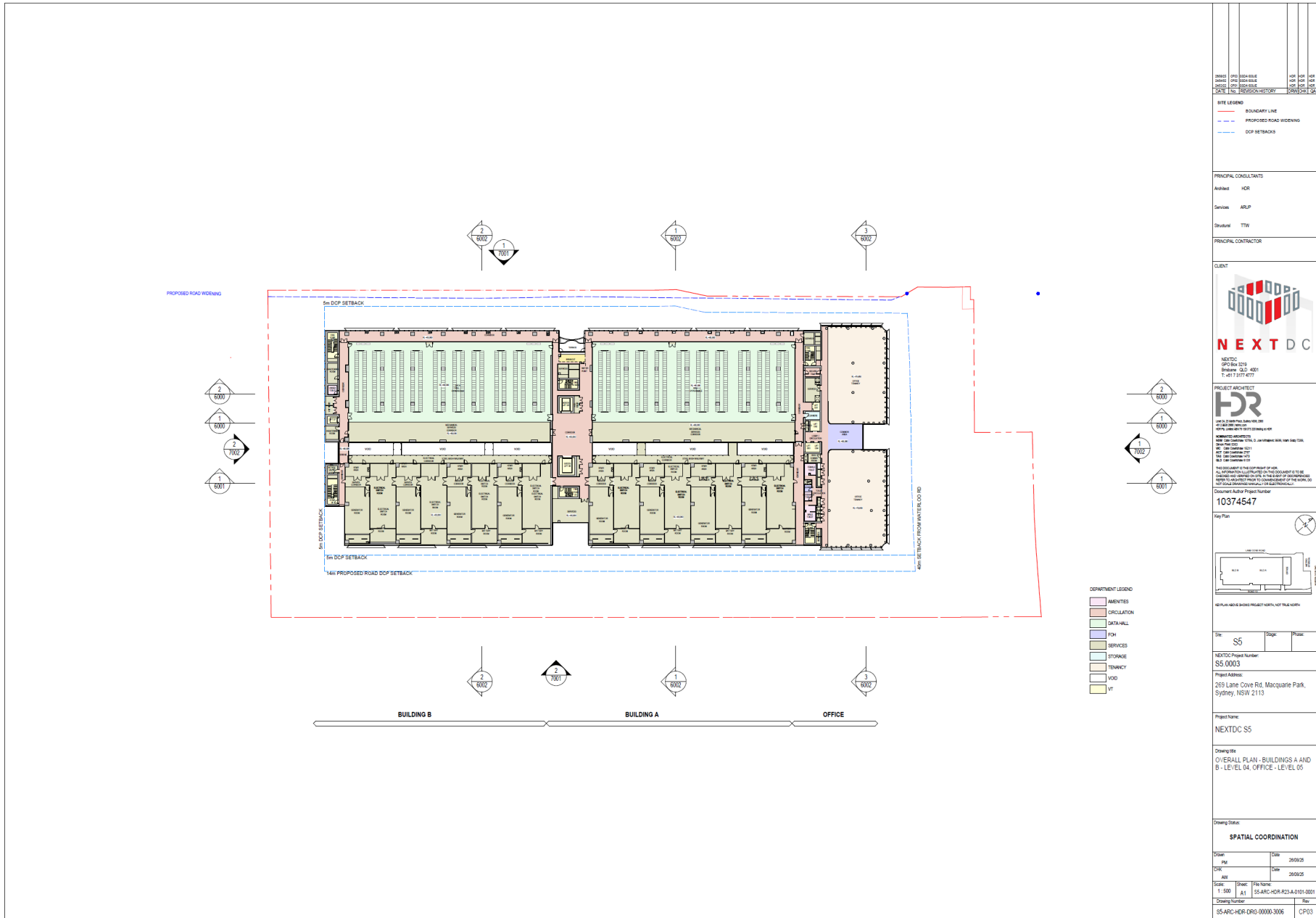
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Appendix A

Masterplan drawings



DATE	NO.	REVISION HISTORY	DRAWN	CHECK
2025/09/25	01	ISSUED FOR PERMIT	CP03	CP03
2025/09/25	02	REVISED PER COMMENTS	CP03	CP03
2025/09/25	03	REVISED PER COMMENTS	CP03	CP03

SITE LEGEND

- BOUNDARY LINE
- - - PROPOSED ROAD WIDENING
- DCP SETBACKS

PRINCIPAL CONSULTANTS

Architect: HCR
 Services: ARUP
 Structural: TTW

PRINCIPAL CONTRACTOR

CLIENT



NEXTDC

NEXTDC
 5/10 Macquarie Park
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PROJECT ARCHITECT




HR

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 Sydney, NSW 2113
 T: 61 7 937 4777

10374547

Key Plan



FOR ALL WORKS IN THIS PROJECT CONTACT NEXTDC

Site	S5	Stage	Phase
------	----	-------	-------

NEXTDC Project Number:
 S5-0003

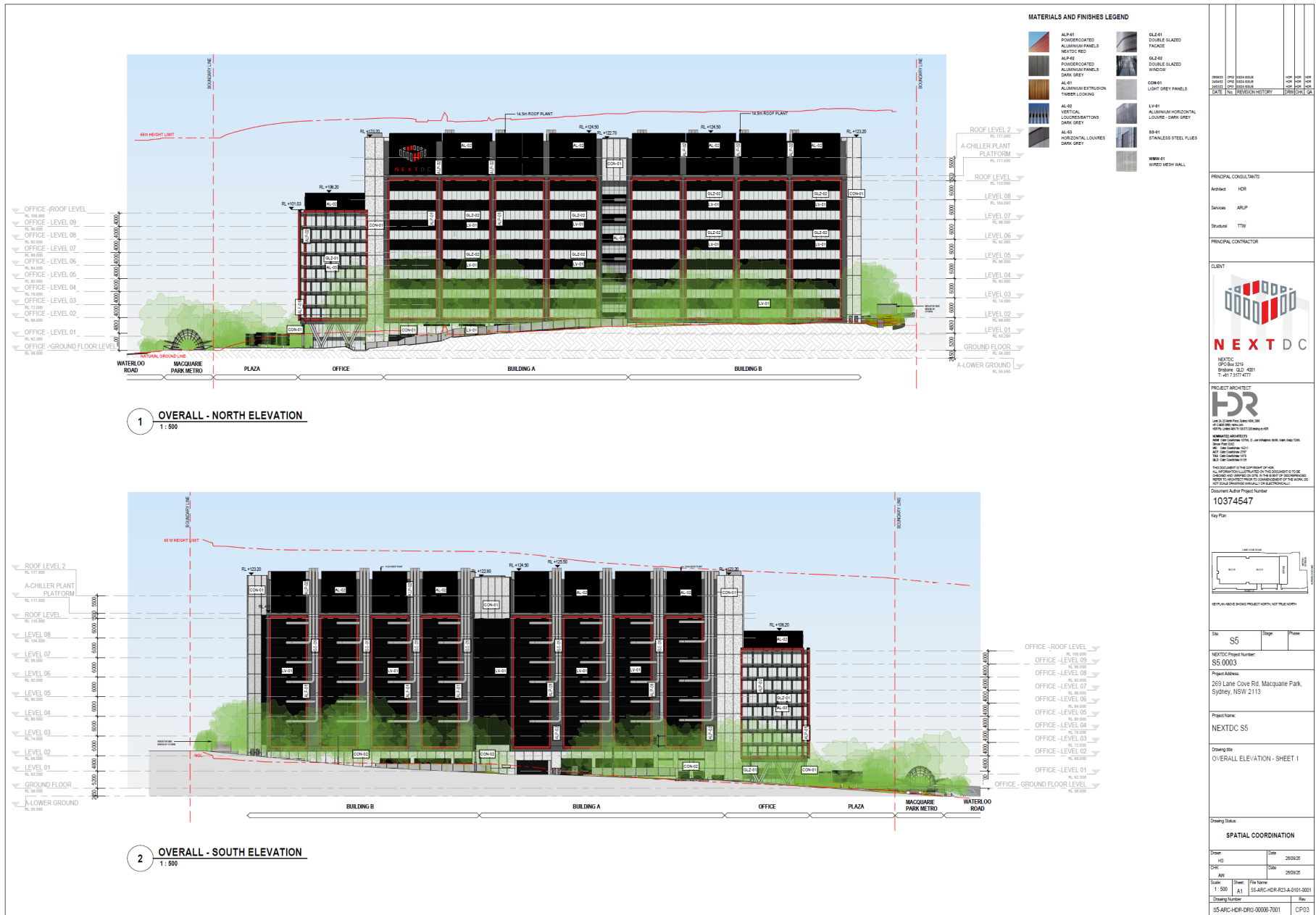
Project Address:
 255 Lane Cove Rd, Macquarie Park,
 Sydney, NSW 2113

