Air Quality Impact Assessment

Proposed Kamerunga to Woree Transmission Line Replacement Project and T274 Substation Development

Powerlink Queensland

JBS&G 64974 | 160,616

31 July 2024

We acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We pay respect to Elders past and present and in the spirit of reconciliation, we commit to working together for our shared future.

Caring for Country The Journey of JBS&G
Artist: Patrick Caruso, Eastern Arrernte

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Executive Summary

Powerlink Queensland (Powerlink) has an existing 132 kilovolt (kV) connection in Cairns, Queensland, between the Kamerunga and Woree Substations, which provides the critical services of connecting the Barron Gorge power station to the transmission network, supplying power to northern cairns. Both the existing 132kV transmission line, and the Kamerunga Substation are reaching the end of their designed life and as such are scheduled for replacement. Powerlink are undertaking a transmission line replacement project for the 132kV transmission line between the existing Kamerunga and Woree Substations, that will also include replacing the existing Kamerunga Substation.

Powerlink have identified that the preferred approach for delivery of the transmission line is via an overhead component from the Kamerunga Substation to a Transition Site in the suburb of Redlynch, and via an underground transmission line (cable), from the Transition Site to the Woree Substation. Additionally, Powerlink have identified a new greenfield site for the new substation due to constructability constraints associated with the existing Kamerunga Substation location.

An assessment of construction-related air emissions impacts has been prepared for the project. The assessment has been undertaken for the construction phase of the open trench and horizontal directional drilling (HDD underboring) for the underground section only, which represents the worst-case scenario for the construction phase of the Project. Construction of the overhead component involves a relatively small number of earthworks compared with the open trench and boring works and as such, pose a lower risk of emissions impacts. Construction of the proposed T274 Substation and the proposed Transition Site will involve placement of fill material to allow for construction above the Q200 flood level. It has been assumed that any risks associated with dust emissions and earthmoving equipment exhaust emissions impacts at nearest residential areas will be mitigated by the distances from the sites to the residences, and through the implementation of suitable mitigation measures as detailed within the Project Construction Environmental Management Plans during construction.

The assessment has therefore focussed on modelling of the dispersion of dust and gaseous emissions from the construction of the underground transmission line in order to predict concentrations of emissions at sensitive locations located in close proximity to the works.

The assessment has identified the following:

- Based on the regional topography and the prevailing wind directions, the greatest potential impacts associated with underground component are predicted to occur at Goomboora Park;
- Dispersion modelling of particulate and gaseous emissions from trenching activities at Goomboora Park has shown predicted ground level concentrations to be below all adopted exposure limits;
- As such, air emissions from the underground component trenching works are unlikely to give rise to adverse impacts to health and well-being of residents of houses located along the entire length of the underground component;
- A cumulative assessment of fine particles (PM_{10} and $PM_{2.5}$) using available monitoring data from Cairns airport, combined with predicted concentrations from the transmission line works shows a low risk of adverse impacts to residents; and
- Based on the fact that the worst-case scenario is below adopted exposure limits, it can be assumed that all other activities (ie. construction relating to the Substation and overhead transmission line) will also be below the adopted exposure limits.

1. Introduction

1.1 Project background

Powerlink Queensland (Powerlink) has an existing 132 kilovolt (kV) connection in Cairns, Queensland, between the Kamerunga and Woree Substations, which provides the critical services of connecting the Barron Gorge power station to the transmission network, supplying power to northern cairns. Both the existing 132kV transmission line, and the Kamerunga Substation are reaching the end of their designed life and as such are scheduled for replacement. Powerlink are undertaking a transmission line replacement project for the 132kV transmission line between the existing Kamerunga and Woree Substations, that will also include replacing the existing Kamerunga Substation.

The existing transmission line was constructed on a 20m wide easement that has seen high levels of urbanisation, particularly between the suburbs of Redlynch and Woree. Powerlink have undertaken a detailed corridor selection process has identified that the preferred approach for delivery of the transmission line is via an overhead component from the Kamerunga Substation to a Transition Site in the suburb of Redlynch, and via an underground transmission line (cable), from the Transition Site to the Woree Substation. Additionally, Powerlink have identified a new greenfield site for the new substation (referred to herein as T274 Substation) due to constructability constraints associated with the existing Kamerunga Substation location.

1.2 Purpose and scope of this report

This Air Quality Impact Assessment (AQIA) has been prepared for the construction phase of the open trench and horizontal directional drilling (HDD under boring) for the underground (UG) component only, which represents the worst-case scenario for the construction phase of the Project.

Construction of the overhead (OH) component involves a relatively small number of earthworks compared with the open trench and boring works and as such, pose a lower risk of emissions impacts. Construction of the proposed T274 Substation and the proposed Transition Site will involve placement of fill material to allow for construction above the Q200 flood level. It has been assumed that any risks associated with dust emissions and earthmoving equipment exhaust emissions impacts at nearest residential areas will be mitigated by the distances from the sites to the residences, and through the implementation of suitable mitigation measures as detailed within the Project Construction Environmental Management Plans during construction.

Therefore, for the purposes of this AQIA, the ‘Project area’ is the UG transmission line corridor proposed between the suburbs of Redlynch and Woree.

The assessment has involved atmospheric dispersion modelling of dust and gaseous emissions from the construction of the UG transmission line, in order to predict concentrations of emissions at sensitive locations nearby the works. This report describes the methodology used for the assessment, the results from the modelling, as well as comparisons of predicted Ground Level Concentrations (GLCs) with relevant air quality standards to identify the potential for adverse impacts to health and well-being of persons residing near to the construction works.

Operational or maintenance activities have not been included within this assessment as there will be minimal to no activities during operation or maintenance that may result in impacts to air quality.

1.3 Structure of this report

The preparation of the AQIA has been undertaken as follows:

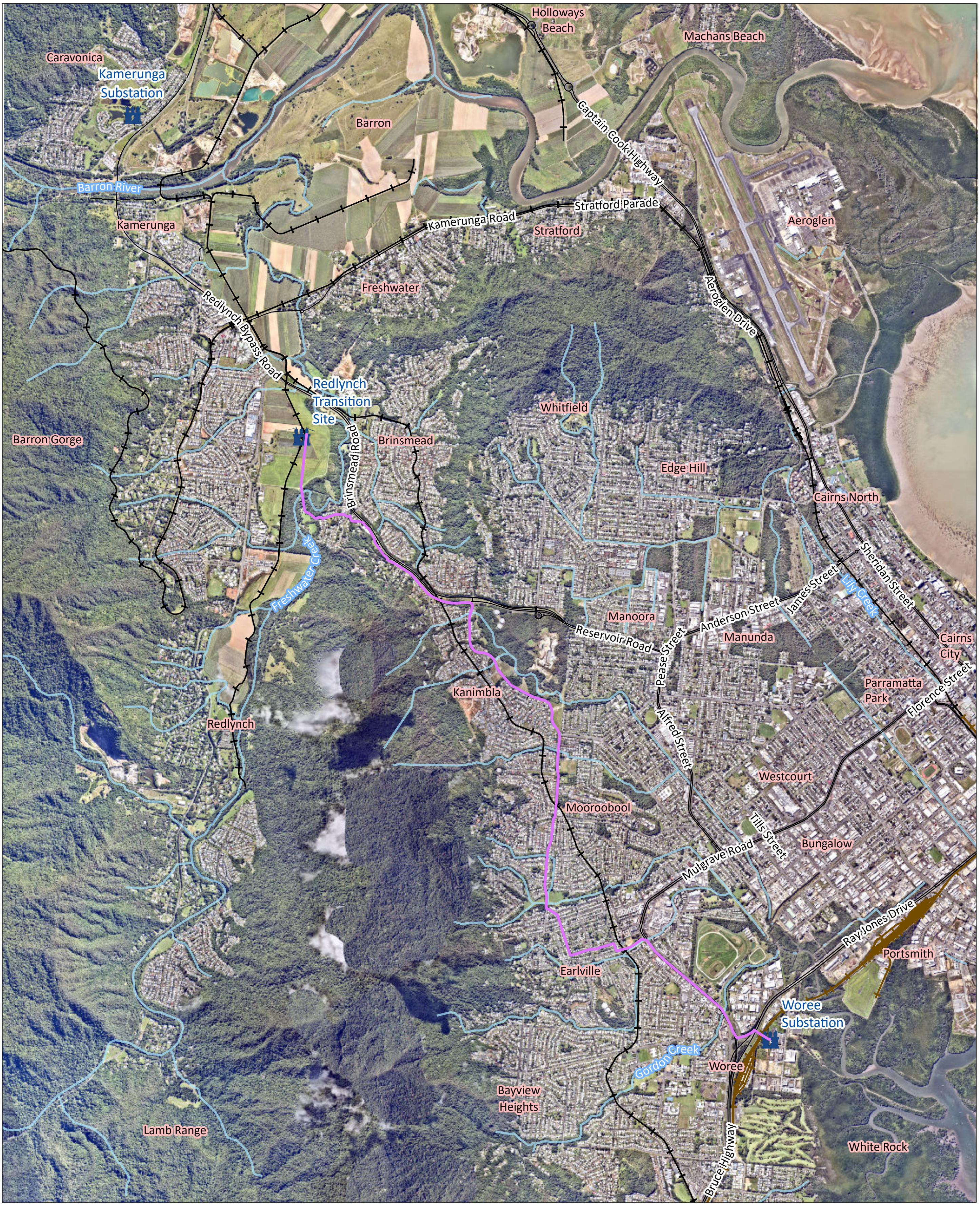
- Description of the project location and construction activities, as well as identification of the locations of potential dust and gaseous emission generating activities associated with the construction phase of the open trench and under boring of the UG transmission line (**Section 2**);
- Identification of relevant legislative requirements (**Section 2.2.2**);
- Identification and preparation of an emissions inventory (**Section 4**);
- Identification of topography and meteorological setting for the Project area (**Section 5**);
- Identification of the proposed modelling methodology, preparation of the model input meteorological files and identification of sensitive receptors (**Section 6**);
- Undertaking of an initial screening level model run to identify the locations of greatest impacts from the emissions from the works along the route, and determination of the activity with the highest emission rate for modelling where peak GLCs are likely to occur. This then narrowed down the various parts of the Project area for modelling of the calculated emission rates from the various construction activities (**Section 7.1**);
- Dispersion model using emissions data for that activity, extract and collate the results for the areas along the route that were identified as having the highest emission rate (**Section 7.2**); and
- Comparison of the predicted GLCs with relevant air quality limits and standards to determine the significance of the emissions (**Section 7.3**).

2. Project description

2.1 Project area

The location of the Project area is shown in **Figure 2-1** and consists mostly of land within State Controlled and Local Council controlled road reserves between the suburbs of Redlynch and Woree. Small sections of freehold land is intersected, mostly associated with the location of the Project area within Goomboora Park.

The Project is being assessed via the Ministerial Infrastructure Designation (MID) Pathway under the *Planning Act 2016*. For the purposes of approval, an ‘MID corridor’ will be approved. For the Project area (the UG component), the MID corridor will mostly extend from property boundary to property boundary where it is located within road reserves, however, the final location within this area will be confirmed during detailed design and following confirmation of interactions with existing underground assets. For the AQIA, a general alignment within this corridor has been selected for the purposes of assessing impacts to air quality.



Legend

- Substation / Transition Site
- State Controlled Road
- Waterway
- North Coast Line
- Railway Corridor
- Project area

Scale 1:55,000

0 1 2 km

Coord. Sys. GDA2020 MGA Zone 55

Date 9/07/2024

Powerlink QUEENSLAND

Kamerunga to Woree Connection Project
Cairns, Queensland

PROJECT AREA

FIGURE 2-1

Reference: ESRI Topographic Basemap - Accessed Imagery: 09/07/2024. nearmap.com - Imagery Date: 16/09/2022

2.2 Construction activities

2.2.1 Underground transmission line

The main construction technique of the UG transmission line will be via trenching, however, under boring techniques will be used in areas to avoid impacts to existing in-ground infrastructure, waterways, major roads, or rail lines. Under boring types include HDD, encompassed HDD, pipe jacking and auguring.

These activities have the potential to generate airborne emissions of particulates (dust) from excavation and materials (soil) handling for the trenching works, and spoil handling from underboring works. Exhaust emissions of nitrogen and sulfur oxides, carbon monoxide, fine particles (soot) and volatile organic compounds (VOCs) will also be generated from diesel-powered machinery such as excavators, loaders, and trucks.

As such, an assessment of the potential impacts of these emissions is required to identify the potential risk to health and amenity for sensitive receptors within proximity to the construction activities.

The high-level construction methodology is detailed in **Table 2-1**.

