Vipac Engineers and Scientists Limited
Level 2, 146 Leichhardt Street, Spring Hill, QLD 4000, Australia
PO Box 47, Spring Hill, Qld, 4000 Australia
t. +61 7 3377 0400 | **f.** +61 7 3377 0499 | **e.** brisbane@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Vipac Engineers & Scientists

TNG Limited

Darwin Magnetite Processing Facility EIS Noise & Air - APM for TNG Ltd

Air Quality Assessment

70Q-19-0071-TRP-6756675-6

25 January 2021

Report Title: Air Quality Assessment

Job Title: Darwin Magnetite Processing Facility EIS Noise & Air - APM for TNG Ltd

DOCUMENT NO: 70Q-19-0071-TRP-6756675-	**REPORT CODE:** TRP
PREPARED FOR:	**PREPARED BY:**
APM on behalf of TNG Ltd	Vipac Engineers and Scientists Limited
47 Caroline Retreat	Level 2, 146 Leichhardt Street,
Henley Brook, Western Australia, 6055, Australia	Spring Hill, QLD 4000, Australia
CONTACT: Sharon Arena	
Tel: 0862965155	**Tel:** +61 7 3377 0400
Fax:	**Fax**: +61 7 3377 0499

PREPARED BY:

Author: Dr Steve Thomas, Principal Air Quality Scientist — Date: 25 Jan 2021

REVIEWED BY:

Reviewer: Jackson Yu, Principal Acoustic Consultant, Team Leader — Date: 25 Jan 2021

AUTHORISED BY:

Jackson Yu, Principal Acoustic Consultant, Team Leader — Date: 25 Jan 2021

REVISION HISTORY

Revision No.	Date Issued	Reason/Comments
2	21/11/2019	Client Comment Revision
3	9/11/2020	Response to EPA Comments
4	21/12/2020	Response to further EPA Comments
5	13/1/2021	Response to further EPA Comments
6	25/1/2021	Response to external peer review Comments

DISTRIBUTION

Copy No.______	**Location**
1	Project
2	Client (PDF Format) Uncontrolled Copy

KEYWORDS:

EXECUTIVE SUMMARY

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by TNG Ltd to prepare an air quality assessment for the proposed Darwin TIVAN® Processing Facility (the Project). The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the construction and operational stages of the Project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

The air quality impact assessment has been carried out as follows:

- An emissions inventory of PM_{10}, $PM_{2.5}$, deposited dust, NO_2, SO_2, NH_3, HCl and Cl_2 for the proposed Project was compiled using manufacturer specification data derived for maximum potential emission limits for the operation of the Project.
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model.
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria as part of the impact assessment. Air quality controls are applied to reduce emission rates where specified.

The results of the modelling assessment can be summarised as follows:

- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project in isolation are well below the relevant criteria.
- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project including background (cumulative) are below the relevant criteria.
- The most affected of the modelled receptors is the Bladin Village – Workers Accommodation, which is in the westerly direction from the Project and in the direction of the prevailing winds (from the east) which have the potential to carry air emissions to the receptor. It is also noted that the predictions are driven by the conservative approach adopted for the modelling which included an elevated background already close to the criteria for the annual average and a total particulate matter emission rate assigned for $PM_{2.5}$.
- The model results also show that the maximum predicted concentrations of NO_2 and SO_2 are below the adopted criteria for all sensitive receptors modelled for the Project operating in isolation and including background. Furthermore, the maximum predicted concentrations of NH_3, Cl_2 and HCl are below the adopted criteria for all sensitive receptors modelled.

Whilst elevated predictions of $PM_{2.5}$ concentrations are driven by the background levels and the conservative approach to modelling, it is recommended that an ongoing measurement program for this pollutant is undertaken at the most affected receptor locations (the Bladin Village – Workers Accommodation). Furthermore, scrubbers and filters are also proposed for the control of emissions from multiple Project stack sources with ongoing stack emissions monitoring (continuous and discontinuous) proposed for all primary sources.

Overall, with the recommended control and monitoring measures in place, the Project operations are not expected to adversely impact the surrounding air environment.

TABLE OF CONTENTS

1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by TNG Ltd to prepare an air quality assessment for the proposed Darwin TIVAN® Processing Facility (the Project). The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the construction and operational stages of the Project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

2 PROJECT DESCRIPTION

2.1 PROJECT SETTING

TNG Limited (TNG) proposes to develop the Project on Lot 1817, Hundred of Ayers, Middle Arm Peninsula of Darwin Harbour. The site is located adjacent to the Elizabeth River Bridge and is approximately 507ha. The Project, with associated access roads, supporting infrastructure and services comprises a development footprint of approximately 270.5 ha. This location is shown in Figure 2-1. Construction of the Project is expected to take approximately 24 months.

The Project is within the Litchfield Municipality area and is located on relatively flat terrain with the occasional gentle undulation. The project is located within the suburb of Wickham approximately 30km by road from Darwin and 9km by road from Palmerston.