Project Name:
 NEXTDC S5

Drawing title:
 OVERALL PLAN - BUILDINGS A AND
 B - LEVEL 04, OFFICE - LEVEL 05

SPATIAL COORDINATION

Drawn	CP03	Date	2025/09/25
Checked	AW	Date	2025/09/25
Scale	1:500	Sheet	A1
Drawing Number	S5-ARC-HDR-DRG-0000-3006	File Name	S5-ARC-HDR-R23-A-0101-0001
Revision	01	Rev	01
Project Number	S5-ARC-HDR-DRG-0000-3006	Rev	CP03



PRINCIPAL CONSULTANTS	Architect	HR
Services	ARUP	
Structural	TTW	
PRINCIPAL CONTRACTOR		
CLIENT	<p>NEXTDC 9/10 Macquarie Street Sydney NSW 2000 T: +61 2 9737 4777</p>	
PROJECT ARCHITECT	<p>HDR Level 10, 100 Macquarie Street, Sydney NSW 2000 PO BOX 970, SYDNEY NSW 2001 WWW.HDR.COM.AU</p>	
Document Author Project Number	10374547	
Key Plan		
Site	S5	Stage / Phase
NEXTDC Project Number	S5.0003	
Project Address	255 Lane Cove Rd, Macquarie Park, Sydney, NSW 2113	
Project Name	NEXTDC S5	
Drawing title	OVERALL ELEVATION - SHEET 1	
Drawing Status	SPATIAL COORDINATION	
Drawn	HS	Date
Checked	MS	Date
Scale	1: 500	Sheet
Drawing Number	S5-ARC-HER-DRG-0000-7001	Rev.
	CP03	

Appendix B

Standby generator specification



Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94LF				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	10				
mg/mN ³ values base on residual oxygen value of [%]	5				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	3307	2480	1653	827	331
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1499	1499	1500	1499
Engine speed relative	[-]	1	1	1	1	1
NOX-Emissions specific	g/kWh	8.58	7.72	6.23	6.61	17.21
CO-Emissions specific	g/kWh	0.55	0.67	1.94	2.89	5.57
HC1-Emissions specific	g/kWh	0.09	0.11	0.16	0.33	2.09
NMHC-Emissions specific	g/kWh	0.09	0.11	0.16	0.32	
NOX+HC1-Emissions specific	g/kWh	8.67	7.84	6.39	6.94	19.3
NOX+NMHC-Emissions specific	g/kWh	8.67	7.83	6.39	6.93	
PM-Emissions specific (Meas.)	g/kWh	0.03	0.046	0.147	0.266	0.192
NOX-Emissions (based on 5% O2)	mg/m3N	3071	2824	2130	2063	4581
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	3103	2863	2185	2164	5123
NOX+NMHC-Emissions (based on 5% O2)	mg/m3N	3102	2862	2184	2162	

Description of Revision		Frequency	<p>All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.</p> <p>Emissionstage NEA Singapore for ORDE</p> <p>Emissionstage basis NEA Singapore for ORDE</p>	<table border="1"> <tr> <th>PDF</th> <th>Name</th> <th>Project no.</th> <th>Size</th> </tr> <tr> <td></td> <td></td> <td>MSFT</td> <td rowspan="5">A4</td> </tr> <tr> <td>Configurator</td> <td>Lenhof, Torsten (TARC)</td> <td>Order no.</td> </tr> <tr> <td>Approver1</td> <td>Kneifel, Alexander (TSLI)</td> <td>EDS-ID</td> </tr> <tr> <td>Approver2</td> <td>Breuer, Joerg (TVA)</td> <td>2185-10.01.2023</td> </tr> <tr> <td>Approver3</td> <td></td> <td></td> </tr> <tr> <td>Approver4</td> <td></td> <td></td> <td></td> </tr> <tr> <td>User</td> <td>APAC/zhenge</td> <td></td> <td></td> </tr> <tr> <td colspan="2">Engine model</td> <td colspan="2">20V4000G94LF</td> </tr> <tr> <td colspan="2">Title</td> <td colspan="2">Emission data sheet</td> </tr> <tr> <td colspan="2">Configuration-ID</td> <td colspan="2">Sheet</td> </tr> <tr> <td>295</td> <td>Documentation</td> <td colspan="2">5 of 6</td> </tr> </table>	PDF	Name	Project no.	Size			MSFT	A4	Configurator	Lenhof, Torsten (TARC)	Order no.	Approver1	Kneifel, Alexander (TSLI)	EDS-ID	Approver2	Breuer, Joerg (TVA)	2185-10.01.2023	Approver3			Approver4				User	APAC/zhenge			Engine model		20V4000G94LF		Title		Emission data sheet		Configuration-ID		Sheet		295	Documentation	5 of 6	
PDF	Name	Project no.		Size																																												
		MSFT		A4																																												
Configurator	Lenhof, Torsten (TARC)	Order no.																																														
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Configuration-ID		Sheet																																														
295	Documentation	5 of 6																																														
Data generated by EDS Creator version 1.0 and unipilot. Ref.-dataset: 420122_364_NEA_G94LF_D2.nc for 295 in EDS platform.																																																



CO-Emissions (based on 5% O2)	mg/m3N	189.4	235.5	644.5	889.1	1446
HC1-Emissions (based on 5% O2)	mg/m3N	31.5	39.2	54.7	100.8	542
PM-Emissions (based on 5% O2)	mg/m3N	10.4	16.4	49	81.9	49.8

Description of Revision		Frequency	All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.	PDF	Name	Project no.	Size
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 420122_364_NEA_G94LF_D2.nc for 295 in EDS platform.				Configurator	Lenhof, Torsten (TARC)	MSFT	
				Approver1	Kneifel, Alexander (TSLE)	MSFT	2185-10.01.2023
				Approver2	Brauer, Joerg (TVA)	EDS-ID	
				Approver3		Title	
			Approver4		Emission data sheet		
Engine model	20V4000G94LF						
Configuration-ID	Documentation	Emissionstage	NEA Singapore for ORDE	Sheet	6		
295		Emissionstage basis	NEA Singapore for ORDE	of	6		