Table 2-1 UG transmission line construction methodology

Activity group	Field activities	Construction window
Under borings and conduits	• Site set out • Establish launch and retrieval locations • Install under borings • Install conduits • Site reinstatement	Year 1
Trenching and conduits	• Site set out and excavate • Install conduits • Backfill with thermal backfill • Temporary surface reinstatement • Final surface reinstatement	Years 1 and 2
Joint bays	• Site set out and excavate • Install framework • Pour concrete footing and wall • Install covers	Years 1 and 2
Cable installation and jointing	• Clean conduits • Set up cable drums and winching equipment • Pull cable in • Make joints • Testing and commissioning	Years 2 and 3

2.2.2 Substation and Transition site works

Construction of the proposed T274 Substation will involve earthworks to prepare a 220 m x 110 m pad, with an average fill depth of 3 m. A batter will surround the pad, with overall dimensions of the earthworks area of 255 m x 156 m.

A smaller area of 40 m x 20 m x 2 m fill will be required within the Suburb of Redlynch for the Transition Site substation.

The risk of dust emissions from those earthworks will be mitigated by the distances from those sites to the nearest residences (350 to 600 m) and the implementation of Construction Environmental Management Plans for those activities. The primary control measures will involve maintaining adequate moisture levels in the fill material and for all activities at the site. Soil stabilisation will be carried out as appropriate to minimise the risk of wind erosion as a source of dust emissions, in particular, for hot and dry periods.

Risks from earthmoving machinery exhaust emissions are also mitigated by the separation distances from the earthwork's activities and nearby residential areas.

2.2.3 Overhead transmission line works

The OHL works involves a relatively minor number of earthworks for construction of footings for the towers. Similar to the Substation and Transition Site, risks from dust emissions can be mitigated from implementation of a Construction Environmental Management Plan.

3. Legislative considerations

3.1 National Environmental Protection (Ambient Air Quality)

The Commonwealth *National Environment Protection Council Act 1994* (NEPC Act), and complementary State and Territory legislation allow the National Environment Protection Council to make National Environment Protection Measures (NEPMs). NEPMs are a special set of national objectives designed to assist in protecting or managing particular aspects of the environment. NEPMs can be made about a variety of environmental matters as prescribed by the NEPC Act, one of which is for ambient air quality.

The NEPM for Ambient Air Quality specifies air quality goals for particles as PM_{10} and $PM_{2.5}$, as well as for other pollutants generated from earthmoving activities (NOx, SO_2 and CO) These are also captured within the Queensland Environmental Protection (Air Quality) Policy 2019 (EPP (Air)) as specified below, albeit that the values for NOx and SO_2 in the EPP (Air) have been superseded by the revised values from the 2021 amendment to the NEPM.

3.2 Environmental Protection (Air Quality) Policy 2019

The EPP (Air) provides air quality objectives for a range of compounds with the potential to impact on the health and well-being and aesthetics of the environment. Specifically, the objectives are intended to enhance or protect the following environmental values:

(a) the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and

(b) the qualities of the air environment that are conducive to human health and wellbeing; and

(c) the qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures, and other property; and

(d) the qualities of the air environment that are conducive to protecting agricultural use of the environment.

Table 3-1 presents a summary of the air quality objectives applicable to the assessment from the EPP (Air). The substances listed (indicators) are based on those listed in the National Pollutant Inventory emissions factors for fugitive emissions (NPI 2012a), mining (NPI 2012b) and combustion engines (NPI 2008).

Table 3-1 Schedule 1 EPP (Air) Quality Objectives

Indicator	Environmental value	Air quality objective (µg/m3)	Period
Total suspended particles	Health and wellbeing	90	1 year
PM10	Health and wellbeing	50	24 hour
		25	1 year
PM2.5	Health and wellbeing	25	24 hour
		8	1 year
Nitrogen dioxide (NO2) as NOx	Health and wellbeing	164	1 hour
		28	1 year
	Health and biodiversity of ecosystems	62	1 year
Sulfur dioxide (SO2)	Health and wellbeing	286	1 hour
		57	24 hour
	Protecting agriculture	31	1 year
	Health and biodiversity of ecosystems	21	1 year

Indicator	Environmental value	Air quality objective (µg/m3)	Period
Carbon monoxide (CO)	Health and wellbeing	11,000	8 hour
Formaldehyde	Health and wellbeing	54	24 hour
	Aesthetic environment	109	30 minutes
Polycyclic aromatic hydrocarbons (as BaP)	Health and wellbeing	0.0003	1 year

Notes:

1. VOCs are included in the emissions factors for combustion emissions but no objective is provided in the EPP (Air).
2. NOx emissions include NO and NO_2, reported as NO_2.

3.3 Safe Work Australia Exposure Standards

The close proximity of some residences to the UG transmission line route, and the short duration of exposure to the emissions for any single residence, suggests that the NEPM and EPP (Air) objectives are not necessarily relevant to inform the actual risk from those emissions. Those standards and objectives are intended to be protective of the population that is inclusive of individuals who are more susceptible to impacts from airborne pollutants. They are not intended as a "pass/fail" criteria whereby exceedance of a limit or objective will lead to adverse impacts to health and well-being of an individual.

The nature of the trenching activities is that each residence may only be directly impacted for numbers of hours in one day when the activities occur directly opposite that residence, and to a lesser extent for day(s) when activities occur in front of adjoining and nearby residences. This means the risk from particulate and gaseous pollutants emitted from the trenching activities is limited to acute impacts that may occur over that time frame. Boring activities present the potential for impacts at a particular location for a longer period of time, likely to be limited to 1 week or thereabouts. The risks from trenching and boring at any location are not ongoing and will be short-term in nature during the construction phase of the Project.

A more appropriate benchmark to assess the acute risk from the trenching and boring activities could be occupational exposure standards. In effect, the close proximity of those works to the residences is akin to those residences being part of the workplace. Occupational exposure standards consider acute impacts via Short Term Exposure Limits (STELs) and ongoing impacts from the 8-hour Time Weighted Average (TWA) limits.

Therefore, the significance of the emissions exposures from the trenching activities has been considered from comparison with occupational exposure standards from Safe Work Australia, which are listed in **Table 3-2**.

Note that PM_{10} and $PM_{2.5}$, and PAHs are not listed in the Safe Work exposure standards. Coal tar pitch volatiles, which are listed by Safe Work, contain PAHs and as such have been utilised as a surrogate for PAHs. In regard to PM_{10} and $PM_{2.5}$, Business Queensland provides exposure limits for dust emissions from mineral mines and quarries that appear appropriate for assessment of acute impacts from trenching activity dust emissions. Those limits are 5.0 mg/m^3 (TWA) for respirable dust and 10 mg/m^3 (TWA) for inhalable/inspirable dust.[1] PM_{10} are $PM_{2.5}$ are considered as respirable dust sizes, so the 5.0 mg/m^3 (5,000 µg/m^3) TWA value has been utilised for the assessment of PM_{10} and $PM_{2.5}$ emissions impacts (see **Table 3-2**). The 10 mg/m^3 (10,000 µg/m^3) TWA value has been used for assessment of Total Suspended Particles (TSP) emissions.

[1] https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/hazards/dust/exposure-limits

Table 3-2 Safe Work Australia and Business Qld Workplace Exposure Standards

Emission parameter	Equivalent occupational exposure parameter	Time weighted average (µg/m3)	Short term exposure level (µg/m3)	Reference
Total suspended solids	Inhalable dust	10,000	Not listed	Business Qld
PM10	Respirable dust	5,000	Not listed	Business Qld
PM2.5				
Nitrogen dioxide (NO2) as NOx	Nitrogen dioxide	5,600	9,400	Safe Work Australia
	Nitric oxide	31,000	Not listed	
Sulfur dioxide (SO2)	Sulfur dioxide	5,200	5,000	Safe Work Australia
Carbon monoxide (CO)	Carbon monoxide	34,000	Not listed	
Formaldehyde	Formaldehyde	1,200	2,500	Safe Work Australia
Polycyclic aromatic hydrocarbons (as BaP)	Coal tar pitch volatiles	200	Not listed	Safe Work Australia

4. Emissions inventory

4.1 Overview

Emissions inventories for dust and gaseous emissions were prepared for the respective activities associated with the works. Dust emission rates for TSP and PM_{10} were calculated using NPI emission factors for fugitive emissions (NPI 2012a) and mining operations (NPI, 2012b), and gaseous emission rates from diesel powered machinery calculated from NPI emission factors for combustion engines (NPI, 2008). Details of the calculations are shown below.

4.2 Dust emissions

Dust emission rates for the various activities have been calculated using the volumes of soil handled for those activities and the NPI emission factors. Control factors have been applied that reflect the application of standard dust management practices for earthworks, which largely involve wetting of soils during excavation and handling. An allowance has also been made for inherent moisture in the soil excavated in the trenching operations on the assumption that the soil underlying roadways receive some rainwater from infiltration through cracks in the road surface, leaks in the stormwater drainage system and from nearby gardens and grassed areas.

The majority of the UG transmission line will be constructed using open trenching along residential streets. As such, this provides the greatest potential for dust impacts due to the relatively close proximity of residential premises. The underboring works constitute approximately 10% of the route and as such are considered as having a lower or at worst, an equivalent potential for dust impacts at any location..

Powerlink has advised that the works will be carried out in the dry season months, to avoid the potential for flooding of open trenches and joint bays during the wet season months. This means that the modelling has not considered the impacts of rainfall on soil moisture and wet deposition of pollutants.

4.2.1 Dust emissions from trenching works

The NPI emission factors are based on the mass of materials handled (i.e., kg of dust emitted per tonne of material) for various earthmoving activities. The trenching operations associated with the UG component will involve the following materials handling activities:

- Removal of road surface and road base;
- Excavation of trench to a depth of nominal 1600 mm and width of nominal 1380 mm;
- Trucking of the excavated soil from the excavation site to a location elsewhere for disposal;
- Laying of conduits for electrical cabling in the trench;
- Encapsulation of the conduits with a low strength cement (thermal backfill); and
- Replacement of road base and resurfacing.

A diagram (not to scale) of a typical trench cross section is shown in **Figure 4-1**.

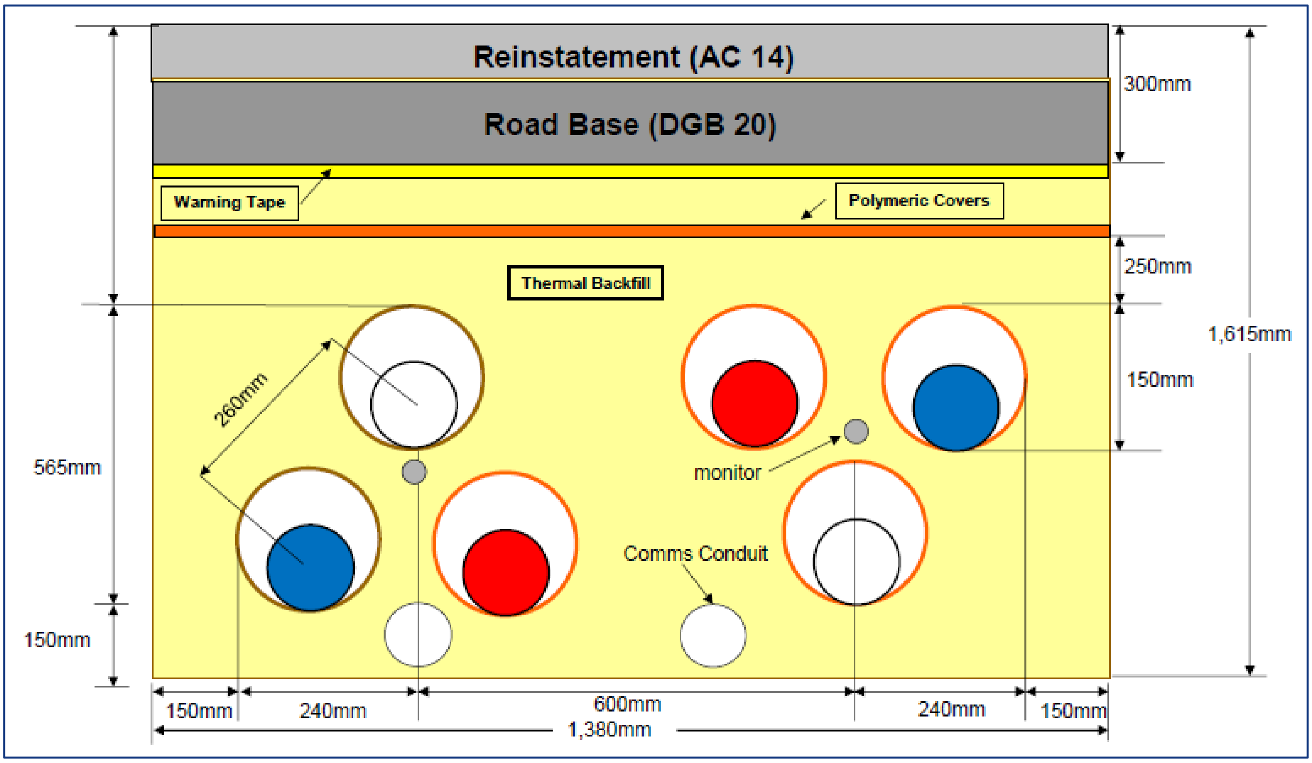


Figure 4-1 Typical roadway trench cross section (not to scale)

This AQIA has been undertaken on the basis that a total of 96 m of trench will be excavated per 8-hour day which equates to a total of 187.5 m^3 of soil. Following placement of conduits, the void will be filled with thermal backfill (low strength cement) prior to placement of road base and temporary (and then permanent) reinstatement of the road surface (bitumen and aggregate). These activities are unlikely to be significant sources of dust emissions, with the soil excavation and handling activities providing the greatest potential for dust emissions. The dust emission rates from excavation are therefore determined from handling of 187.5 m^3 of soil which equates to 243.7 tonne per 8 hour working day (30.5 t/hour) based on a soil bulk density of 1.3 tonne/m^3. The same rate is assumed for handling of spoil from underground boring activities.