Figure 2-1 Surrounding Land Use

2.2 PROPOSED CONSTRUCTION

The key atmospheric emission of concern during the construction phase of the proposed development is dust. Dust generation will be associated with all of the construction activities including clearing of vegetation, soil and fill, excavation activities, for site levelling and trenching, loading and dumping of material, wheel-generated dust and wind erosion from exposed surfaces and stockpiles.

However, the volume and duration of the emissions during construction will not be significant in comparison to emission levels during the operation phase. Furthermore, they will not be concentrated in a single location for any extended period of time.

Discharges to air (in particular dust) during the construction phase are primarily a management issue and can be minimised with good management practices (see section 7.1 for recommendations). Air dispersion modelling has therefore not been undertaken for the construction phase.

2.3 OPERATIONS PHASE

The project will process magnetite concentrate to produce vanadium pentoxide, titanium dioxide pigment and iron. The three products will be exported through the Port of Darwin's East Arm Wharf. The magnetite concentrate will be railed from the proposed Mount Peake Project, 235km northwest of Alice Springs. The proposed project life is expected to be 40 years, during which processing of magnetite concentrate would occur at a rate of 770,000 tonnes per annum.

On average three train loads of concentrate per week will be delivered to the Processing Facility from Mount Peake. Each train will have 90 hopper wagons with two 20 ft containers per wagon and a capacity of 26 tonnes of concentrate in each container (4680 tonnes total). Unloading is expected to occur over a nine hour period.

Processing broadly involves reduction of the concentrate, followed by an iron selective ferric chloride leach, a vanadium selective TIVAN® leach, and a vanadium recovery process. This production requires the installation of a titanium pigment plant and an acid regeneration plant in proximity to the TIVAN® plant. Concentrate will initially be treated using the TIVAN™ hydrometallurgical process to recover V_2O_5. The TIVAN® leach residue from the TIVAN® leach will then be fed through the dedicated titanium pigment plant. Hematite is generated within the acid regeneration process. A simplified process block diagram based on the processing facility operating at full production is shown in Figure 2-2. Figure 2-3 shows the proposed indicative site layout at the time of assessment.

The products will be exported to the East Arm Wharf via rail in shipping containers or loaded into open rail cars (dependant on the product). The Project is expected to result in one ship movement per week.

The key sources of air emissions during the operations phase may include:

- Fugitive dust from:
  - Stockpiles and exposed areas
  - Transfer points
  - Wheel-generated dust from unsealed roads
- Stack emissions from the Processing Facility including:
  - Vapour Scrubbers
  - Kiln Off-gas
  - MEE Off-gas
  - Power Station

The primary air pollutants of interest therefore include:

- Particulate matter as PM_{10}, $PM_{2.5}$ and deposited dust;

- Nitrogen dioxide (NO_2);
- Ammonia (NH_3);
- Sulphur dioxide (SO_2);
- Chlorine (Cl_2); and
- Hydrogen chloride (HCl).

There are therefore no significant sources of odour and as a consequence impacts on odour in the surrounding air environment from the Project are expected to be negligible.