Appendix C

Modelled generator stacks coordinates

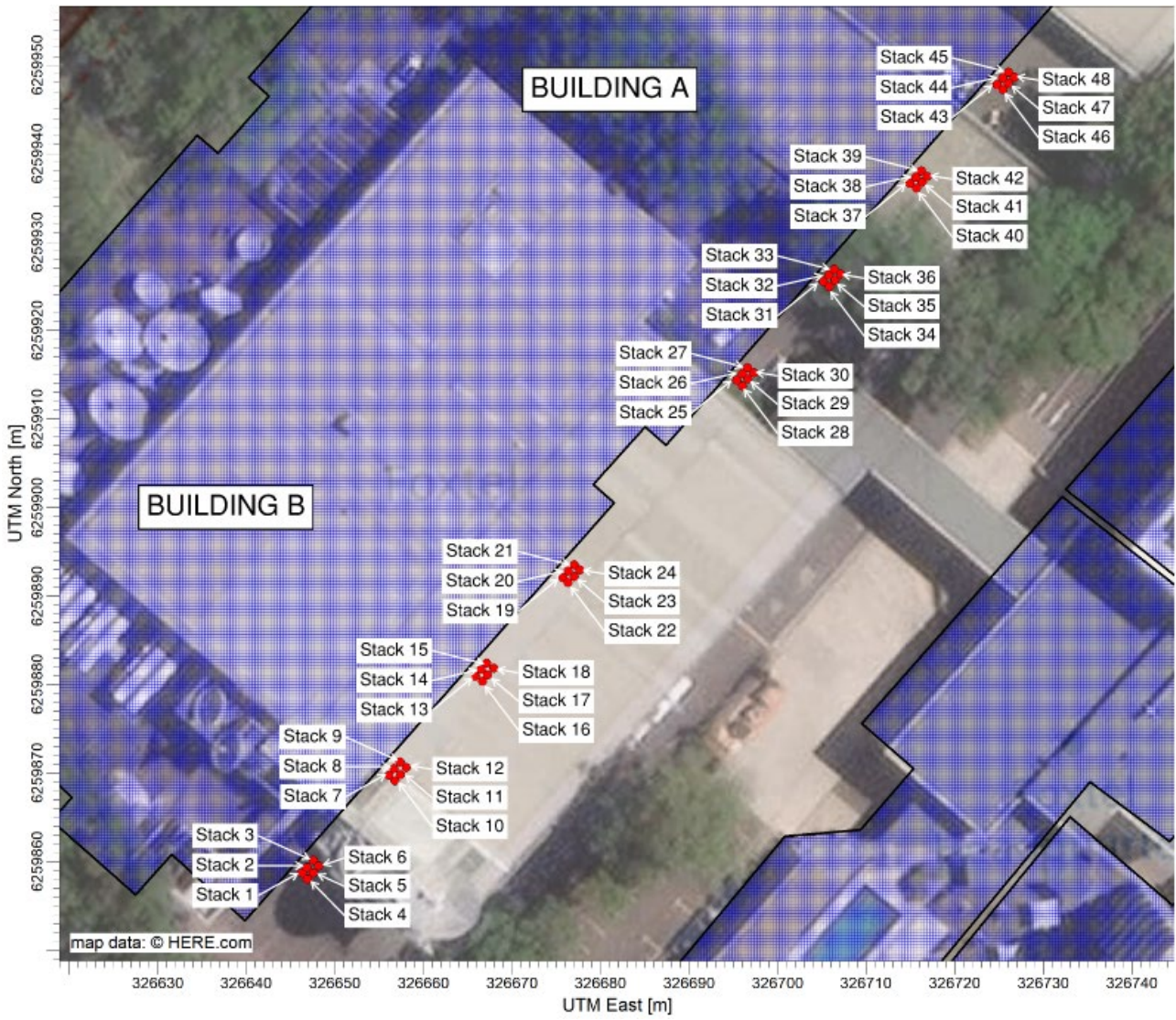


Figure 22 – Map of modelled generator stack ID

Table 32 – Standby generator stack location coordinates

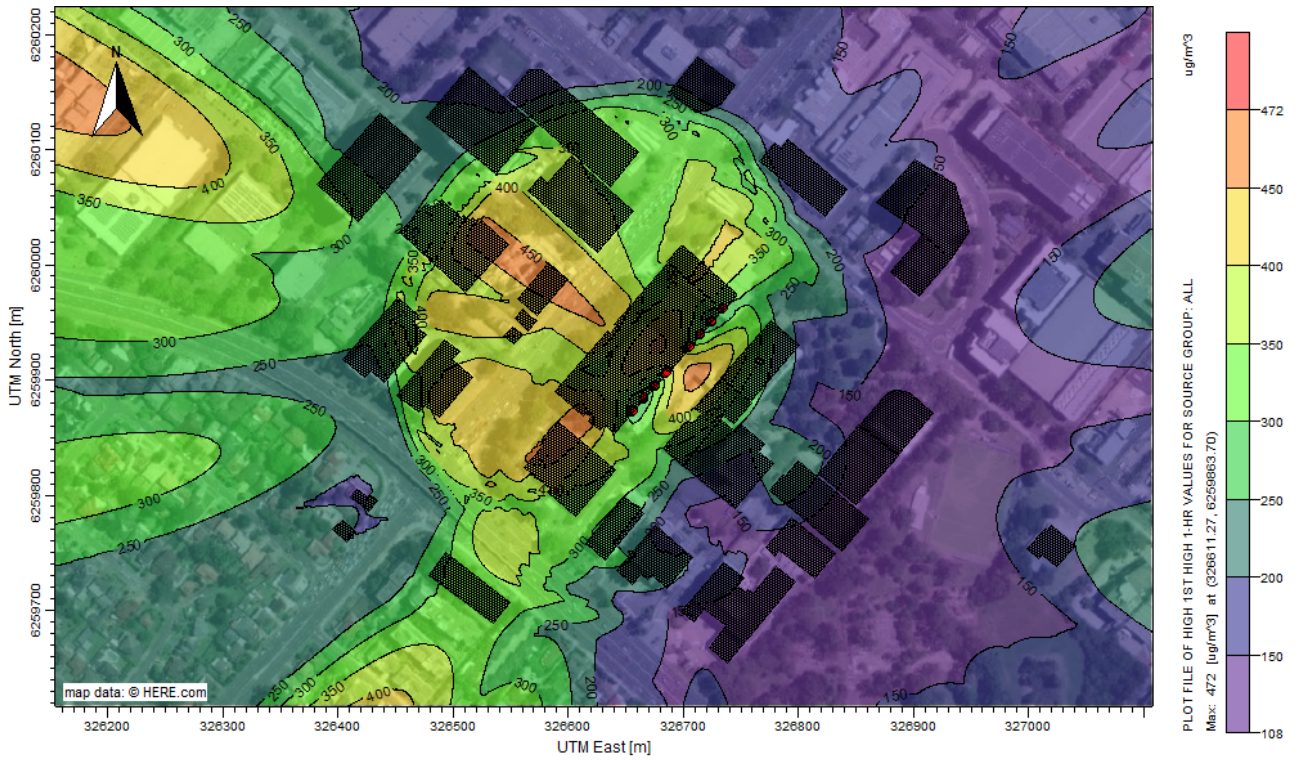
Building	Stack ID (Figure 22)	Stack Coordinate		Stack Height (m) (above ground level)
		X: Easting (m)	Y: Northing (m)	
Building B	Stack1	326654.33	6259872.42	61
	Stack2	326654.90	6259873.04	61
	Stack3	326655.60	6259873.86	61
	Stack4	326654.97	6259871.73	61
	Stack5	326655.60	6259872.42	61
	Stack6	326656.26	6259873.21	61
	Stack7	326664.16	6259883.47	61
	Stack8	326664.73	6259884.21	61
	Stack9	326665.41	6259884.97	61
	Stack10	326664.85	6259882.83	61
	Stack11	326665.47	6259883.55	61
	Stack12	326666.13	6259884.36	61
	Stack13	326673.92	6259894.68	61
	Stack14	326674.59	6259895.41	61
	Stack15	326675.22	6259896.12	61
	Stack16	326674.73	6259894.10	61
	Stack17	326675.27	6259894.78	61
	Stack18	326676.02	6259895.57	61
	Stack19	326683.80	6259905.79	61
	Stack20	326684.41	6259906.52	61
	Stack21	326685.07	6259907.24	61
	Stack22	326684.39	6259905.25	61
	Stack23	326685.07	6259905.92	61
	Stack24	326685.68	6259906.67	61
Building A	Stack25	326703.40	6259928.12	66
	Stack26	326704.04	6259928.83	66
	Stack27	326704.68	6259929.53	66
	Stack28	326704.09	6259927.46	66
	Stack29	326704.72	6259928.24	66
	Stack30	326705.37	6259928.95	66
	Stack31	326713.20	6259939.27	66
	Stack32	326713.83	6259939.97	66
	Stack33	326714.47	6259940.67	66
	Stack34	326713.88	6259938.70	66
	Stack35	326714.54	6259939.42	66
	Stack36	326715.17	6259940.11	66