Details of the dust emission rates calculated for the various activities are shown in **Table 4-1**.

The excavation of trenches or underground boring and loading of trucks along the various streets were identified as having the highest emission rates. TSP and PM_{10} emission rates from those activities were therefore modelled to provide a conservative (worst-case) understanding of dust impacts at nearby receptors.

Table 4-1 Dust emission rate calculations for trenching, boring and construction of joint bays

Activity	TSP emission factor (kg/t)	PM10 emission factor (kg/t)	Dust emission controls	Control factor	TSP emission rate (g/s) with controls	PM10 emission rate (g/s) with controls
Removal of road surface	0	0	Bitumen and blue metal is low dust emitter	Assume negligible dust emissions	0	0
Removal of road base	0	0	Aggregate and limestone road base has low fines content, manual wetting of materials during excavation	Assume negligible dust emissions	0	0
Excavation of trench and loading trucks	0.025	0.012	Manual wetting of materials during excavation plus inherent soil moisture	95%	0.0106	0.0051
Underground boring spoil loading into trucks	0.025	0.012	Manual wetting of materials during handling plus inherent soil moisture	95%	0.0106	0.0051
Transport of soil in dump trucks to offsite disposal site	0	0	Covered trucks	100%	0	0
Placement of road base	0	0	Wetting of aggregate	Assume negligible dust emissions	0	0
Placement of road surface	0	0	Bitumen and blue metal are low dust emitters	Assume negligible dust emissions	0	0
Excavation of joint bays	0.025	0.012	Manual wetting of materials during excavation plus inherent soil moisture	95%	0.0045	0.0022
Loading of trucks	0.025	0.012	Manual wetting of materials during excavation plus inherent soil moisture	95%	0.0045	0.0022
Transport of soil in dump trucks to offsite disposal site	0	0	Covered trucks	100%	0	0

4.3 Gaseous emissions

The primary source of gaseous and carbonaceous fine particle emissions (from the diesel-powered machinery) is likely to be excavators used for the open trenching works and spoil handling from boring activities in the streets along the UG transmission line route. An assumption is made that a single excavator will operate continuously for each 8-hour working day, removing soil to build the trenches, loading of soil from trenching and boring into trucks.

NPI emissions factors for diesel powered track type loaders were used to calculate gaseous and fine particle emissions. Those factors are in units of kg pollutant per kWh of power. An excavator of 81 kW power rating has been specified for trenching works. Details of the calculated emission rates are shown in **Table 4-2**.

Table 4-2 Gaseous and fine particle emission rates from trenching and spoil handling

Emission substance	Emission factor (kg/kWh)	Emission rate (g/s)
Carbon Monoxide (CO)	0.003	0.11
Formaldehyde	0.00013	0.0048
Nitrogen oxides (NOx)	0.012	0.44
PM2.5	0.00081	0.030
PM10	0.00088	0.032
PAH	0.00000058	0.000021
Sulfur dioxide (SO2)	0.0000075	0.00028
VOCs	0.0015	0.055

5. Existing environment

5.1 Topography

The topography of the Cairns area consists of a coastal flood plain of the Cairns city that is bordered to the west and northwest by the Whitfield Range and extends approximately 10 km southwards to Edmonton (**Figure 5-1**). The terrain provides a barrier to wind flows in the westerly direction, with the prevailing winds at ground level tending follow the elevated terrain of that range.

Elevation within the Project area has minimal variation, ranging from between approximately 5 m Australian Height Datum (AHD) and 20 mAHD, with elevation reaching a peak of approximately 50 m AHD along Brinsmead Road.

Legend

- Substation / Transition Site
- State Controlled Road
- Waterway
- Topographical Contour (50m)
- North Coast Line
- Railway Corridor
- Project area

Scale 1:55,000

0 1 2 km

Coord. Sys. GDA2020 MGA Zone 55

Date 9/07/2024

Kamerunga to Woree Connection Project
Cairns, Queensland

TOPOGRAPHY

FIGURE 5-1

Reference: ESRI Topographic Basemap - Accessed Imagery: 09/07/2024. nearmap.com - Imagery Date: 16/09/2022

5.2 Climate

The Bureau of Meteorology (BoM) operates a network of monitoring stations around Australia that have long-term climatic data available for analysis. The closest BoM station to the Project area is Cairns Aero (Station No. 031011) located approximately 5 km from the Project area.

Climate data across the Project area is consistent with a warm tropical climate. Mean annual temperatures vary from 17.2°C to 31.5°C, with the lowest average temperature recorded at 17.2°C (July) and the highest at 31.5°C (December/January). Average monthly rainfall varies from 26.2 mm (August) to 435.1 mm (February). Historical climate data presented in **Table 5-1** shows that the highest rainfall occurs during the summer months, with late winter / early spring experiencing the least rainfall. The overall total annual rainfall for the area is 2,018.7 mm. The highest average relatively humidity for the area is recorded in February/ March/ April at 78%, while the lowest average relatively humidity is recorded in September at around 55%. All historical data indicates that the morning periods are higher in relative humidity compared to afternoon periods, with the greatest variations occurring in August during the winter period.

Temperature, rainfall, and wind data from the Cairns Aero weather station are summarised in **Table 5-1**.

Table 5-1 Climate data for Cairns Aero (No. 031011) weather station

Month	Mean temperature (°C)		Mean Relative humidity (%)		Mean wind speed (km/h)		Rainfall (mm)
	Maximum	Minimum	9 am	3 pm	9 am	3 pm	Mean
January	31.5	23.8	75	66	8.8	15.6	402.1
February	31.3	23.8	78	69	8.9	14.6	435.1
March	30.7	23.2	78	67	12.2	17.3	420.5
April	29.4	21.7	78	65	14.5	19.0	201.7
May	27.7	20.0	76	64	14.7	17.9	91.7
June	26.1	18.0	74	61	15.9	18.1	46.3
July	25.8	17.2	72	58	15.7	18.7	33.2
August	26.7	17.4	70	56	14.8	19.6	26.2
September	28.2	18.8	66	55	13.9	20.5	32.8
October	29.7	20.7	65	57	11.3	19.1	47.4
November	30.8	22.3	68	60	10.0	18.0	88.7
December	31.5	23.4	70	62	9.2	17.0	187.5
Annual	29.1	20.9	72	62	12.5	18.0	2,018.7

Source: BoM 2024; Key: red = highest value, blue = lowest value

An annual wind rose for data from 2019-2023 (inclusive) is shown in **Figure 5-2**. Monthly wind roses are shown in **Appendix A**.

The prevailing winds are dominated by southerly to south easterlies across the year, with some easterly to northerly winds observed in October to December, and some westerlies observed in December to February. The dominant S-SE winds essentially run from south to north across the coastal flood plain alongside the Whitfield Range, where they are constrained by the valley through the range at Brinsmead. These terrain effects are expected to influence the local meteorology and air flows that will determine the extent of dispersion of emissions from the trenching activities.

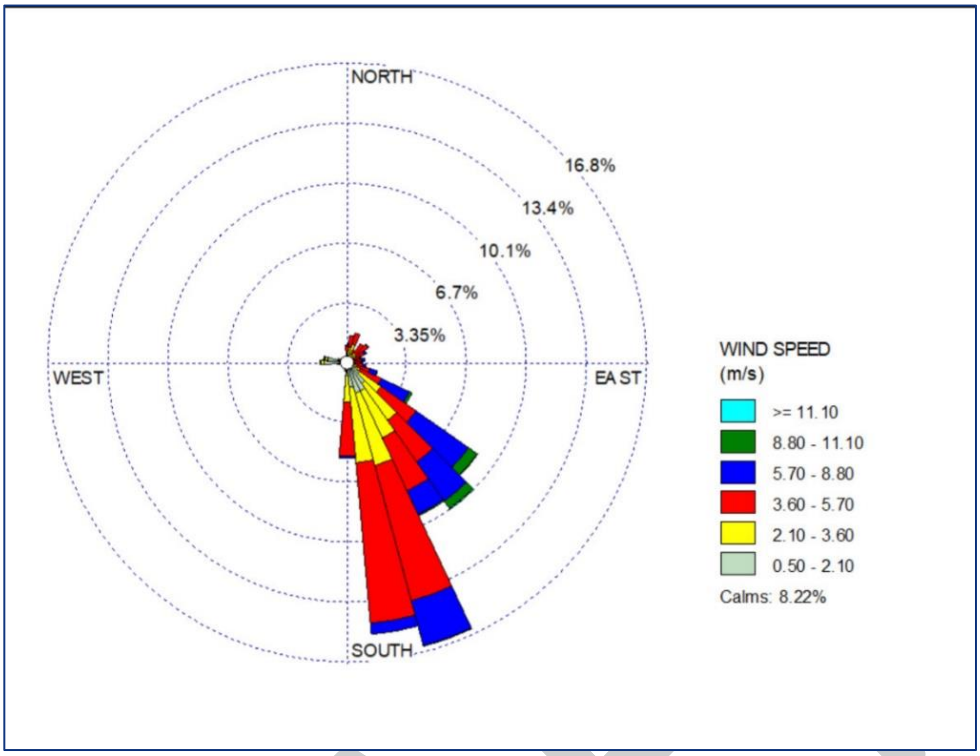


Figure 5-2 Wind rose for BOM Cairns Airport station 2019-2023

6. Modelling methodology

6.1 Air dispersion model

Air dispersion modelling was carried out using the AERMOD, version 21112 (USEPA 2021). AERMOD 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.

There are two input data processors that are regulatory components of the AERMOD modelling system: AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data pre-processor that incorporates complex terrain using USGS Digital Elevation Data.

6.2 Modelling approach

An initial screening level modelling run was carried out using a unit emission rate for a location at each of the 96 m sections of the UG transmission line route to identify locations of the greatest impact from the emissions, with a follow-up modelling run carried out at the locations of the greatest impacts, using the emission rates from the particulate and gaseous emissions inventories. These were used to predict GLCs of pollutants across the model domain for comparison with the air quality objectives in the EPP (Air).

6.2.1 Model parametrisation

A model domain of 20 km x 20 km with a nested grid of 100 m x 100 m cells to 1 km, 200 m x 200 m to 2 km and 500 m x 500 m to 5 km and 1000 m x 1000 m to 20 km was used for the modelling. Terrain elevation data at 30 m resolution across the model domain was obtained from the US National Aeronautics and Space Administration's (NASA) Shuttle Radar Topography Mission (SRTM3/SRTM1) and incorporated into AERMOD using the AERMAP terrain processor.

Urban dispersion coefficients were used in the AERMOD simulation given the surrounding land uses in the immediate area of the transmission line route.

Model input information is presented in **Appendix B**Appendix A.

6.2.2 Receptors

The majority of the project route passes through residential suburbs which are considered sensitive receptors in respect to air emissions impacts. Specific sensitive receptors have not been identified for the assessment of emissions for the entirety of the route of trenching operations, instead, the screening model has identified locations where the highest predicted GLCs are predicted. Details of those locations and specific receptors are shown in **Section 7**.

7. Dispersion modelling results

7.1 Screening modelling

A screening model run of unit emission rates at all locations along the project route was carried out to identify the locations of highest peak 1-hour isopleth (**Figure 7-1**) and highest 1-hour average isopleth (**Figure 7-2**).

Overall, the highest GLCs were predicted at Goomboora Park, where the southerly to south easterly air flows appear to be influenced by the terrain and adversely impact upon dispersion of emissions from the trenching activities.

More specifically, the Isopleths for that location show the peak GLCs are predicted for trenching works carried out alongside the Cairns Western Arterial Road to Christie Drive, View Street, and Shale Street (**Figure 7-3Error! Reference source not found.**). A portion of Shale Street was selected for refined modelling as providing worst-case representation of the surrounding locations where trenching is to be carried out (**Figure 7-4**). Representative sensitive receptors selected for reporting of GLCs are shown in that figure. The results are presented in **Section 7.2**.