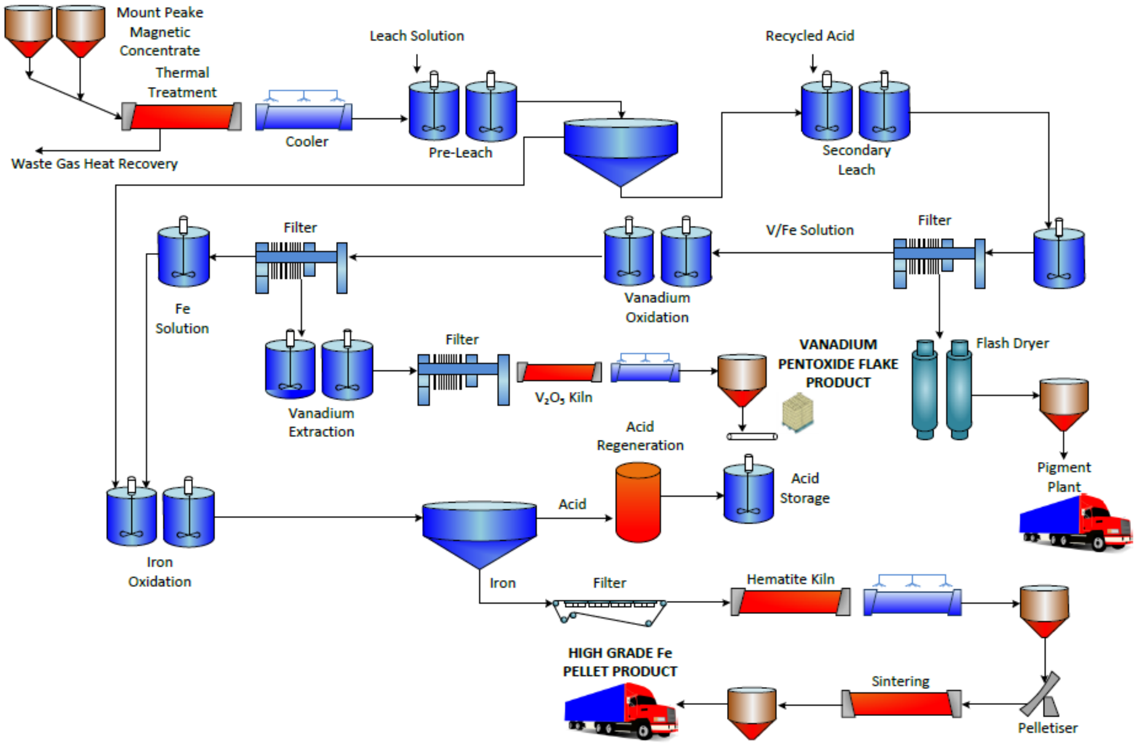


Figure 2-2: Simplified process block diagram

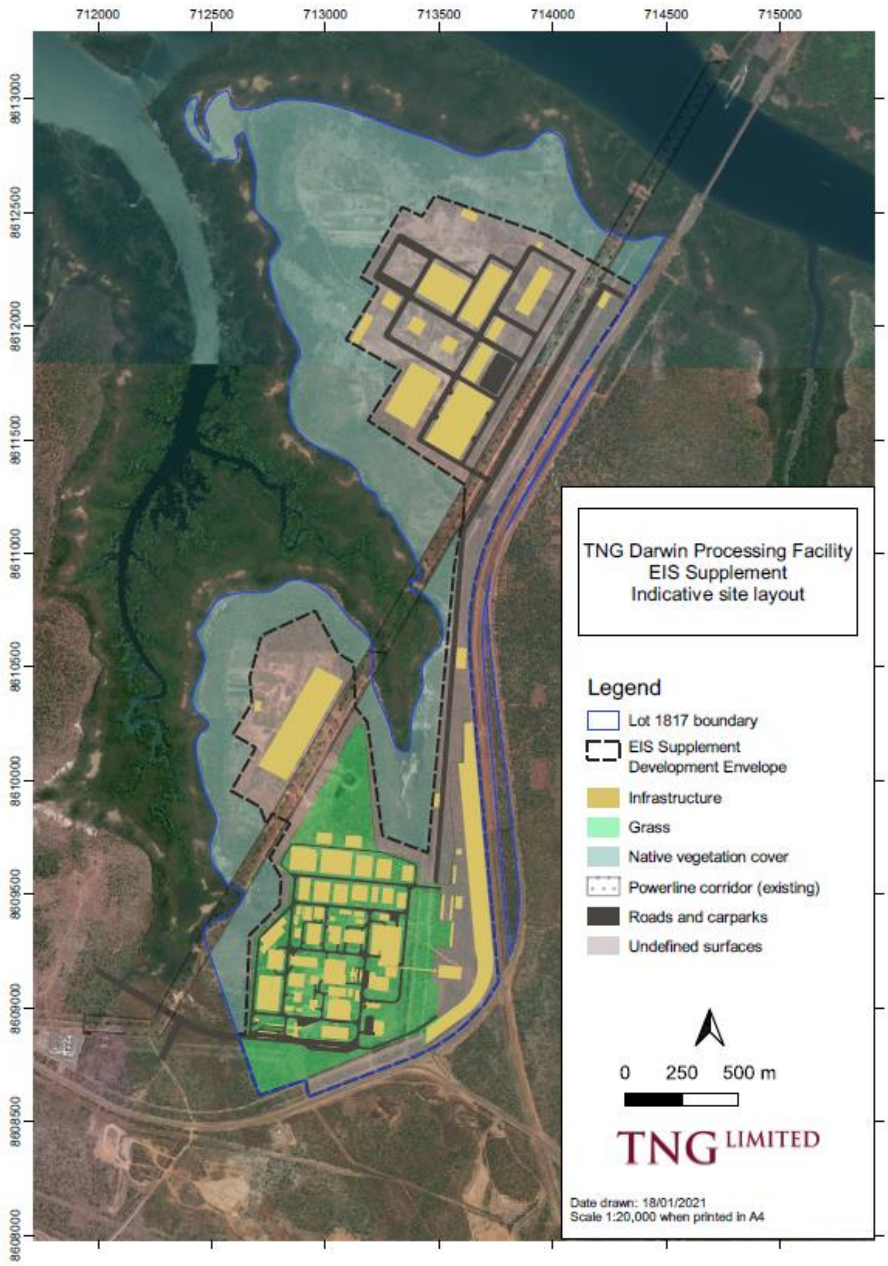


Figure 2-3: Proposed site layout

3 RELEVANT AIR QUALITY REGULATORY REQUIREMENTS

This section outlines the regulatory requirements the Project will be assessed against. In the absence of criteria in the Project jurisdiction, alternative criteria are adopted based on Commonwealth Regulations (i.e. *National Environment Protection (Ambient Air Quality) Measure*) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016).

3.1 NATIONAL ENVIRONMENT PROTECTION MEASURE FOR AMBIENT AIR QUALITY

Australia's first national ambient air quality standards were outlined in 1998 as part of the *National Environment Protection Measure for Ambient Air Quality*.

The Ambient Air Measure sets national standards for the key air pollutants; carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, lead and particles (PM_{10} and $PM_{2.5}$). The Air NEPM requires the state governments to monitor air quality and to identify potential air quality problems. Since specific air quality guidelines are not available for Northern Territory, the goals set in with the Air NEPM air quality standards has been taken as the applicable criteria for the proposed project.