Building	Stack ID (Figure 22)	Stack Coordinate		Stack Height (m) (above ground level)
		X: Easting (m)	Y: Northing (m)	
	Stack37	326723.02	6259950.35	66
	Stack38	326723.67	6259951.08	66
	Stack39	326724.28	6259951.77	66
	Stack40	326723.74	6259949.81	66
	Stack41	326724.36	6259950.47	66
	Stack42	326724.97	6259951.17	66
	Stack43	326732.84	6259961.51	66
	Stack44	326733.48	6259962.25	66
	Stack45	326734.11	6259962.95	66
	Stack46	326733.52	6259960.95	66
	Stack47	326734.12	6259961.68	66
	Stack48	326734.78	6259962.36	66

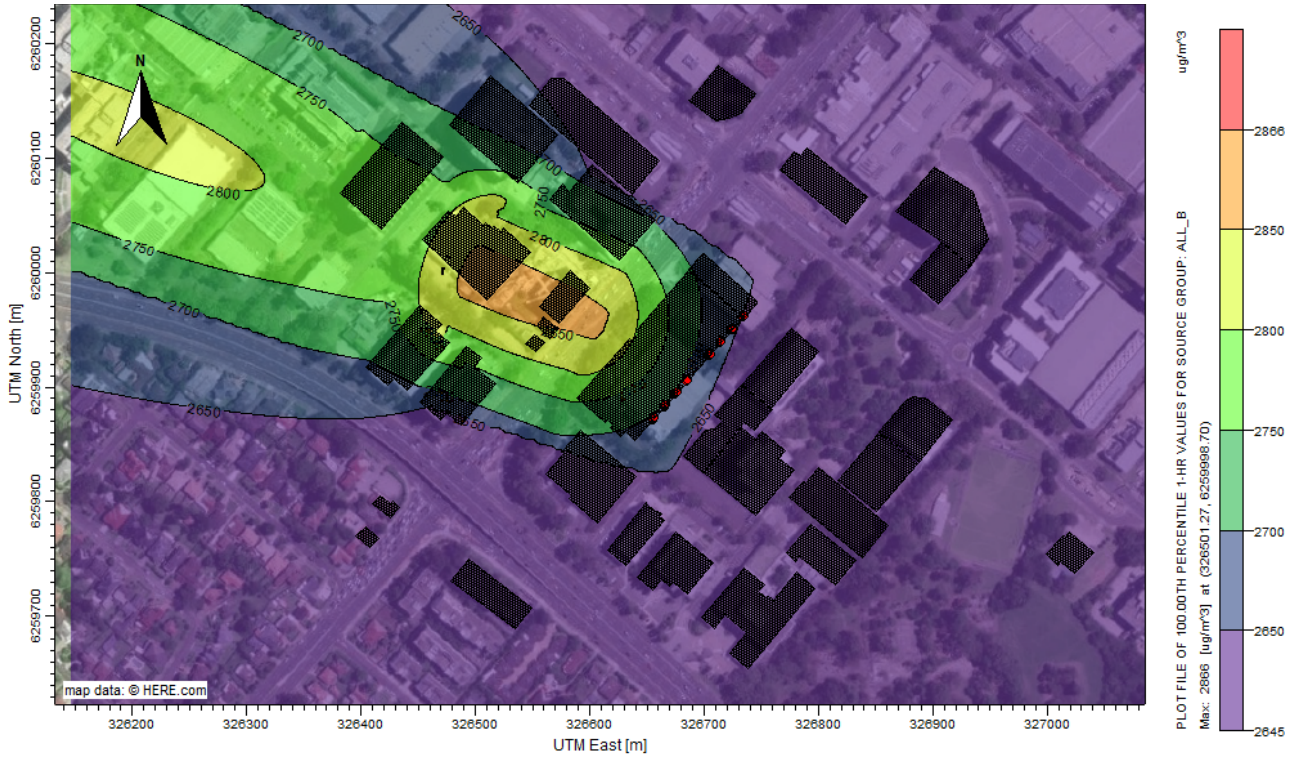
Appendix D

Predicted ground level concentrations – Dispersion modelling contours (Scenario 1)