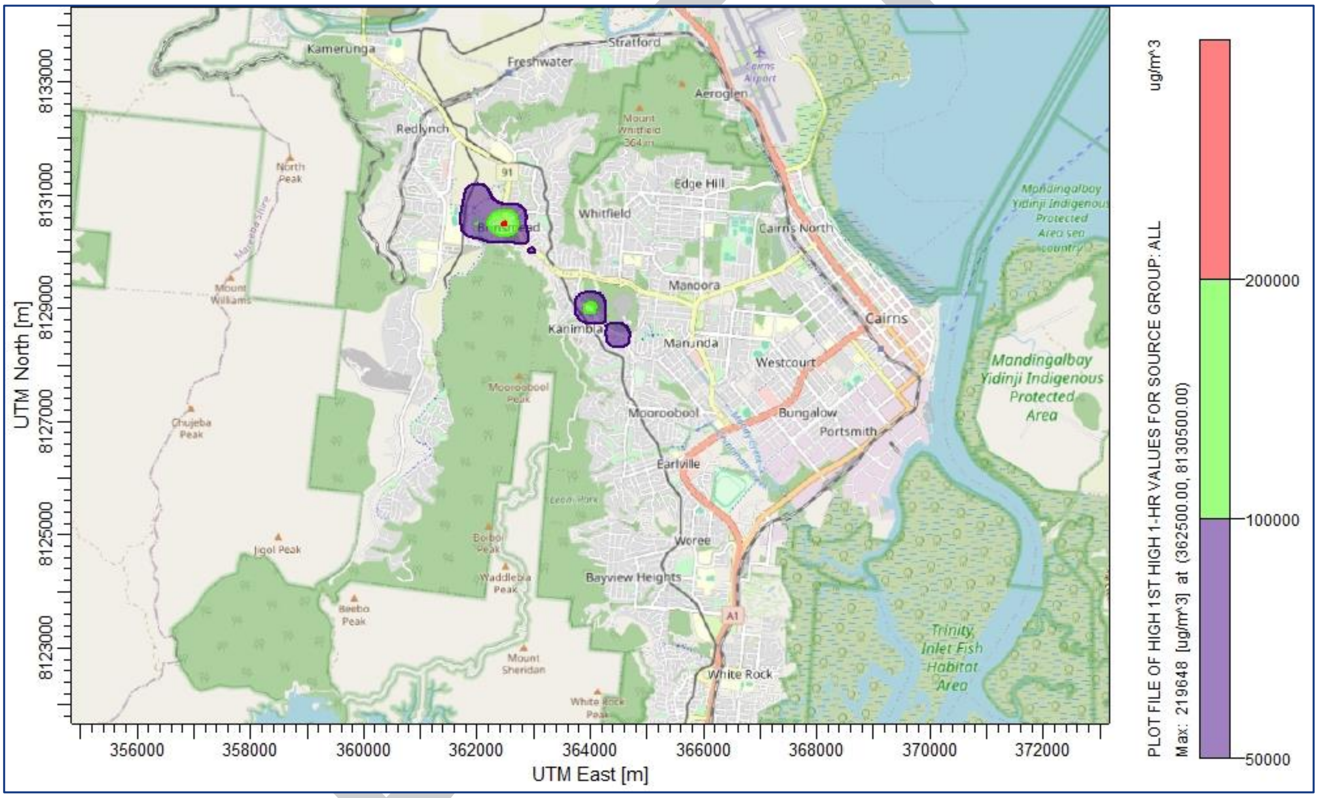


Figure 7-1 Peak 1-hour average isopleth from screening model run of the project route

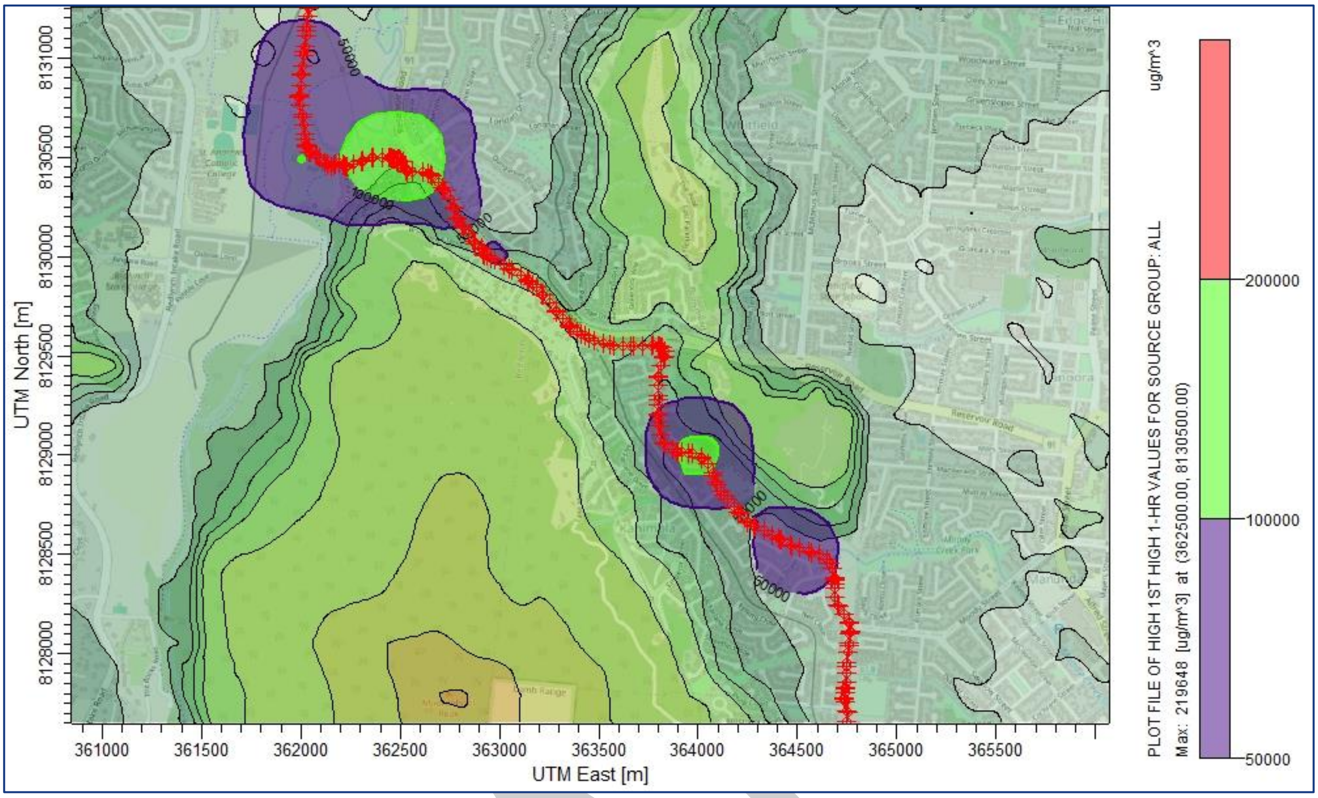


Figure 7-2 1-hour average isopleth at Kanimbla and Redlynch from screening model run

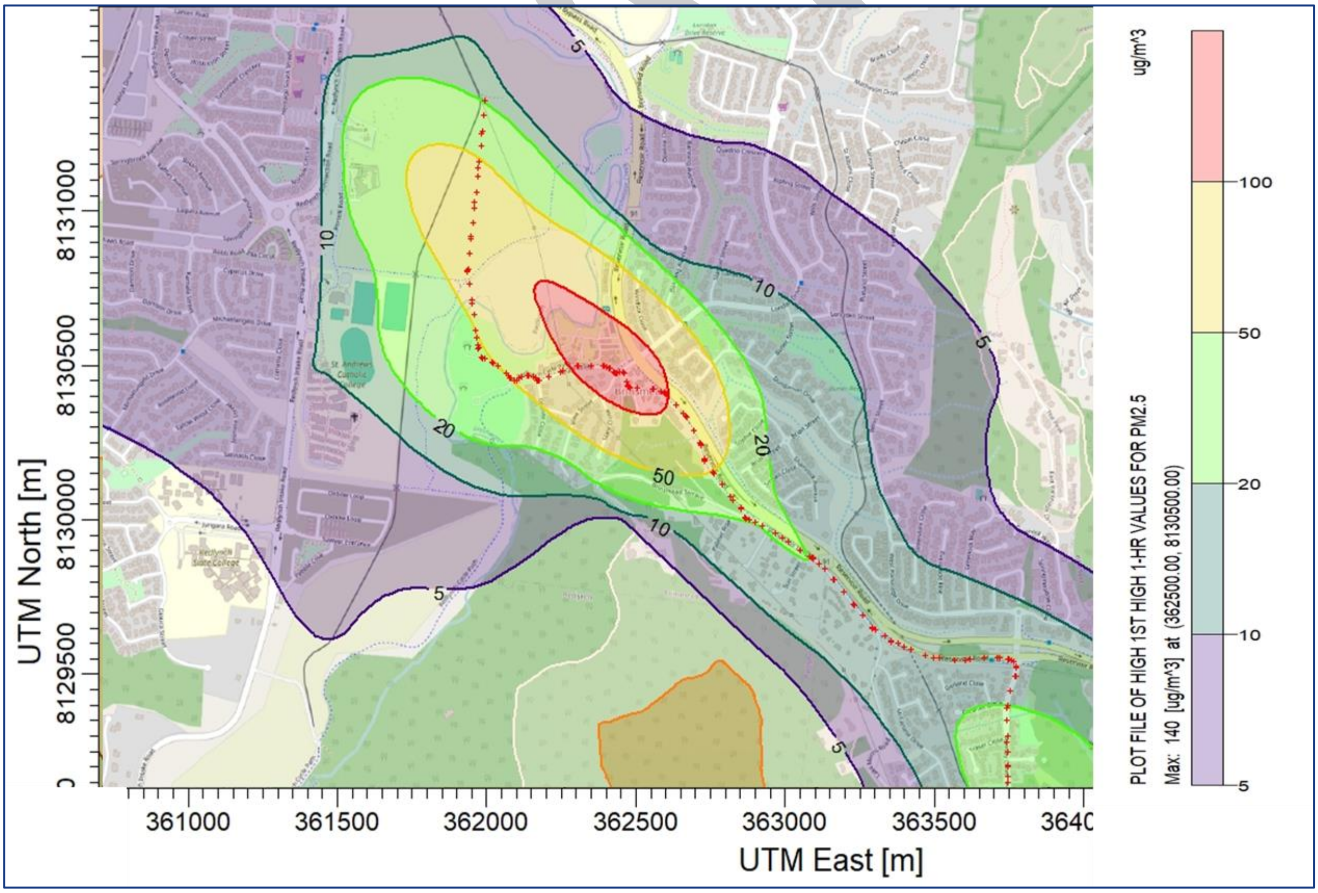


Figure 7-3 Isopleths for predicted highest 1-hour average GLCs (as $PM_{2.5}$) at Goomboora Park

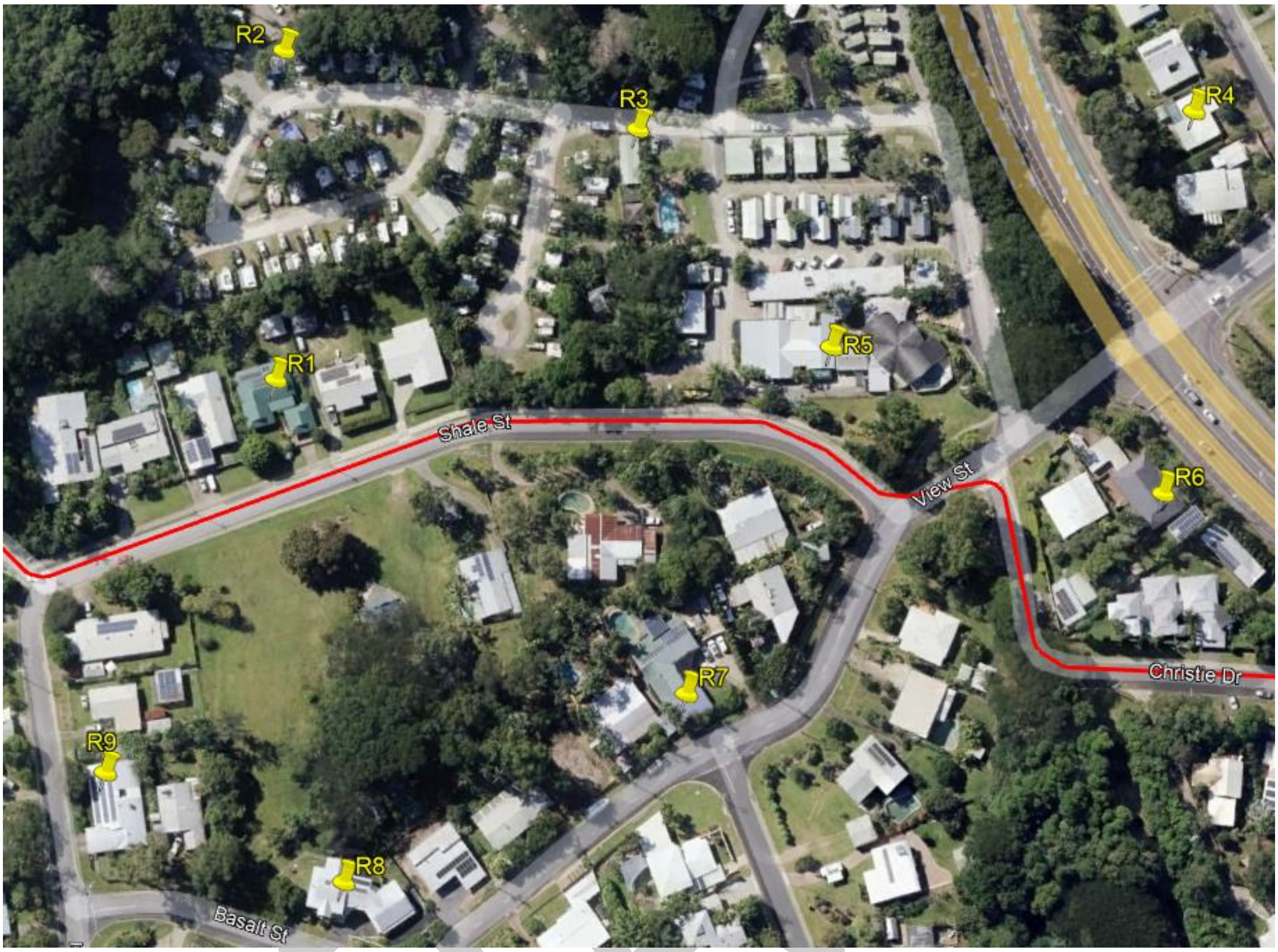


Figure 7-4 Selected sensitive receptor locations for refined dispersion modelling of trenching emissions

7.2 Refined modelling

7.2.1 Emissions source location

AERMOD was re-run using the particulate and gaseous emission rates in **Table 4-1** and **Table 4-2**, respectively. Emissions were discharged from three 96 m segment of trenching activities along Shale Road, with predicted maximum GLCs at selected residential receptors and the Cool Waters Accommodation Park (R1 to R9) reported. Three segments were selected to provide a conservative understanding of overlapping emissions that may occur from day to day as the trenching activities progress along the route.