3.2 DEPARTMENT OF ENVIRONMENT AND CONSERVATIONS (NSW) APPROVED METHODS

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016) detail both the assessment methodology and criteria for air quality assessments. The Approved Methods include criteria for individual toxic air pollutants based on a 1 hour averaging period and deposited dust as a maximum incremental and total level. The criteria specified for the relevant pollutants are outlined in Table 3-1.

3.3 PROJECT CRITERIA

The applicable criteria for this assessment are presented in Table 3-1.

Table 3-1: Project Air Quality Goals

Pollutant	Basis	Criteria	Source	Averaging Time
PM_{10}	Human Health	50 $\mu g/m^3$	Air NEPM	24-hour
	Human Health	25 $\mu g/m^3$	Air NEPM	Annual
$PM_{2.5}$	Human Health	25 $\mu g/m^3$	Air NEPM	24-hour
	Human Health	8 $\mu g/m^3$	Air NEPM	Annual
Nitrogen Dioxide	Human Health	250 $\mu g/m^3$	Air NEPM	1-hour
	Human Health	62 $\mu g/m^3$	Air NEPM	Annual
Sulphur Dioxide	Human Health	570 $\mu g/m^3$	Air NEPM	1-hour
	Human Health	230 $\mu g/m^3$	Air NEPM	24-hour
	Human Health	57 $\mu g/m^3$	Air NEPM	Annual
Deposited dust	Nuisance	2 g/m^2/month[a]	Approved Methods	Annual
	Nuisance	4 g/m^2/month[b]	Approved Methods	Annual
Chlorine	Human Health	50 $\mu g/m^3$	Approved Methods	1 Hour
Hydrogen chloride	Human Health	140 $\mu g/m^3$	Approved Methods	1 Hour
Ammonia	Human Health	330 $\mu g/m^3$	Approved Methods	1 Hour

a maximum increase in deposited dust level
b maximum total deposited dust level

4 EXISTING AIR ENVIRONMENT

4.1 METEOROLOGY

4.1.1 OVERVIEW

Two major atmospheric pressure systems affect Darwin:

- A subtropical ridge of high pressure cells (highs or anticyclones); and
- A broad tropical low pressure region called a monsoon trough.

The monsoon trough is an area of low atmospheric pressure running east-west through the tropics in summer months that brings large amounts of rain when passing near or over land. Seasons are characterised by a dry season between May and September and a wet season from October to April.

4.1.2 REGIONAL METEOROLOGY

The nearest long-term Bureau of Meteorology (BOM) station to the Project site is at the Darwin Airport (Site number 014015), located approximately 16 km to the North. This monitoring station recorded data since 1941 and a summary of the climate is presented in Table 4-1.

The long term mean temperature range is between 19.3°C and 33.3°C with the coldest month being July and with little variability in maximum temperatures throughout the year. The rainfall in the region is variable, with most rainfall in December to March. Rainfall is lowest between May and October, with a mean annual rainfall of 1731 mm. Rainfall reduces the dispersion of air emissions and therefore the potential impact on visual amenity and health.

Table 4-1: Long-term Weather Data for Darwin Airport [BOM]

Month	Temperature		Rainfall			9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)	Mean Rain (mm)	Mean Rain Days	No. of Days ≥ 1 mm	Temp (°C)	RH (%)	Wind Speed (km/h)	Temp (°C)	Mean RH (%)	Wind Speed (km/h)
Jan	31.8	24.9	429.4	21.3	18.9	28	81	11.4	30.2	70	17.8
Feb	31.5	24.7	372	20.3	17.9	27.7	83	11.1	30	72	18.6
Mar	32	24.6	314.8	19.5	16.7	27.6	82	9	30.5	67	16.4
Apr	32.7	24	101.5	9.3	7.2	27.4	74	10.5	31.7	52	16.5
May	32.1	22.2	21.2	2.2	1.7	25.6	65	13.6	31.2	43	17
Jun	30.7	19.9	1.7	0.6	0.2	23.3	60	14.7	29.9	38	16.2
Jul	30.6	19.3	1.1	0.4	0.2	22.8	60	13	29.6	37	17.1
Aug	31.4	20.3	4.6	0.6	0.3	24.4	64	10.7	30.2	40	19
Sep	32.6	23	15.8	2.3	1.6	27	68	9	31.2	47	20.9
Oct	33.3	24.9	70.2	6.9	5.1	28.7	69	8.8	32	52	19.9
Nov	33.3	25.3	143.4	12.5	10	29.2	72	8.7	31.9	58	17.7
Dec	32.7	25.3	251.1	16.8	14.1	28.8	76	9.9	31.2	65	17.5
Annual	**32.1**	**23.2**	**1731.2**	**112.7**	**93.9**	**26.7**	**71**	**10.9**	**30.8**	**54**	**17.9**

On average rainfall is recorded on 113 days per year at Darwin Airport as presented in Figure 4-1.