CO 1-hour Incremental GLCs



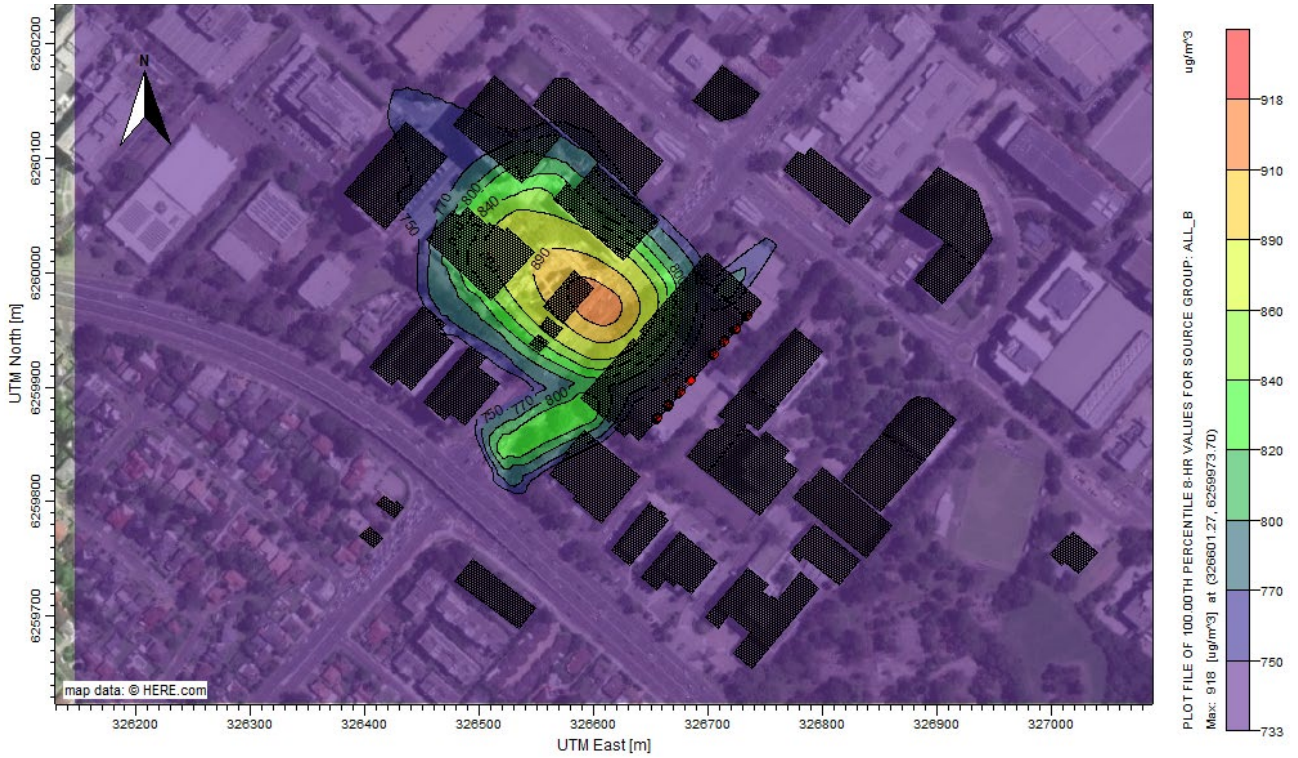
CO 1-hour Cumulative GLCs



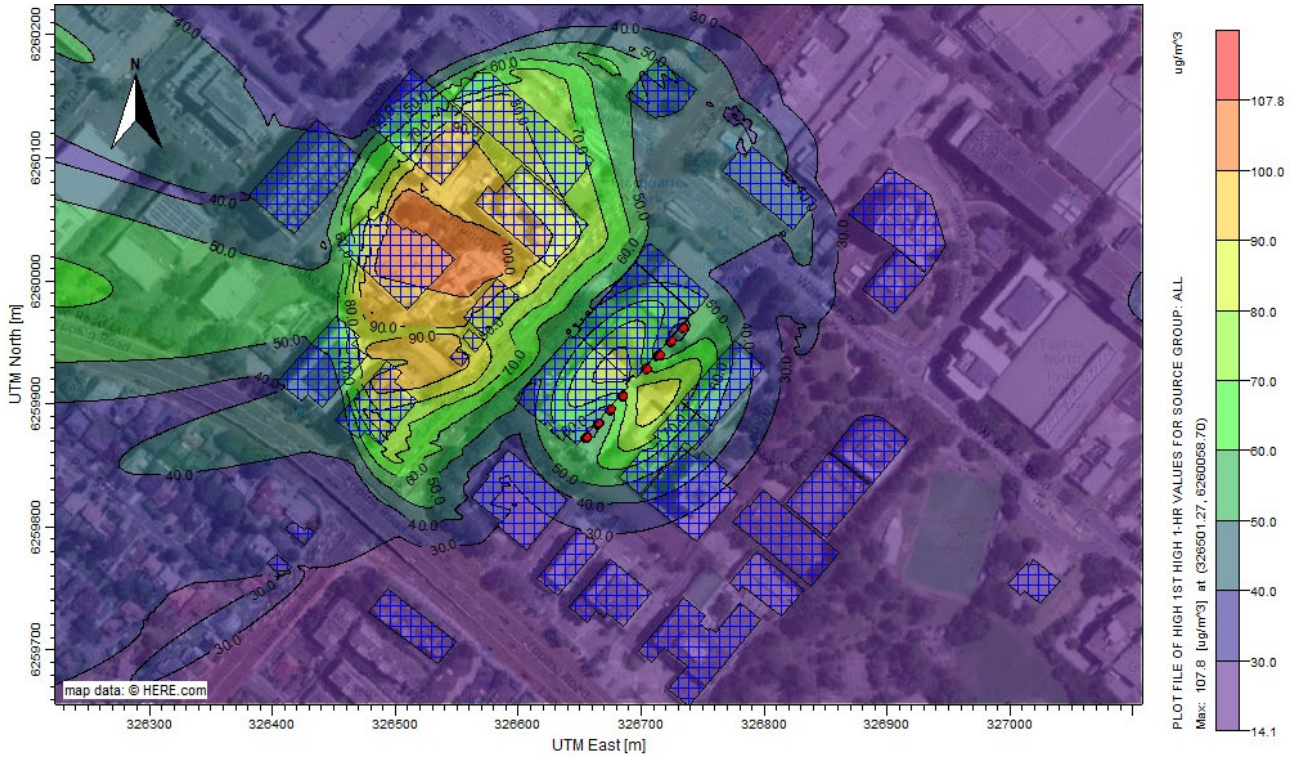
CO 8-hour Incremental GLCs



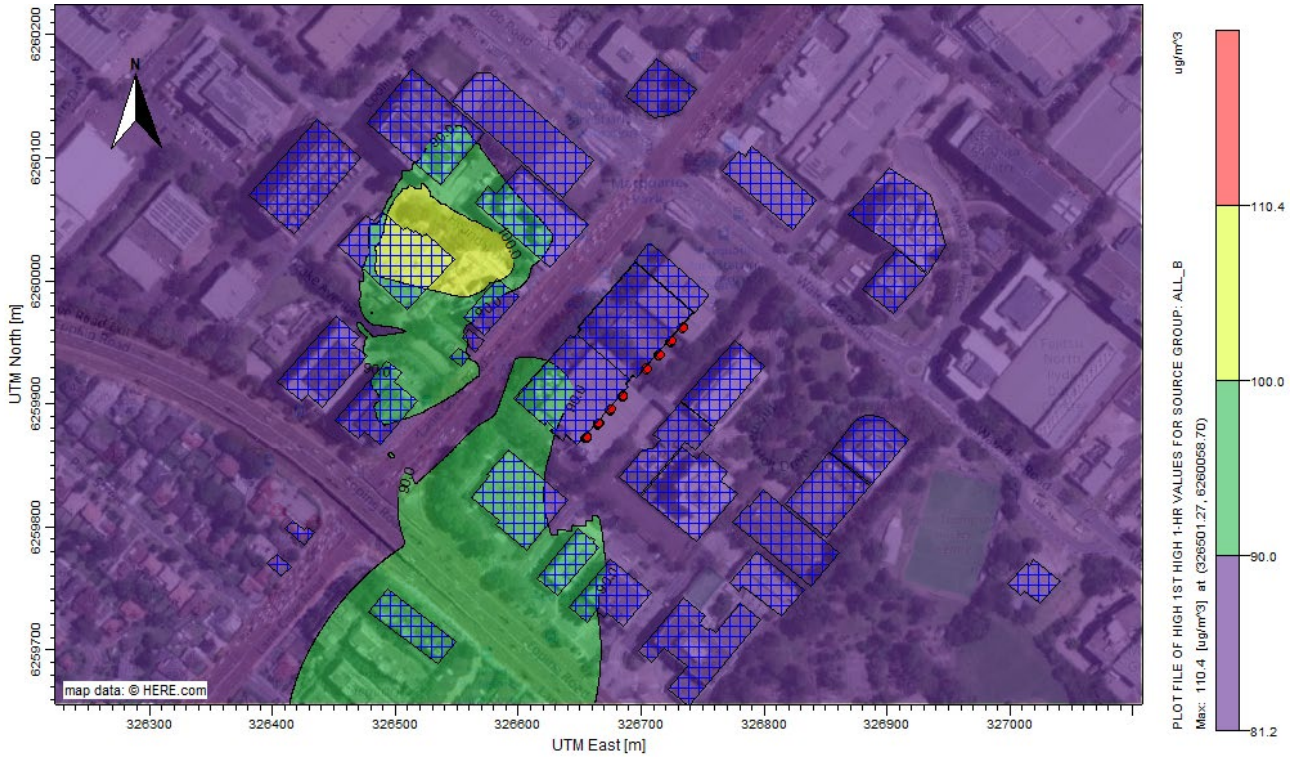
CO 8-hour Cumulative GLCs