7.2.2 Results of refined modelling

The results of the refined modelling for trenching activities are shown in **Table 7-1**Error! Reference source not found.. The maximum predicted 1-hour average GLCs reported from the modelling were adjusted for 8-hour and 15-minute averages for direct comparison with the Safe Work and Business Queensland TWA and Safe Work STEL exposure standards.

The results show the maximum predicted GLCs of particulates at receptors were well below the Business Queensland exposure limits. The most significant impacts were observed at R5, which is the receptor nearest to the trenching activities on Shale Road, with the maximum predicted GLCs being 1.04% (TSP), 1.14% (PM_{10}) and 0.94% ($PM_{2.5}$) of the exposure limits. These are indicative of the worst-case scenario for the entire Project area. Predicted particulate GLCs at the other receptors were below the limits.

NOx was the most significant of the gaseous emission in relation to the exposure standards, with maximum predicted 8-hour GLCs being 17.9% of the TWA standard at R5 and 11.0% of the TWA standard at R6. The maximum predicted 15-minute NOx GLCs were 19.5% of the STEL at R5 and 11.5% of the STEL at R6. Isopleths for particulates and NOx and are shown in **Figure 7-5** and **Figure 7-6**, respectively. Predicted 8-hour GLCs of all other emissions were below the respective exposure standards.

7.2.3 Implications of refined modelling results

As discussed, the predicted GLCs for all emissions from the trenching activities are below the various exposure standards and limits at residences immediately adjacent to the works. As such, these pollutants present a low risk of adverse health impacts to residents at the locations immediately adjacent to the trenching works at Shale Road, Goomboora Park. The same outcome is inferred for the entirety of the project route for both trenching and underground boring activities, since the screening modelling had identified those locations as having a lower maximum GLCs than the modelled area.

The risk from dust emissions can be minimised by strict adherence to the Construction Environmental Management Plan that will be prepared for the project, which will include control measures including (but not limited to):

- Dust emissions controls involving moistening of soils during excavation and handling activities that are maintained at all times;
- Emissions controls on diesel engine machinery are maintained and operated to manufacturer specifications (in particular deNOx and fine particle filters) and comply with best practice emissions control standards; and
- Windows and external doors on residences remain closed during nearby trenching and boring activities.

Table 7-1 Predicted GLCs of emissions at selected sensitive receptors from trenching activities at Shale St (indicative of worst-case scenario for the project)

Emission parameter	Time average	R1 (µg/m3)	R2 (µg/m3)	R3 (µg/m3)	R4 (µg/m3)	R5 (µg/m3)	R6 (µg/m3)	R7 (µg/m3)	R8 (µg/m3)	R9 (µg/m3)	Business Qld TWA (µg/m3)	SafeWork TWA OES (µg/m3)	SafeWork STEL OES (µg/m3)
TSP	8 hour	28	16.0	44	17.1	169	104	31	12.3	9.2	10,000		
PM10	8 hour	15.5	8.7	24	9.3	92	57	16.9	6.7	5.0	5,000		
PM2.5	8 hour	13.0	7.3	20	7.8	77	47	14.1	5.6	4.2	5,000		
NOx	8 hour	169	95	260	101	1,002	614	184	73	54		5,600	
	15 minute	509	401	730	421	1,829	1,084	603	331	276			9,400
SO2	8 hour	0.11	0.06	0.16	0.06	0.63	0.38	0.11	0.05	0.03		5,200	
	15 minute	0.32	0.25	0.46	0.26	1.1	0.68	0.38	0.21	0.17			5,000
CO	8 hour	42	24	65	25	250	153	46	18.2	13.5		34,000	
Formaldehyde	8 hour	1.8	1.0	2.82	1.1	10.9	6.7	2.0	0.79	0.59		1,200	
	15 minute	5.5	4.3	7.9	4.6	19.8	11.7	6.5	3.6	3.0			2,500
PAH (as BaP)	8 hour	0.008	0.005	0.013	0.005	0.048	0.030	0.009	0.004	0.003		200	
VOCs	8 hour	21	11.8	33	12.6	125	77	23	9.1	6.8			

Note: No standards are available for VOCs

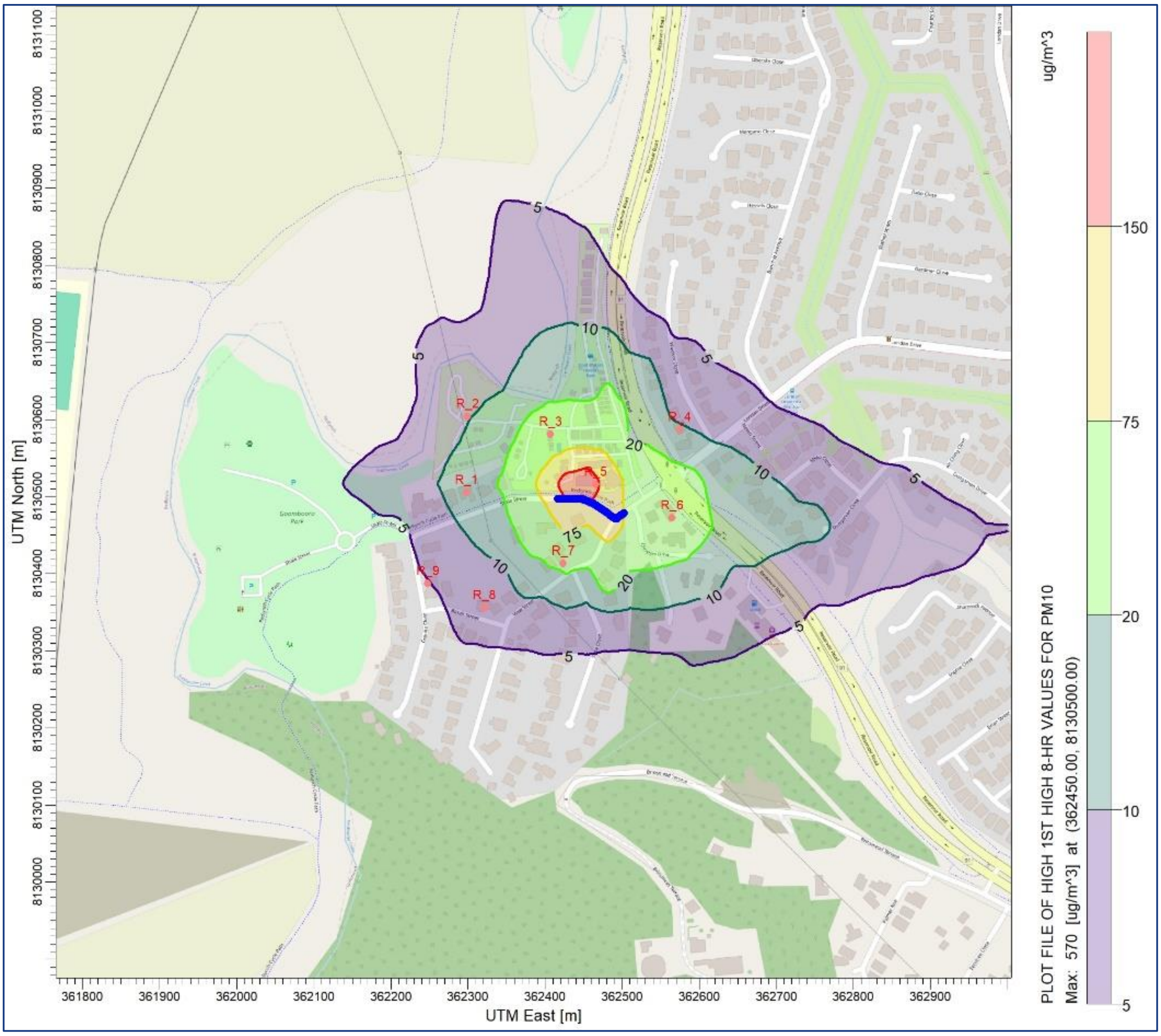


Figure 7-5 Particulates (as PM_{10}) isopleth (maximum 8-hour average) from modelling at Shale St

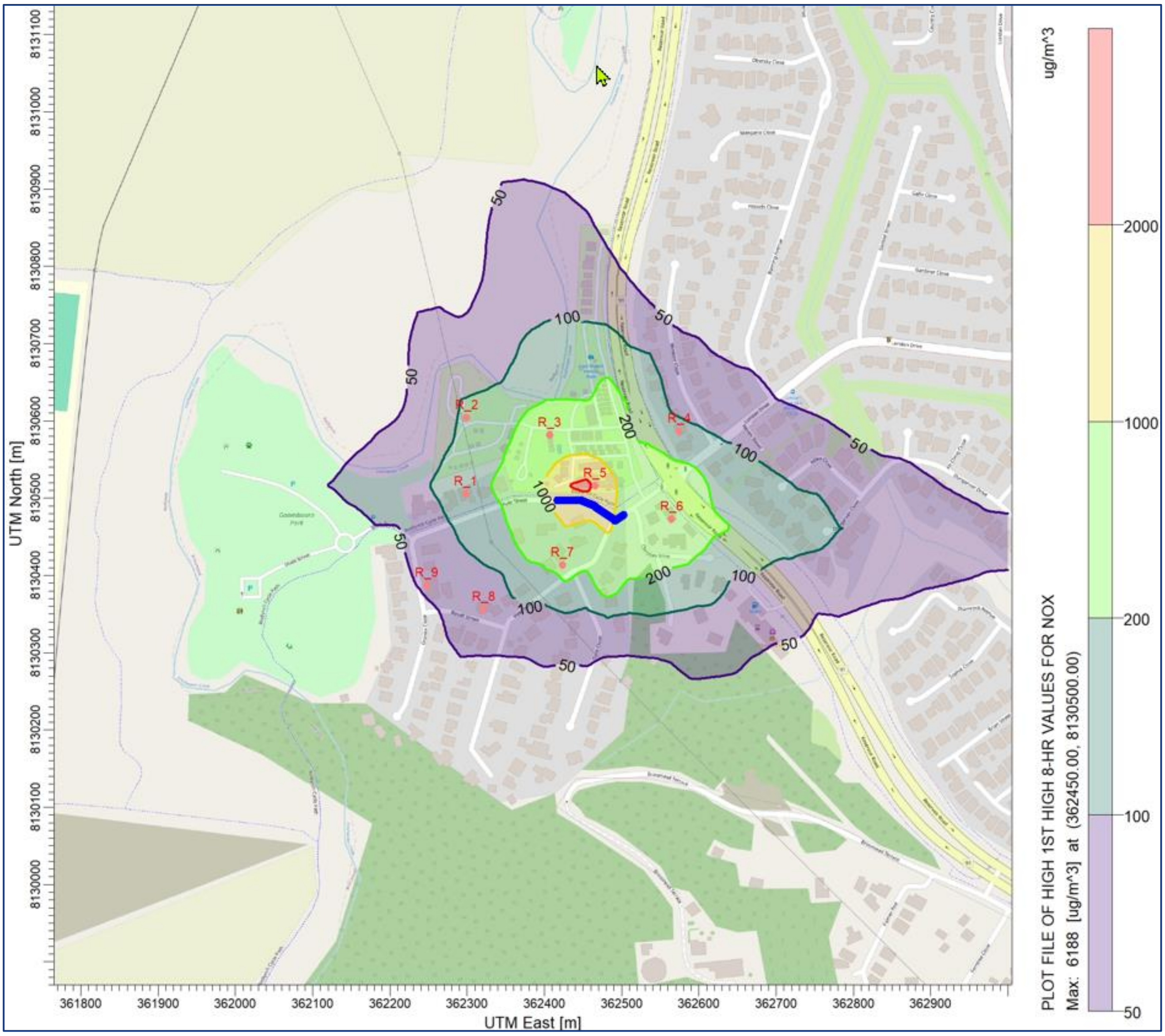


Figure 7-6 NOx isopleth (maximum 8-hour average) from modelling at Shale St

7.3 Cumulative assessment

7.3.1 Existing air quality (PM_{10} and $PM_{2.5}$)

The Queensland Department of Environment, Science and Innovation (DESI) operate a network of ambient air quality monitoring stations across Queensland which monitor for controlled pollutants in areas with large population bases or heavy industry adjacent to residential areas. The closest station to the Project area is located adjacent to Woree State High School and has operated since 9 March 2023. PM_{10} and $PM_{2.5}$ have been monitored at the station along with wind direction, wind speed, humidity, temperature, solar radiation and rainfall. This data has been used for a cumulative assessment of the predicted GLCs from the trenching operations emissions with the existing PM_{10} and $PM_{2.5}$ concentrations.