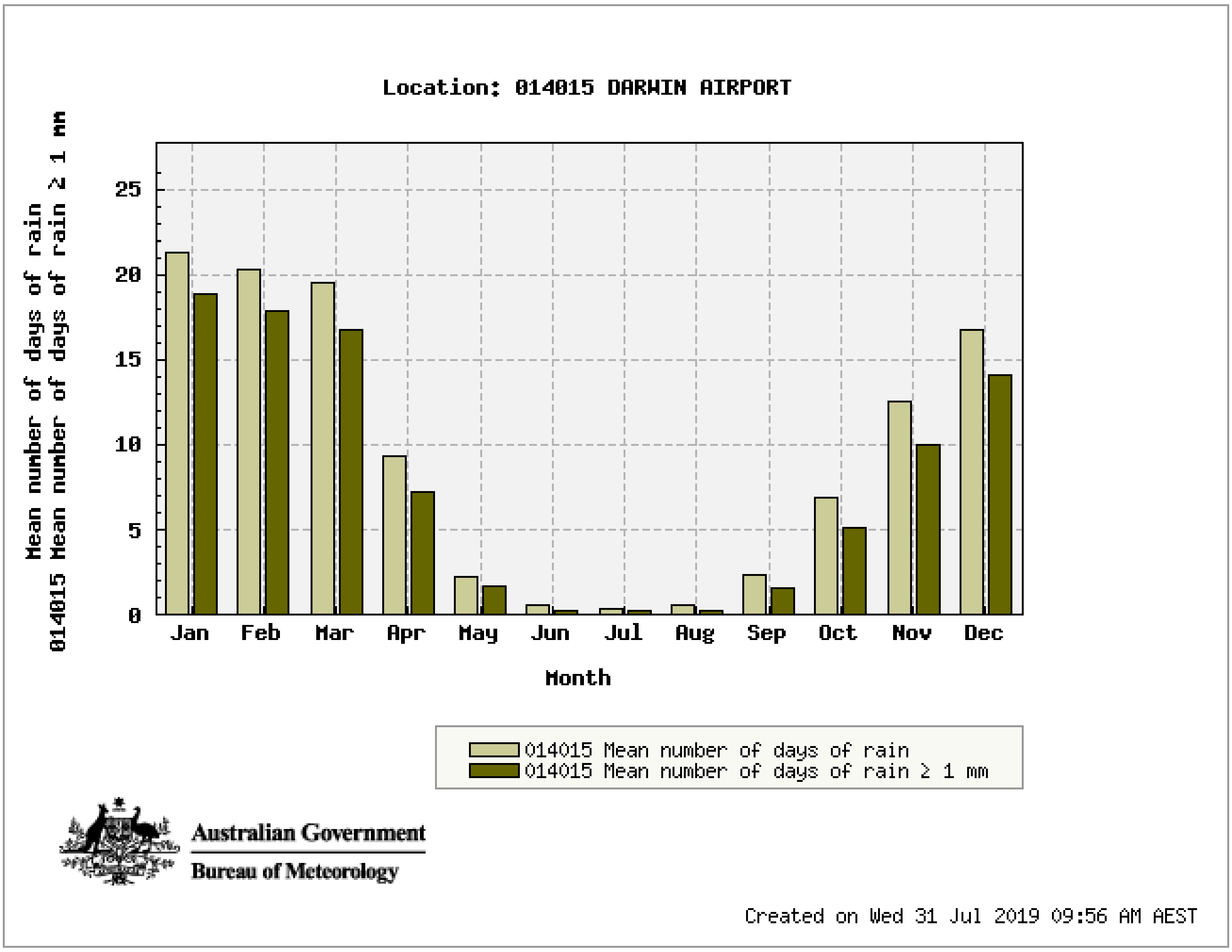
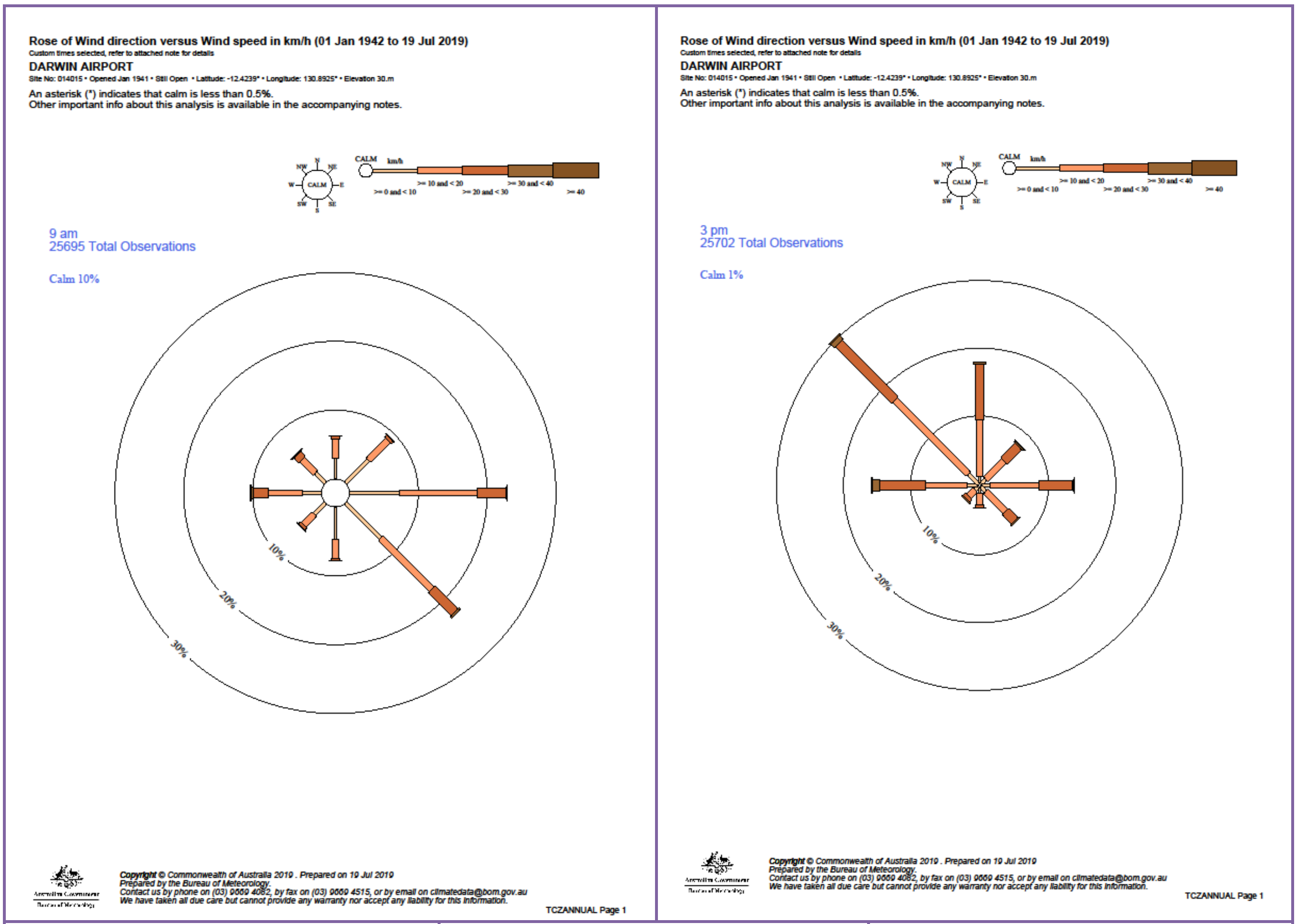