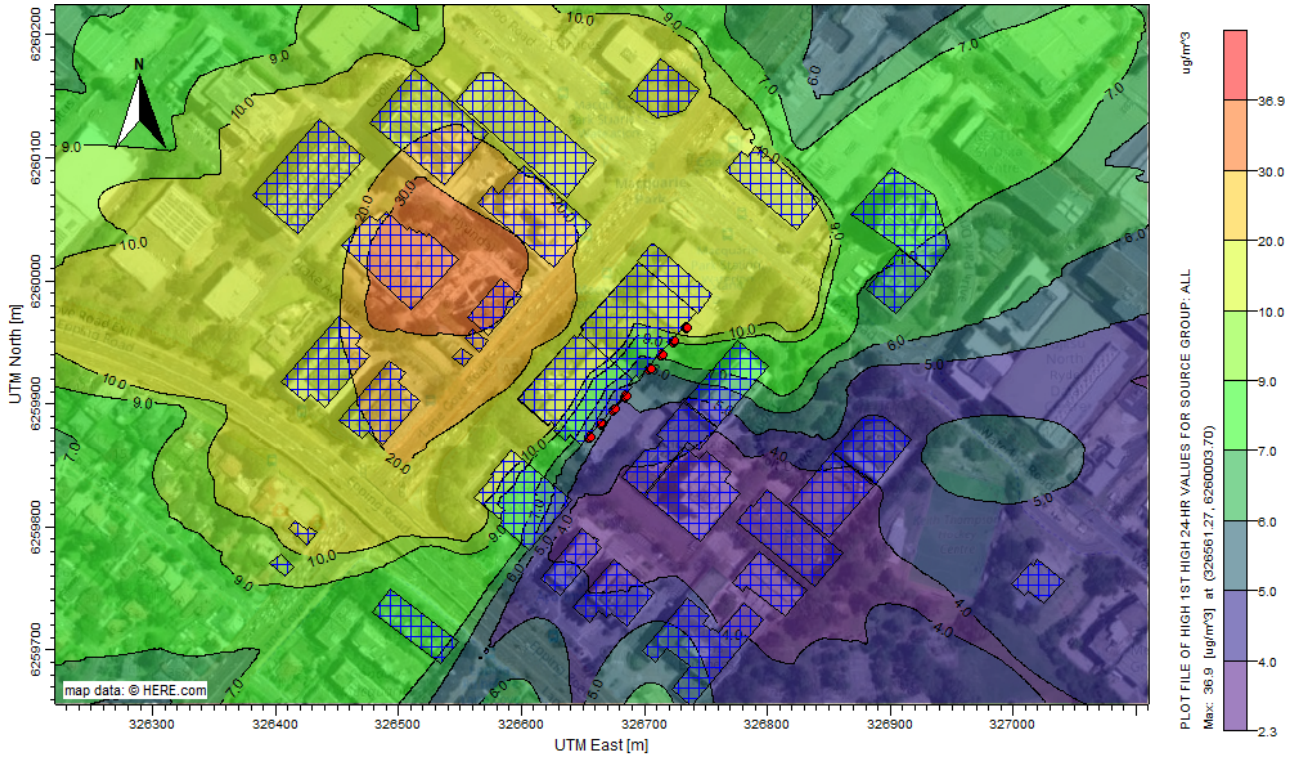
SO₂ 1-hour Incremental GLCs



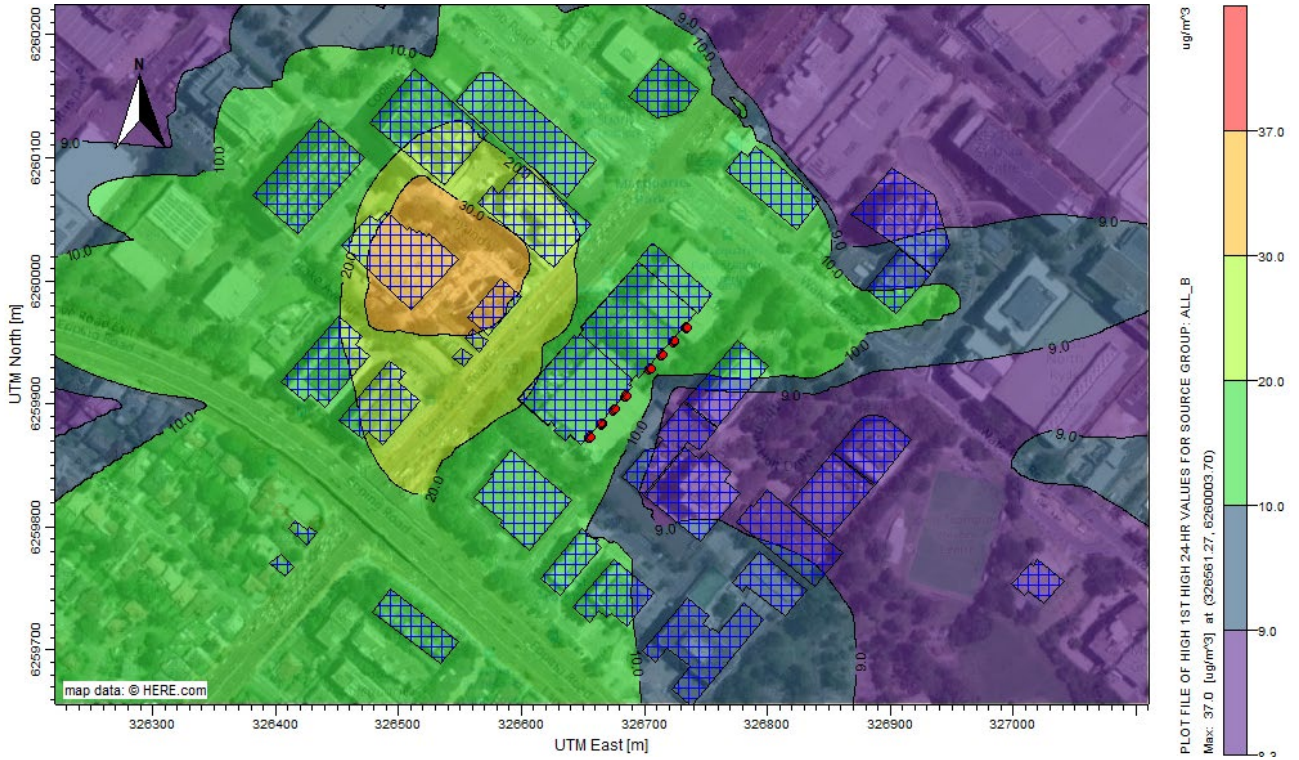
SO₂ 1-hour Cumulative GLCs



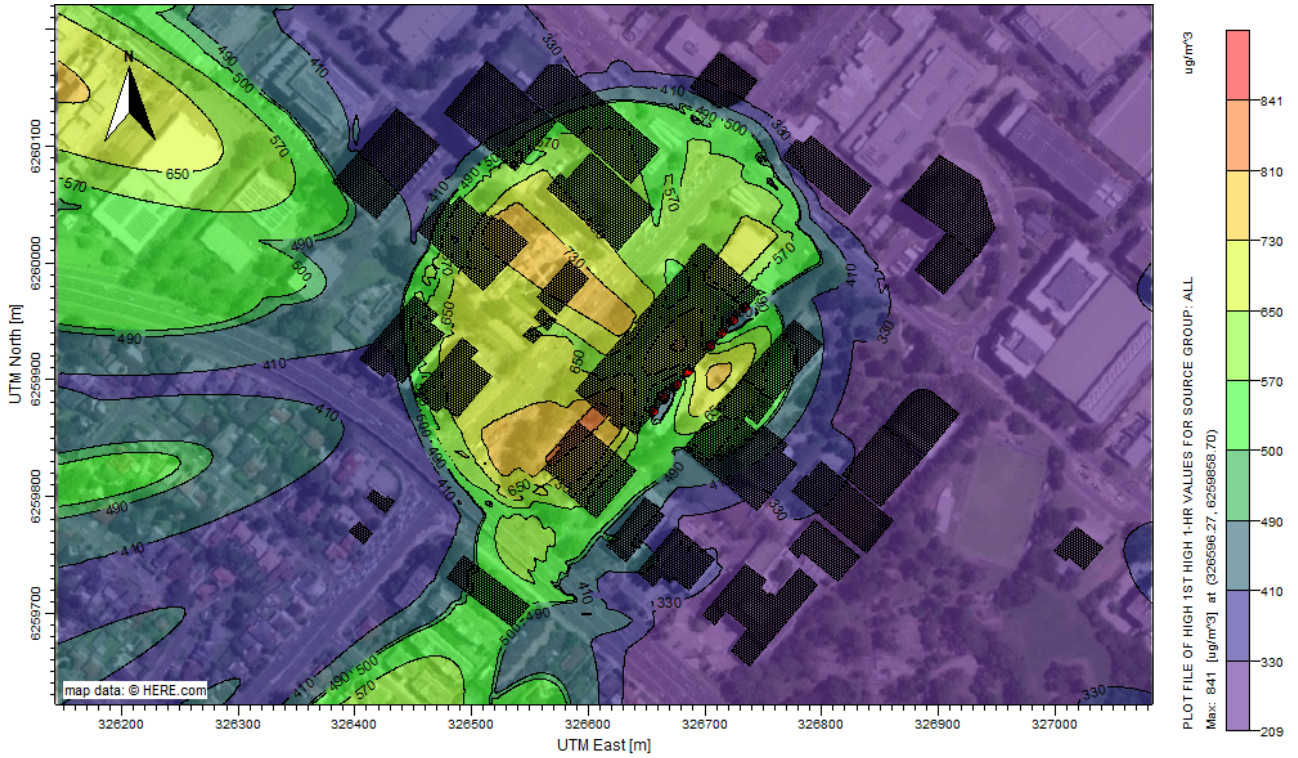
SO₂ 24-hour Incremental GLCs