Twelve months of data was obtained from the DESI website for the cumulative assessment. A time-series graph of the PM_{10} concentrations shows all measured concentrations were below the NEPM (Ambient Air Quality) for PM_{10} (50 µg/m^3, 24-hour average), with the highest value observed on 28 October 2023 of 40.6 µg/m^3 (**Figure 7-7**).

The corresponding data for $PM_{2.5}$ are shown in **Figure 7-8**. The highest concentration was also observed on 28 October 2023 (25.1 µg/m^3), with those concentrations slightly exceeding the $PM_{2.5}$ NEPM (25 µg/m^3).

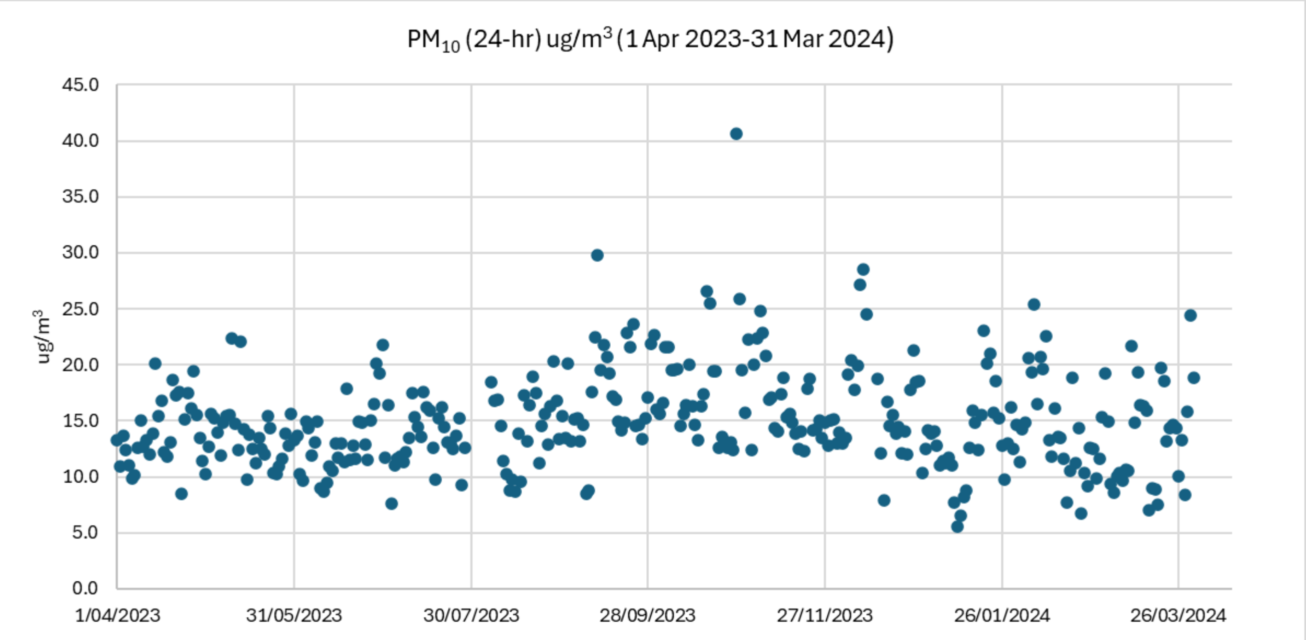


Figure 7-7 PM_{10} (24-hour average) concentrations (µg/m^3) for Cairns (1 April 2023 to 31 March 2024)

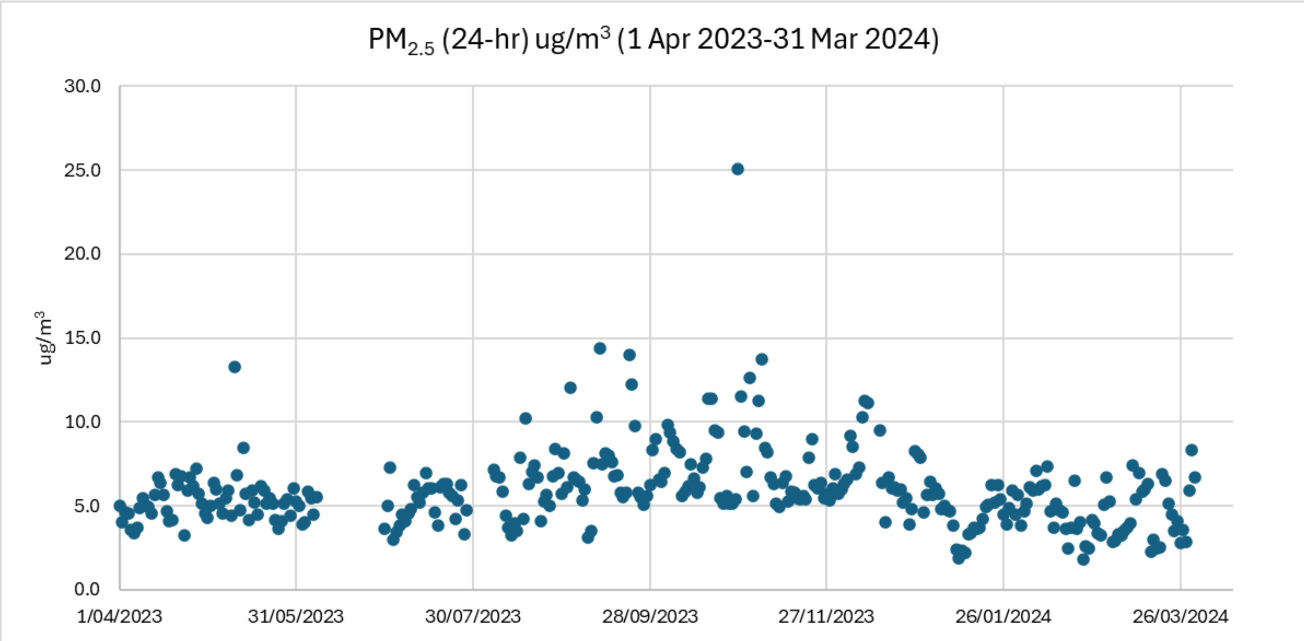


Figure 7-8 $PM_{2.5}$ (24-hour average) concentrations (µg/m^3) for Cairns (1 April 2023 to 31 March 2024)

Descriptive statistics for the current PM_{10} and $PM_{2.5}$ concentrations recorded within the Cairns region are summarised in **Table 7-2**. The average concentrations represent the annual average for comparison with the NEPM annual average limits. The PM_{10} annual average (14.9 µg/m^3) is well below the PM_{10} annual average NEPM (25 µg/m^3) and the $PM_{2.5}$ annual average (5.9 µg/m^3) is also well below the $PM_{2.5}$ annual average NEPM (8 µg/m^3). Overall, the air quality in respect of the levels of fine particles can be considered as providing a low health risk for the residents of Cairns.

Table 7-2: PM_{10} and $PM_{2.5}$ 24-hour average concentrations (µg/m^3) from DESI Cairns monitoring station

Statistic	PM10 concentration (µg/m3)	PM2.5 concentration (µg/m3)
Minimum	5.5	1.8
Average	14.9	5.9
P75	17.0	6.7
P90	20.4	8.4
P99	26.8	13.6
P99.9	36.8	21.5
Maximum	40.6	25.1

7.3.2 Cumulative assessment for trenching PM_{10} and $PM_{2.5}$ emissions

As discussed above, the predicted PM_{10} and $PM_{2.5}$ GLCs at Goomboora Park were reported as 8-hour averages for comparison with the Business Queensland 8-hour (TWA) exposure standards. Eight-hour average ambient PM_{10} and $PM_{2.5}$ concentrations were calculated from the hourly average DESI data to facilitate a cumulative assessment with the model predictions.

Table 7-3 PM_{10} and $PM_{2.5}$ 8-hour average concentrations (µg/m^3) from DESI Cairns monitoring station

Statistic	PM10 concentration (µg/m3)	PM2.5 concentration (µg/m3)
Minimum	2.5	0.6
Average	14.9	5.9
P75	17.4	6.7
P90	21.3	8.6
P99	32.3	15.2
P99.9	41.9	26.2
Maximum	49.5	31.8

The highest predicted 8 hour average PM_{10} and $PM_{2.5}$ GLCs at sensitive receptors are 92 and 77 µg/m^3 (at R5). A cumulative assessment is carried out by addition of the modelled concentration with the measured ambient concentrations. The likelihood of concurrent maximum particulate emissions impacts from trenching activities with peak ambient (background) particulate concentrations is low, which suggests simple addition of these concentrations will significantly overstate the cumulative impacts. A more realistic understanding of the cumulative impacts is provided by using a lower percentile of the measured concentrations, for example the 75th percentile.

Combination of the 75th percentile ambient 8 hour average concentrations (17.4 µg/m^3 for PM_{10} and 6.7 µg/m^3 for $PM_{2.5}$) with the maximum predicted concentrations for the two size fractions (92 and 77 µg/m^3) gives cumulative concentrations of PM_{10} and $PM_{2.5}$ of 109 µg/m^3 and 84 µg/m^3, respectively. These concentrations are well below the exposure limits from Business Queensland, which suggests the short duration cumulative impacts from the trenching activities and background particulate concentrations are unlikely to cause adverse impacts to health and well-being of residents nearby the transmission line works.

8. Conclusions

Based on the assessment methodology adopted, and subject to the limitations presented within **Section 10**, the following conclusions are made:

- Based on the regional topography and the prevailing wind directions, the greatest potential impacts associated with UG trenching or boring works are predicted to occur at Goomboora Park;
- Dispersion modelling of particulate and gaseous emissions from UG trenching activities at Goomboora Park has shown predicted GLCs to be below all adopted exposure limits;
- As such, air emissions from the UG trenching works are unlikely to give rise to adverse impacts to health and well-being of residents of houses located along the entire length of the UG transmission line; and
- A cumulative assessment of fine particles (PM_{10} and $PM_{2.5}$) using available monitoring data from Cairns airport, combined with predicted concentrations from the transmission line works, also shows a low risk of adverse impacts to residents.

9. References

NPI (2008). *Emission estimation technique manual for combustion engines,* Version 3.0. June 2008.

NPI (2012a). *Emission estimation technique manual for fugitive emissions,* Version 20. January 2012.

NPI (2012b). *Emission estimation technique manual for mining,* Version 3.1. January 2012.

10. Limitations

Scope of services

This report ("the report") has been prepared by JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. JBS&G has also not attempted to determine whether any material matter has been omitted from the data. JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to JBS&G. The making of any assumption does not imply that JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law as at the date of this report.