Figure 4-1: Mean Rainfall Days and Rainfall Days ≥ 1 mm at the Darwin Airport Weather Station

The long term wind roses recorded daily at the Darwin Airport station at 9am and 3pm are provided in Figure 4-2. Winds are shown to be primarily from the East at 9am and Northwest at 3pm. Stronger winds (>40km/hr or >11.1m/s) occur infrequently.



Location: Darwin Airport BoM Station	**Data Period:** 1942 to 2019	**Data Type:** Measured Data

Figure 4-2: Annual Wind Roses for Darwin Airport Weather Station (1942 to 2019)

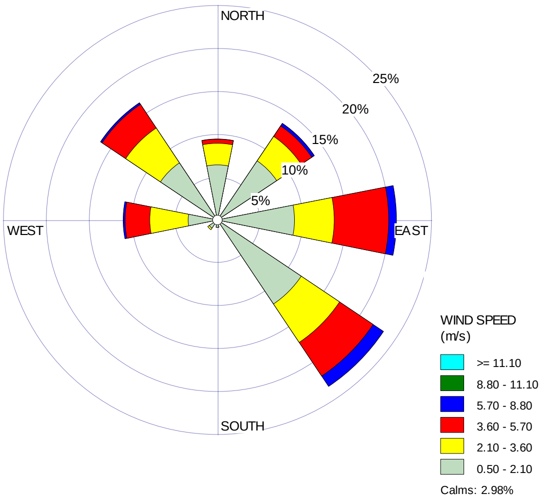
4.1.3 LOCAL METEOROLOGY

4.1.3.1 INTRODUCTION

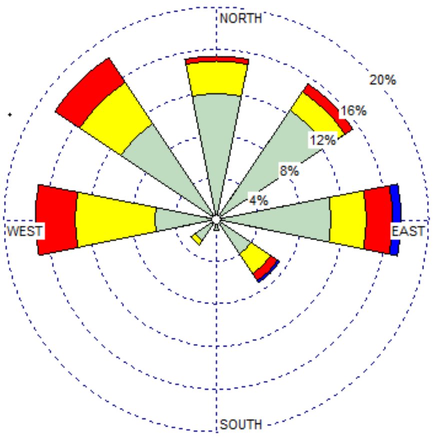
A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects. The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research and can be used as a precursor to CALMET which produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period. The TAPM-CALMET derived dataset for 12 continuous months of hourly data from the year 2017 and approximately centred at the proposed Project has been used to provide further information on the local meteorological influences. Details of the modelling approach are provided in Section 4.3.