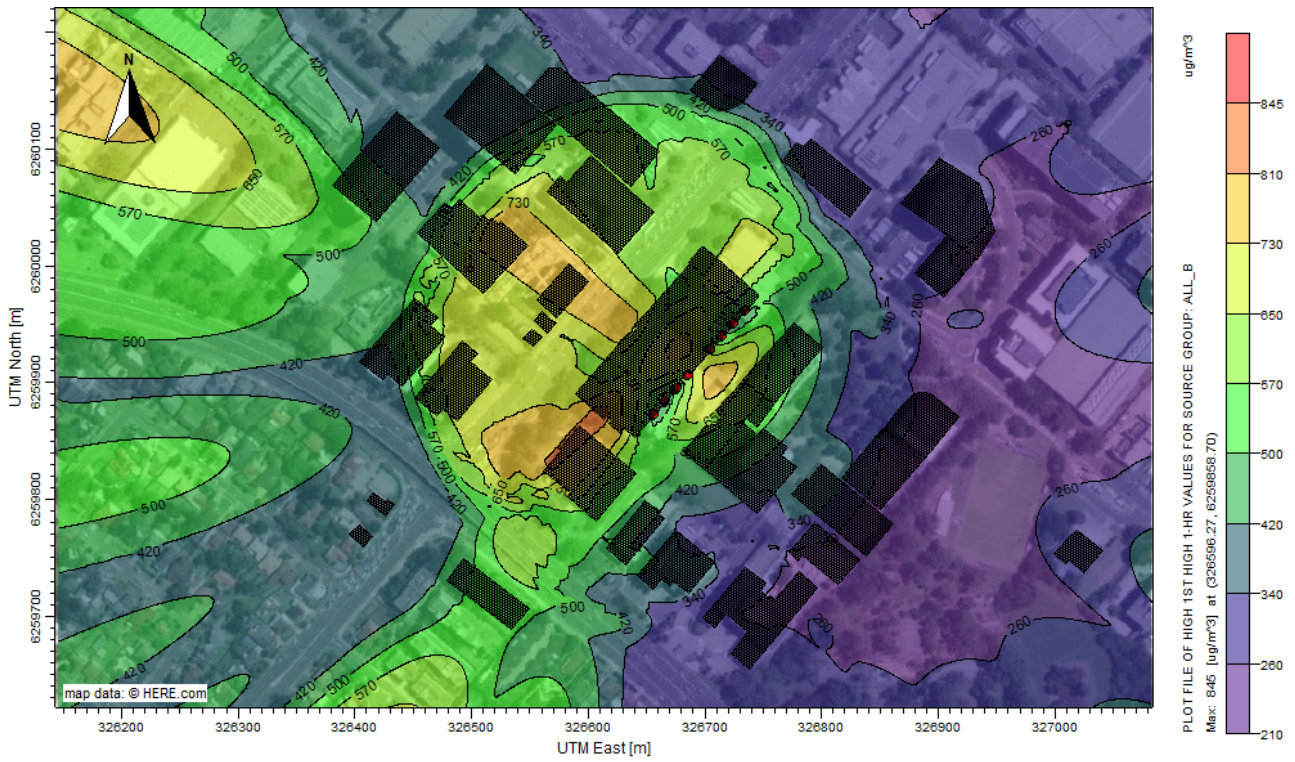
SO₂ 24-hour Cumulative GLCs



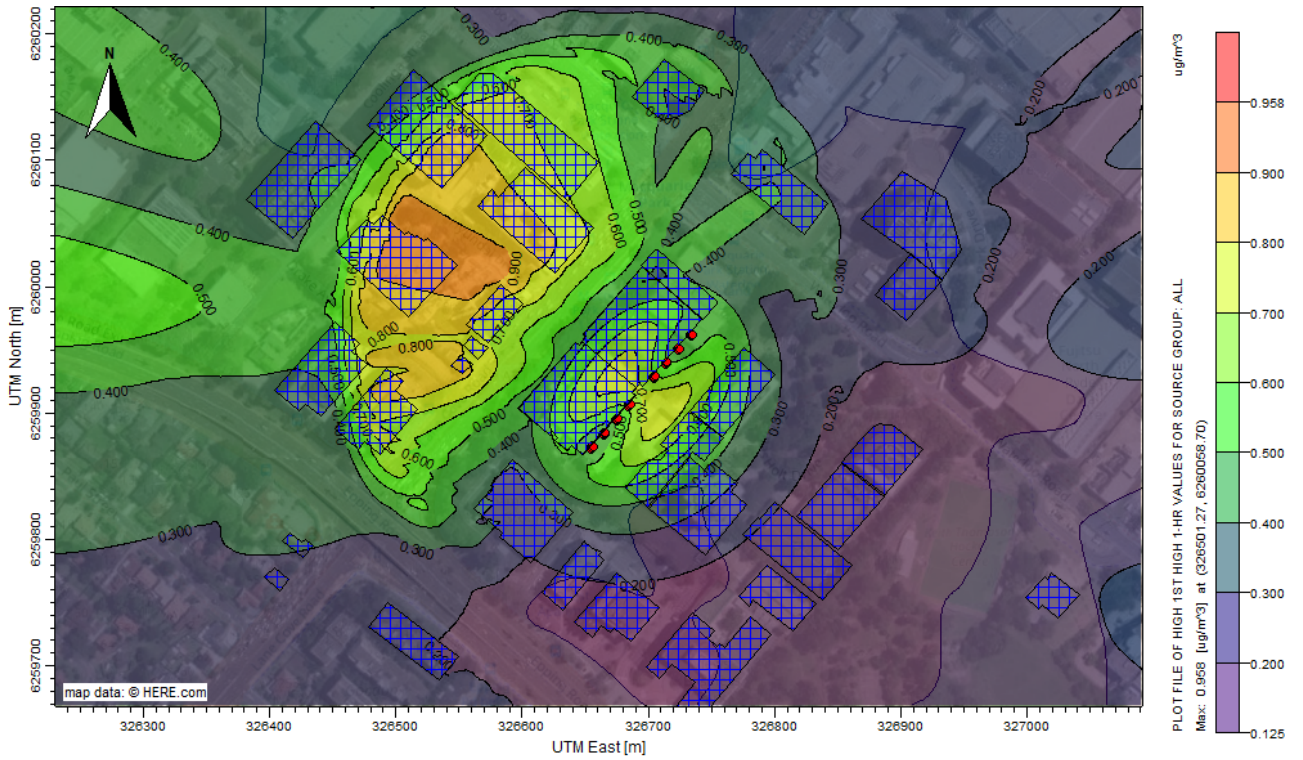
NO₂ 1-hour Incremental GLCs



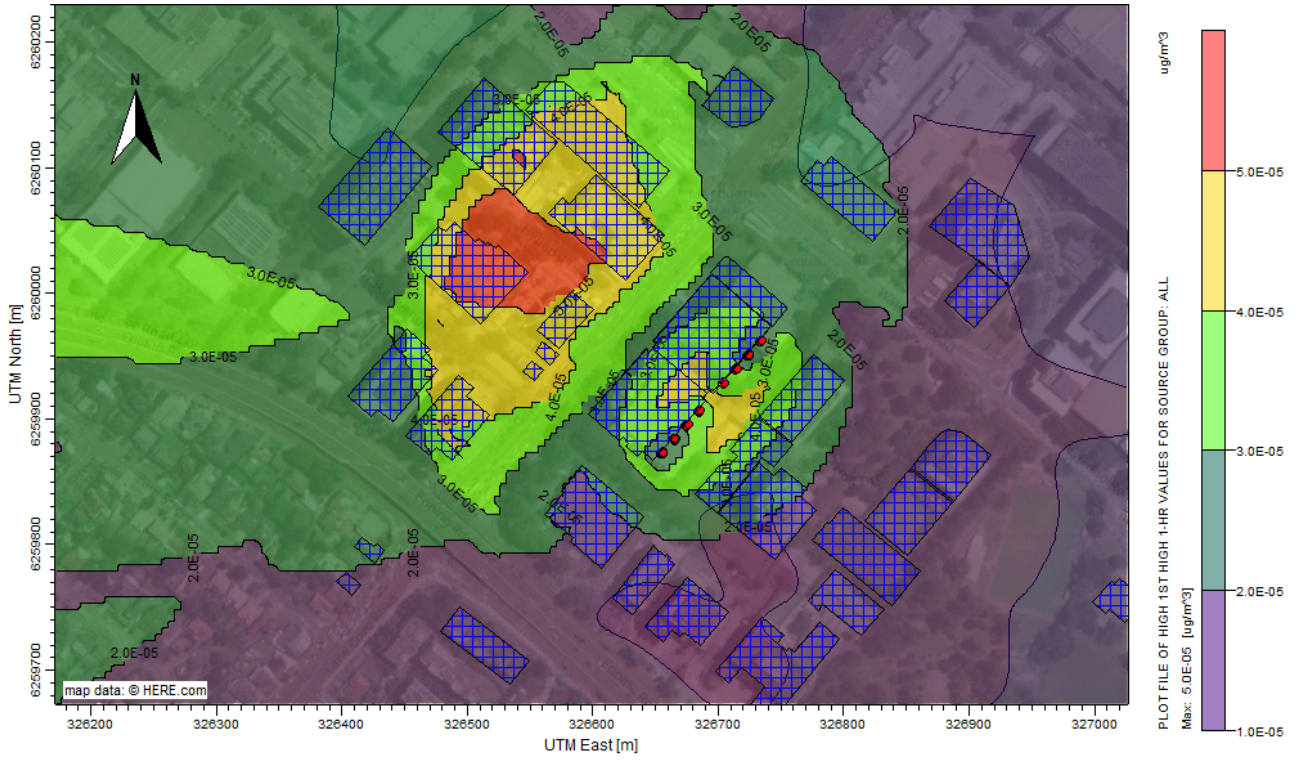
NO₂ 1-hour Cumulative GLCs



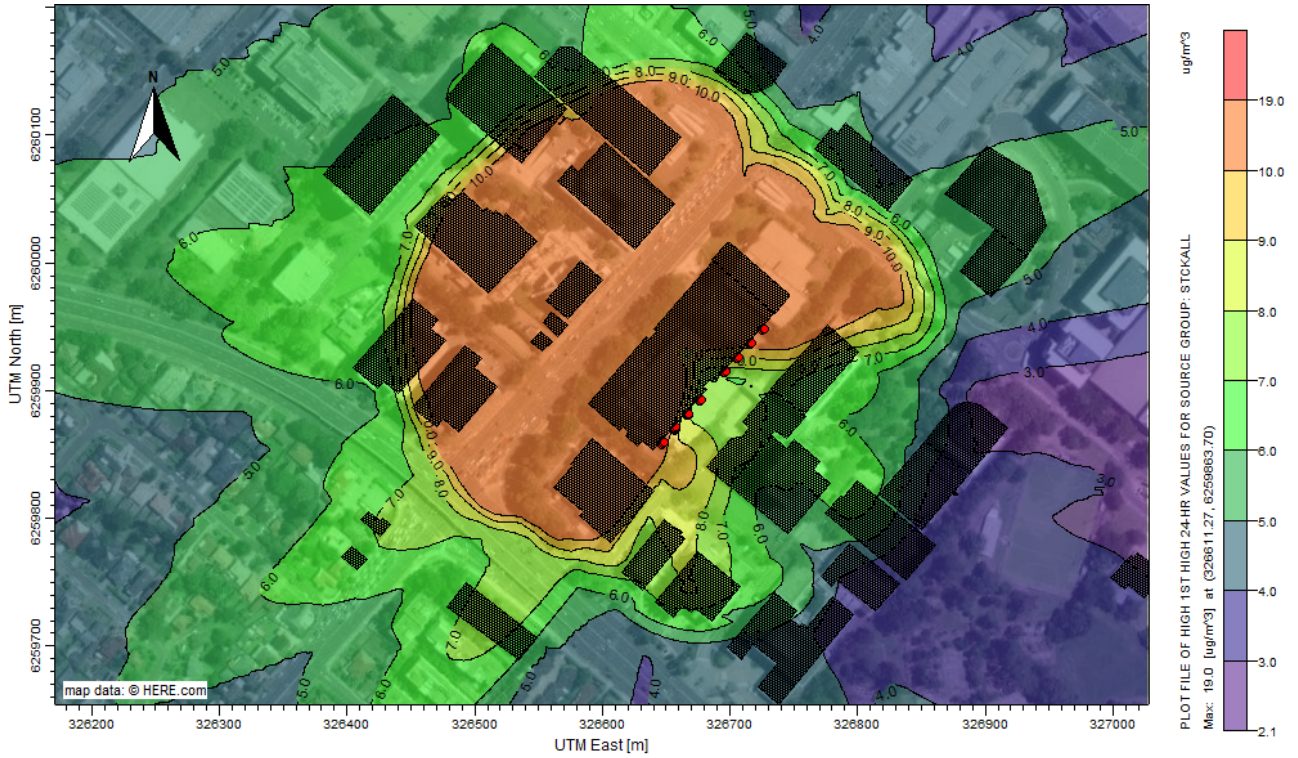