Environmental conclusions

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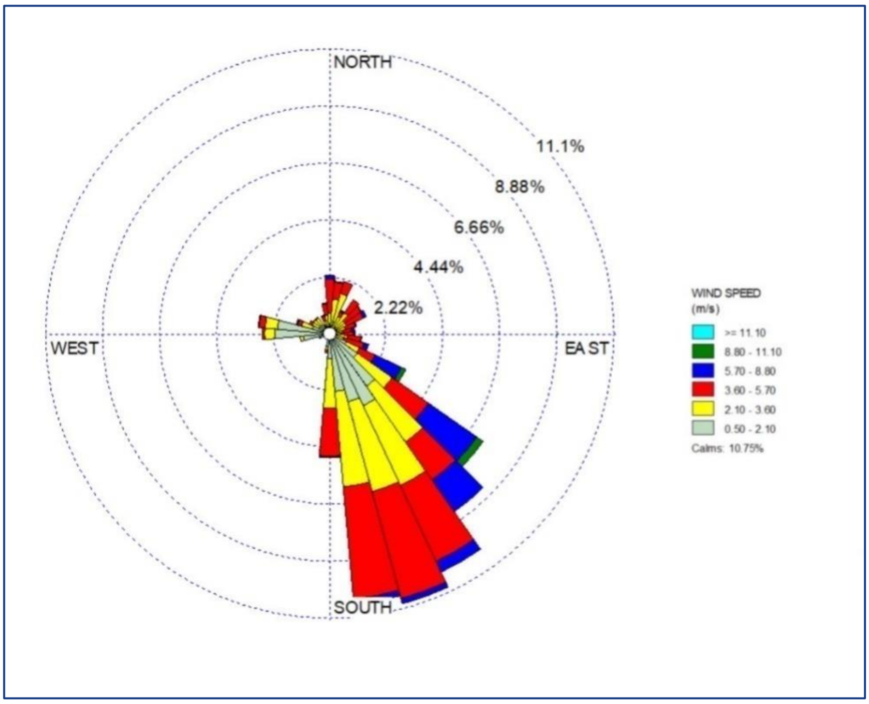
Appendix A Monthly wind roses



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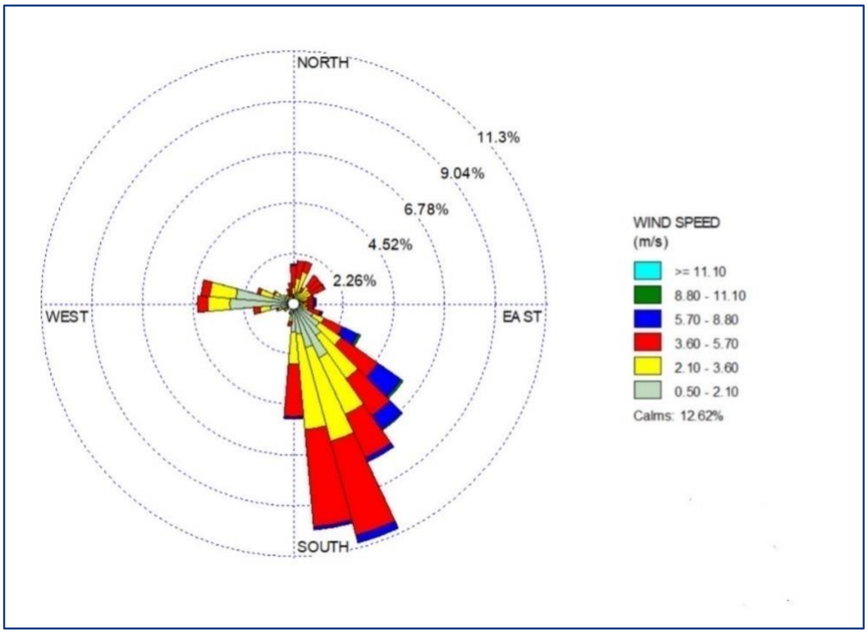

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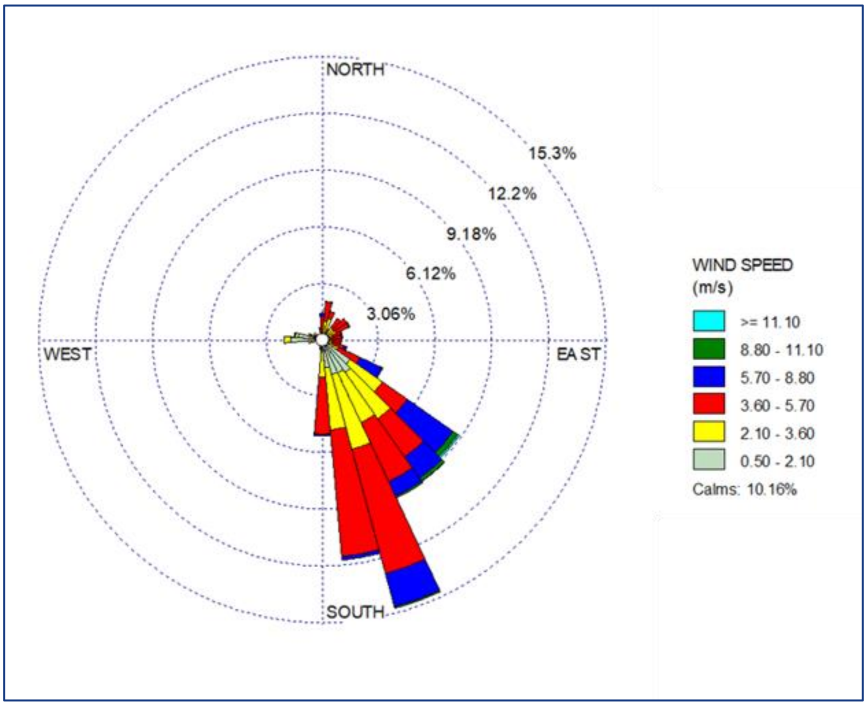

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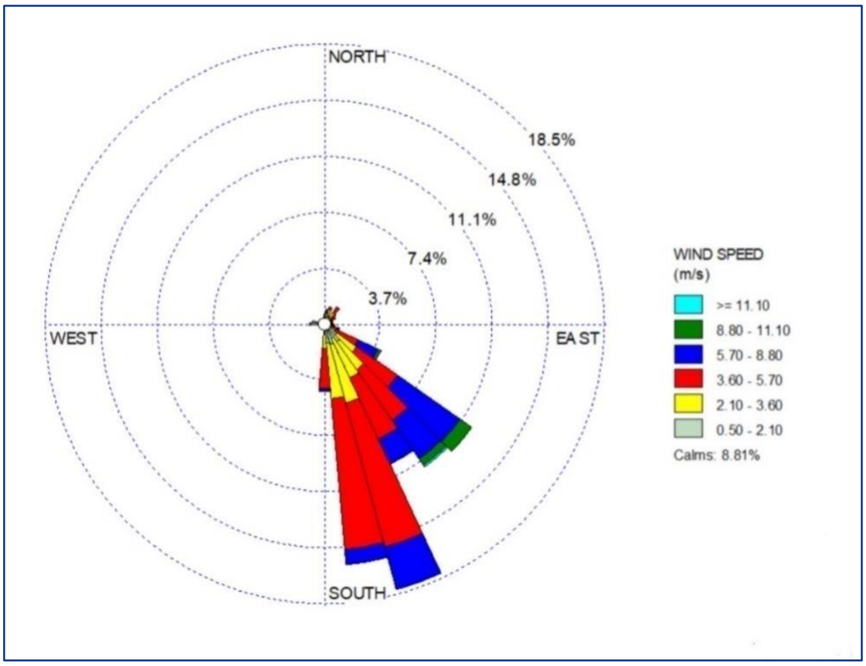

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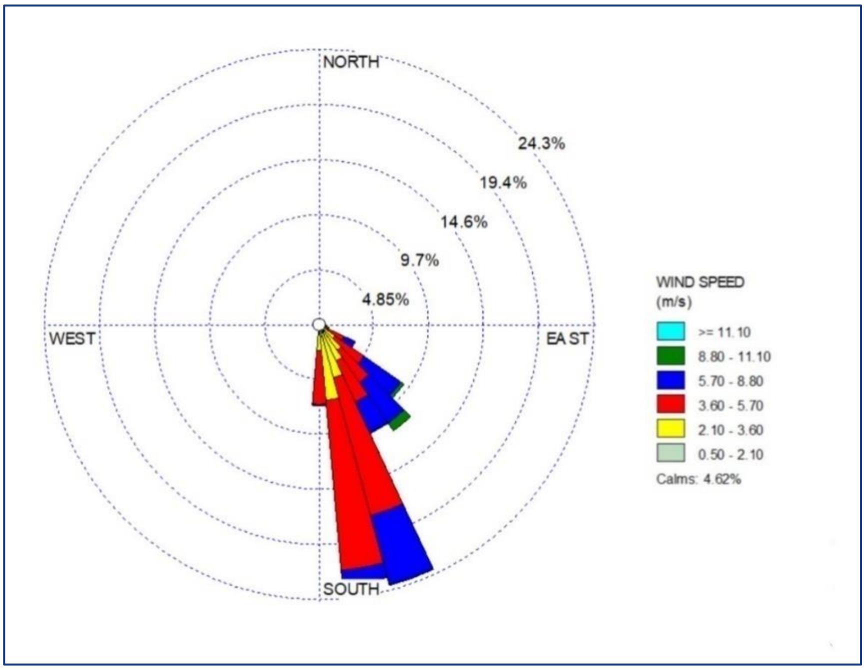

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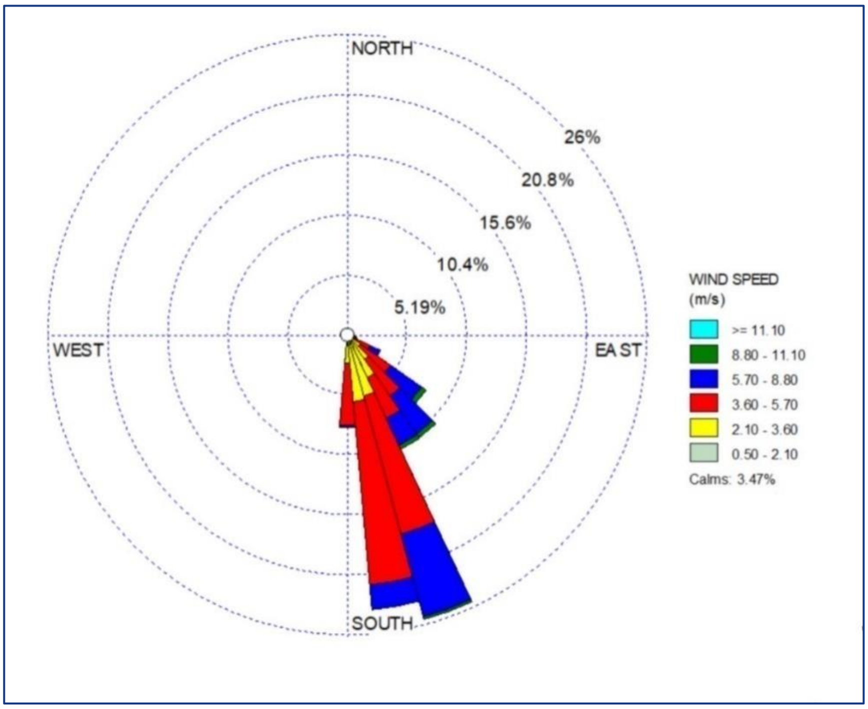
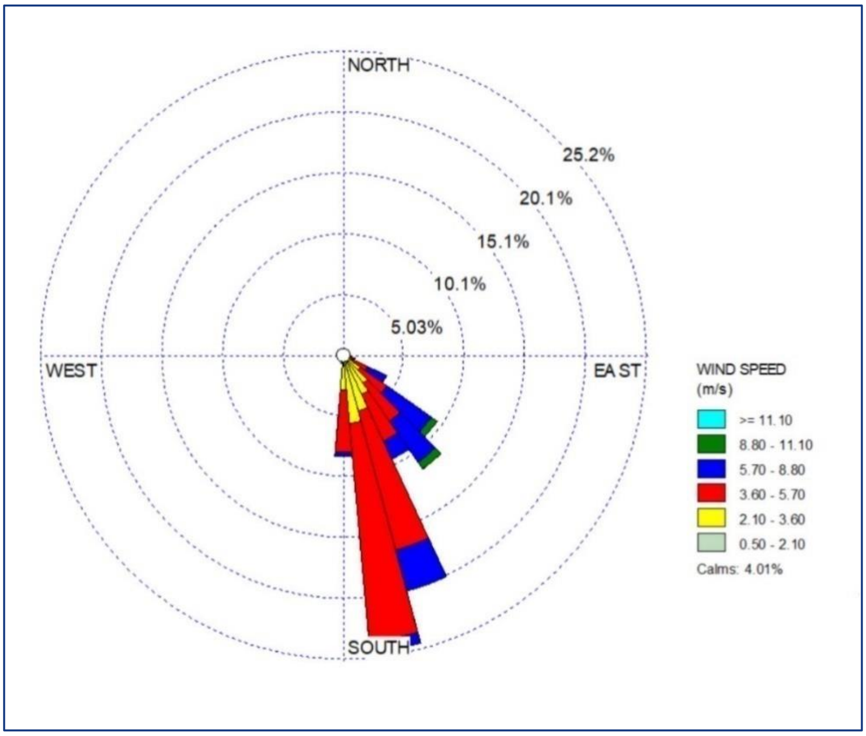
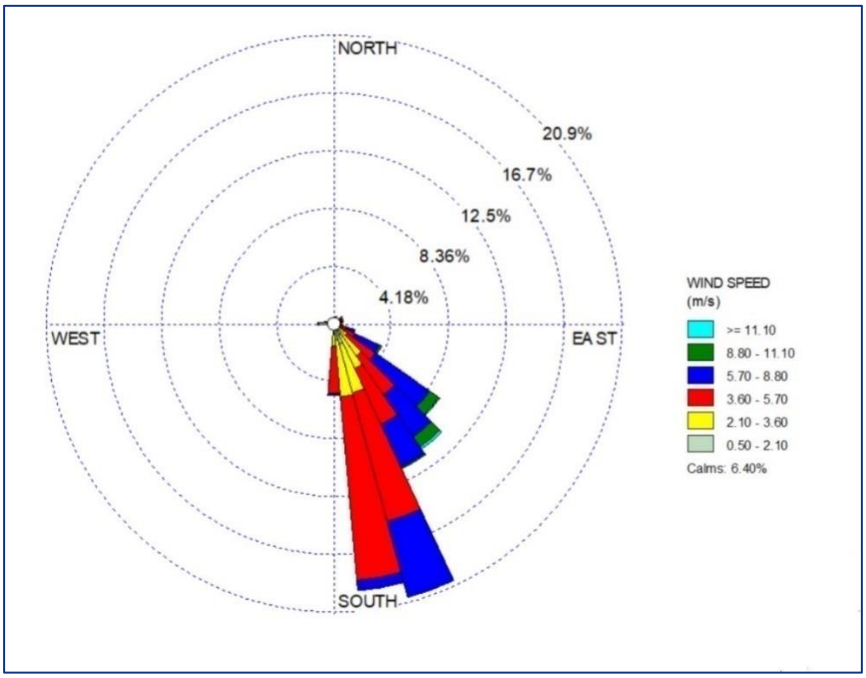