4.1.3.2 WIND SPEED AND DIRECTION

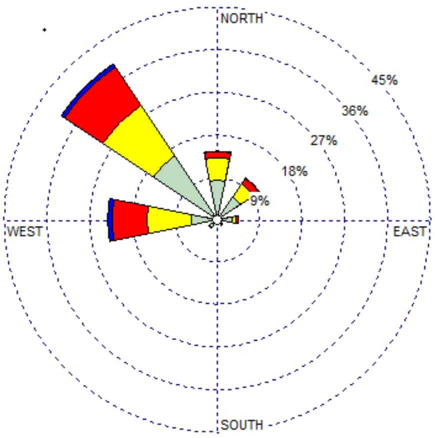
The wind roses from the TAPM-CALMET derived dataset for the year 2017 are presented in Figure 4-3 and Figure 4-4 for the Project site. Figure 4-3 shows that the dominant wind direction is from Northwest and West during the summer months. In autumn and winter the winds are primarily from the Southeasterly directions.



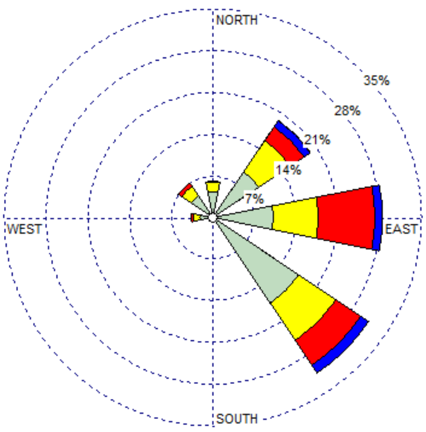
Annual



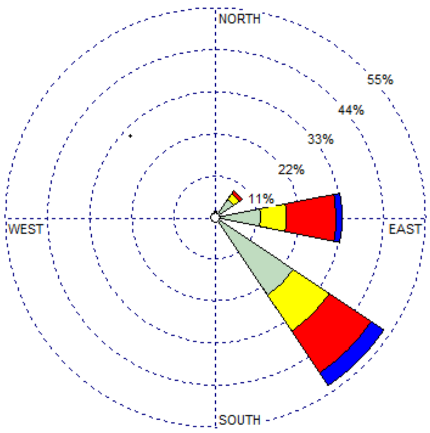
Spring



Summer



Autumn



Winter

Figure 4-3: Site-Specific Wind Roses by Season for 2017

Figure 4-2: Annual Wind Roses for Darwin Airport Weather Station (1942 to 2019) shows the wind roses for the time of day during the year for 2017. It can be seen that there are more frequent and stronger winds from the Southeast and East during the morning and afternoon periods.