Benzene 1-hour Incremental GLCs



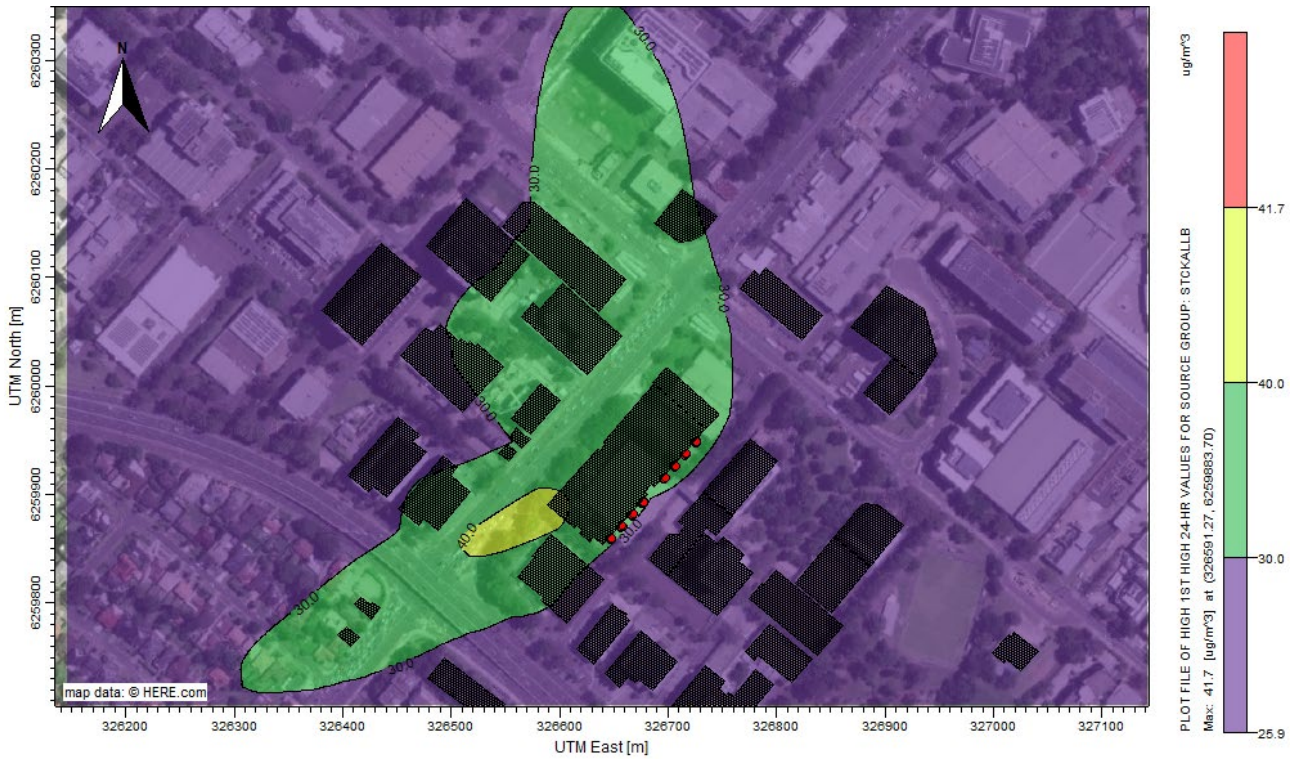
PAH 1-hour Incremental GLCs



PM₁₀ or PM_{2.5} 24-hour Incremental GLCs



PM₁₀ 24-hour Cumulative GLCs



PM_{2.5} 24-hour Cumulative GLCs