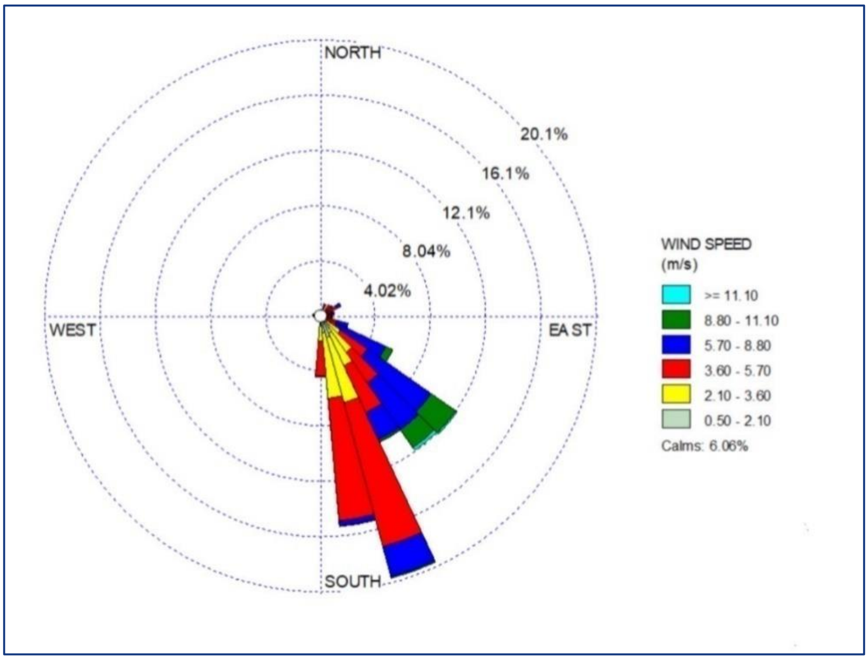
June (2019-2023)



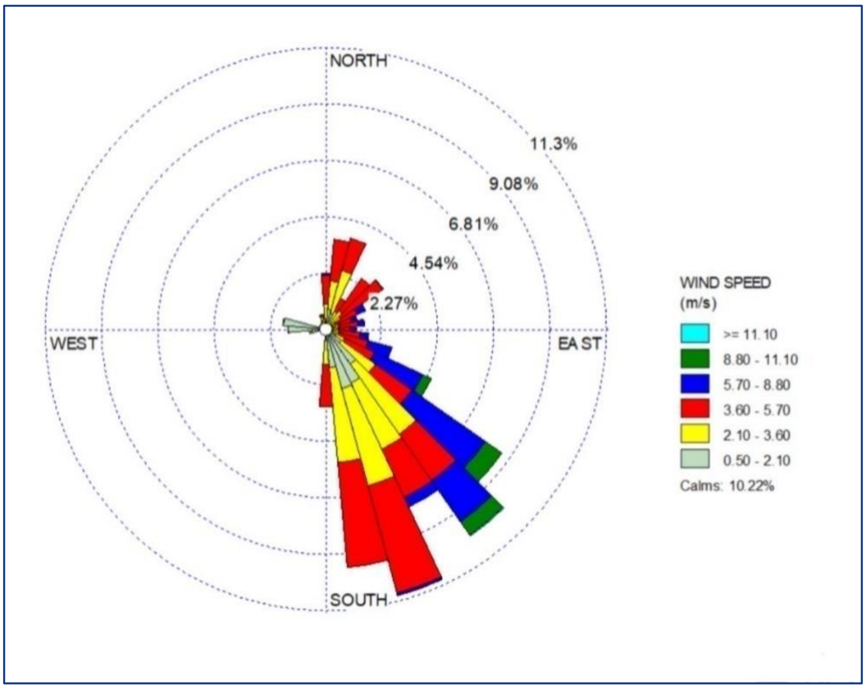
July (2019-2023)



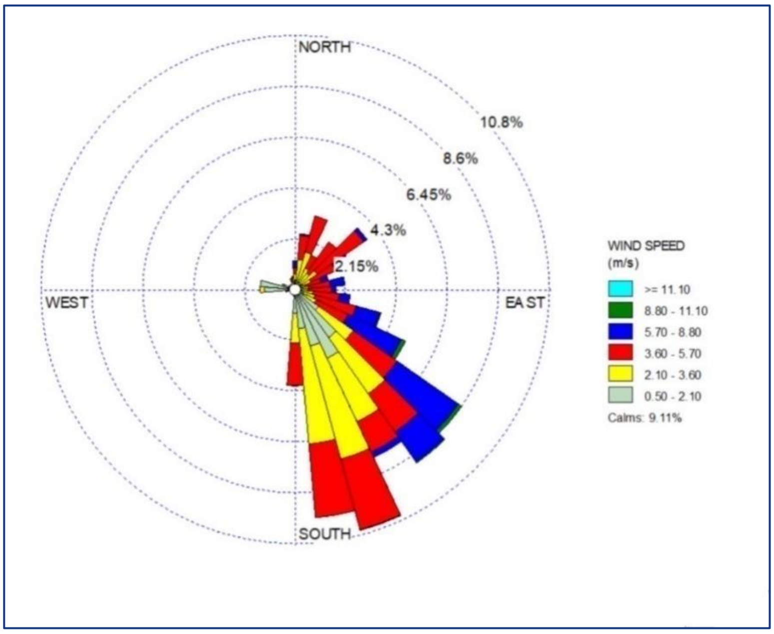
August (2019-2023)



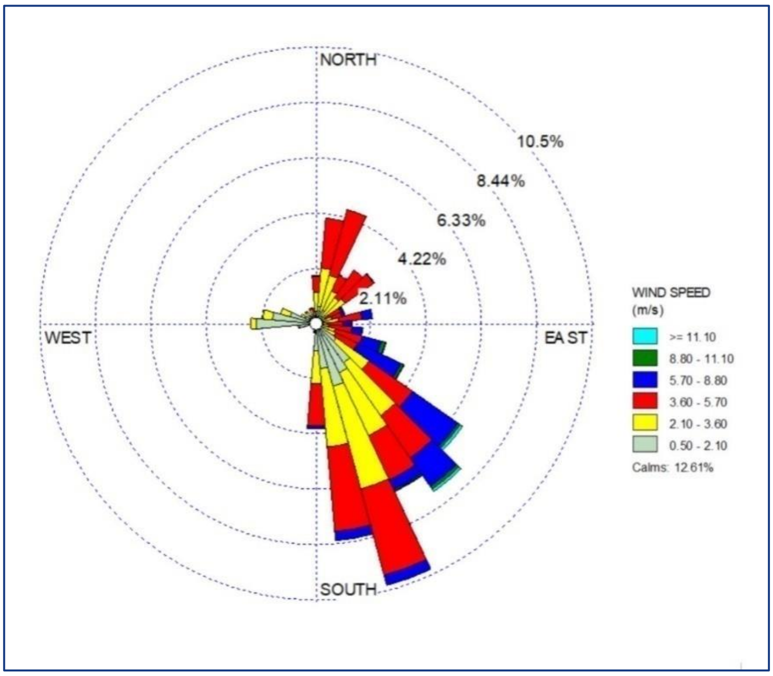
September (2019-2023)



October (2019-2023)



November (2019-2023)



December (2019-2023)

Appendix B AERMOD inputs

```
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** AERMOD View Ver. 12.0.0
** Lakes Environmental Software Inc.
** Date: 6/06/2024
** File: D:\JBSG\Cairns_road_project\ShaleSt\ShaleSt.ADI
**
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**
**
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** AERMOD Control Pathway
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   POLLUTID TRACER
   RUNORNOT RUN
   LOW_WIND 0.2 0.2828 0.1 0.02 24 0
   ERRORFIL ShaleSt.err
CO FINISHED
**
****************************************
** AERMOD Source Pathway
****************************************
**
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** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
** ------------------------------------------------------------------
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** DESCRSRC Day3
** PREFIX
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LOCATION	L0000333	VOLUME	362483.442	8130476.775	25.65
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LOCATION	L0000335	VOLUME	362485.707	8130475.198	25.78
LOCATION	L0000336	VOLUME	362486.839	8130474.409	25.85
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LOCATION	L0000338	VOLUME	362489.104	8130472.832	25.99
LOCATION	L0000339	VOLUME	362490.236	8130472.043	26.06
LOCATION	L0000340	VOLUME	362491.369	8130471.255	26.14
LOCATION	L0000341	VOLUME	362492.493	8130471.458	26.09
LOCATION	L0000342	VOLUME	362493.612	8130472.266	25.97
LOCATION	L0000343	VOLUME	362494.730	8130473.074	25.85
LOCATION	L0000344	VOLUME	362495.849	8130473.882	25.74
LOCATION	L0000345	VOLUME	362496.968	8130474.690	25.63
LOCATION	L0000346	VOLUME	362498.087	8130475.498	25.52
LOCATION	L0000347	VOLUME	362499.205	8130476.306	25.42
LOCATION	L0000348	VOLUME	362500.324	8130477.114	25.32
LOCATION	L0000349	VOLUME	362501.443	8130477.922	25.22

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** AERMOD Meteorology Pathway
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** Profile File Path: D:\JBSG\Cairns_road_project\ShaleSt\..\BOM\
   PROFFILE ..\BOM\cairns.PFL
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   UAIRDATA 31011 2019
   SITEDATA 31011 2019
   PROFBASE 10.0 FEET
ME FINISHED
**
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** AERMOD Output Pathway
****************************************
**
**
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   RECTABLE 1 1ST 8TH
   RECTABLE 8 1ST
   RECTABLE 24 1ST
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   PLOTFILE 8 SLINE3 1ST D:\JBSG\Cairns_road_project\ShaleSt\SHALEST.AD\08H1G001.PLT 32
   PLOTFILE 24 SLINE3 1ST D:\JBSG\Cairns_road_project\ShaleSt\SHALEST.AD\24H1G001.PLT 33
   PLOTFILE 1 STKPILE 1ST D:\JBSG\Cairns_road_project\ShaleSt\SHALEST.AD\01H1G002.PLT 34
   PLOTFILE 8 STKPILE 1ST D:\JBSG\Cairns_road_project\ShaleSt\SHALEST.AD\08H1G002.PLT 35
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OU FINISHED
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** Project Parameters
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** DESCPTN  UTM: Universal Transverse Mercator
** DATUM    World Geodetic System 1984
** DTMRGN   Global Definition
** UNITS    m
** ZONE     -55
** ZONEINX  0
**
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Appendix C Acronyms

Acronym	Meaning
AHD	Australian Height Datum
AQIA	Air Quality Impact Assessment
BaP	Polycyclic aromatic hydrocarbons
BoM	Bureau of Meteorology
CO	Carbon monoxide
DESI	Department of Environment, Science and Innovation
EPP (Air)	Environmental Protection (Air Quality) Policy 2019
GLCs	Ground Level Concentrations
HDD	Horizontal Directional Drilling
kV	Kilovolt
NEPC Act	*National Environment Protection Council Act 1994*
NEPMs	National Environment Protection Measures
NO_2	Nitrogen dioxide
OHL	Overhead
Powerlink	Powerlink Queensland
SO_2	Sulfur dioxide
STELs	Short Term Exposure Limits
TSP	Total Suspended Particles
TWA	Time Weighted Average
UG	Underground
VOCs	Volatile Organic Compounds

1.1.1.1 Document Distribution

Rev No.	Copies	Recipient	Date
Rev 0	1 x PDF	Powerlink	31 July 2024

1.1.1.2 Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
Rev 0	P. Forster	A. Hestehauge and R. Porter	R. Porter		31 July 2024

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