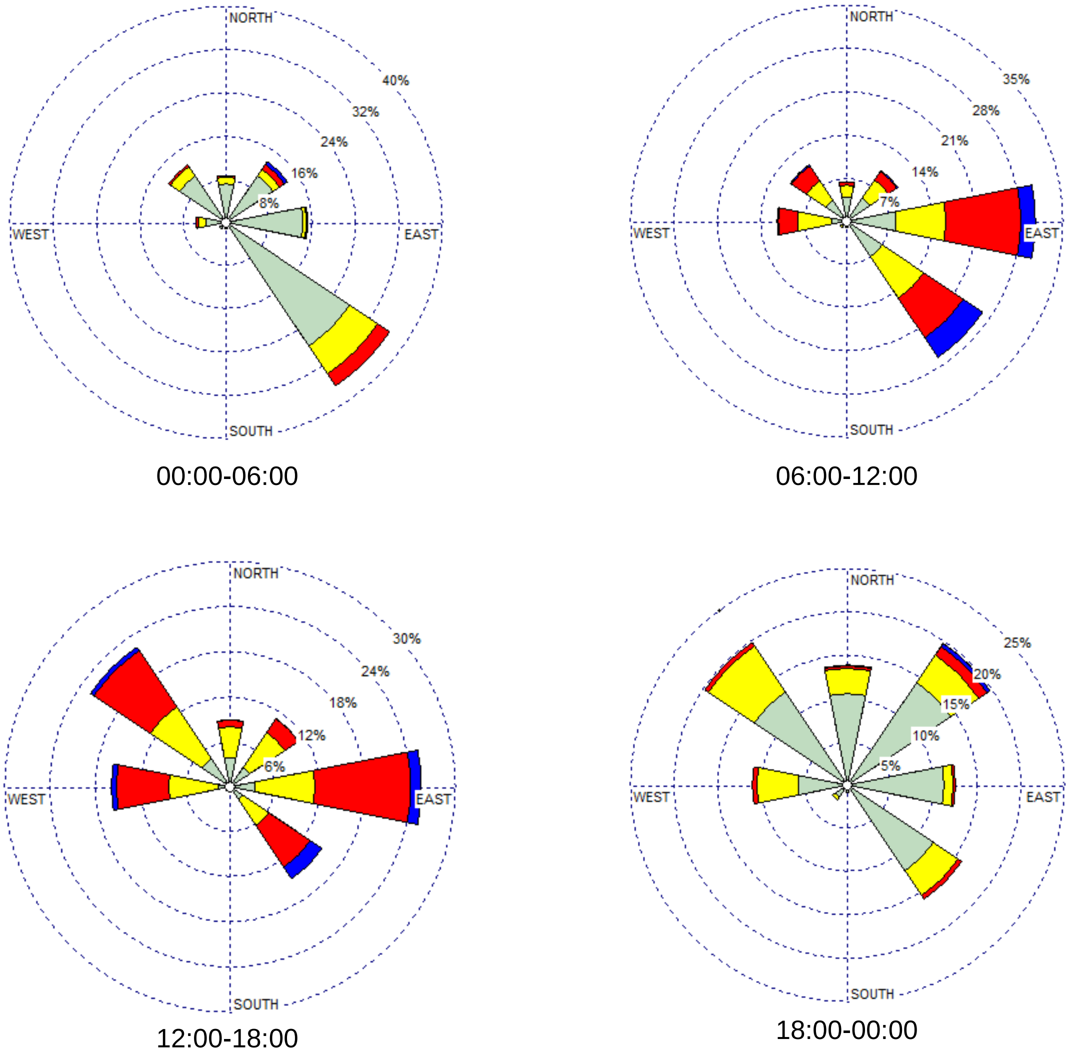


Figure 4-4: Site-Specific Wind Roses by Time of Day for 2017

A comparison of the wind roses at 09:00 and 15:00 hours for the TAPM-CALMET derived dataset (Figure 4-5) at the Project site was also undertaken with the BOM long-term wind roses at Darwin Airport. The wind roses from BOM and TAPM-CALMET are similar. The BOM wind rose, based on approximately 25,700 observations, identifies Easterly and Southeasterly winds as the prevailing winds at 9am, while TAPM-CALMET Southeasterly winds as prevailing with some Easterlies. These differences in wind are influenced from the topography surrounding both the BOM monitoring station and the Project site. Overall, the meteorological data generated by TAPM-CALMET is considered to be representative of the site.

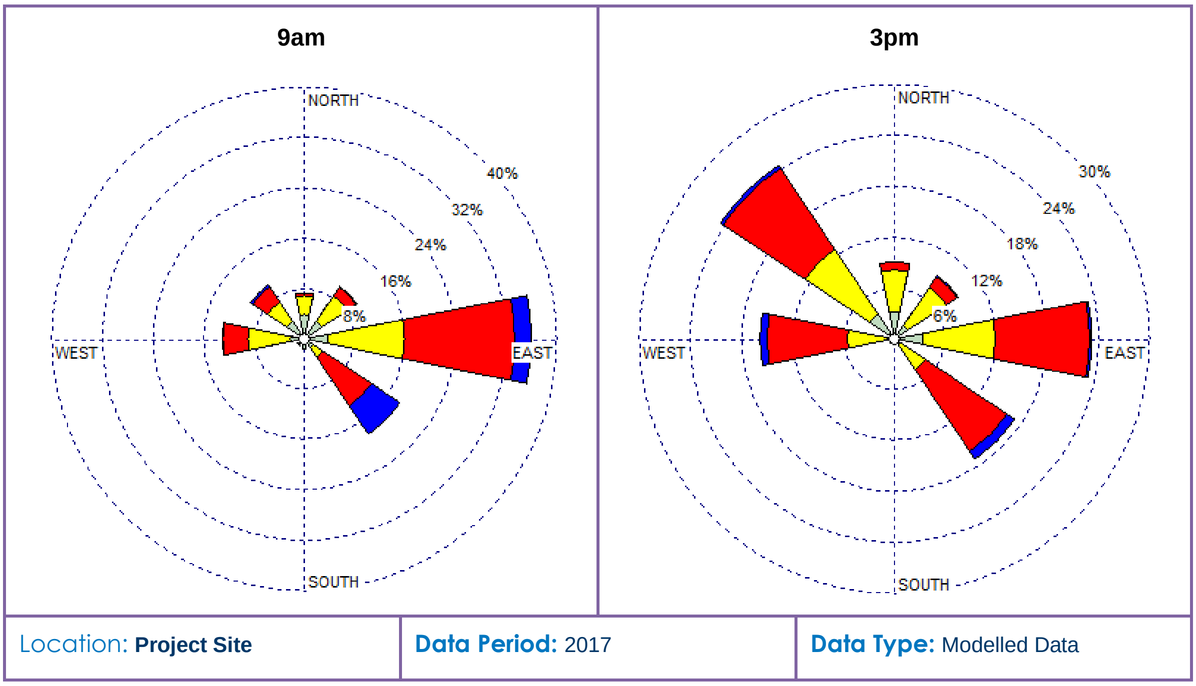


Figure 4-5: Annual Wind Roses for the TAPM-CALMET derived dataset at the Project site, 2017 (9am and 3pm)

4.1.3.3 ATMOSPHERIC STABILITY

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion of pollutants. The Pasquill-Turner assignment scheme identifies six Stability Classes (Stability Classes A to F) to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used in various air dispersion models. Temperature inversions are defined as Class F, these conditions only occur with clear and calm conditions during the evening and night time periods. The frequency of occurrence for each stability class for 2017 is detailed in Table 4-2.

Table 4-2: Annual Stability Class Distribution Predicted [TAPM-CALMET, 2017]

Stability Class	Description	Frequency of Occurrence (%)	Average Wind Speed (m/s)
A	Very unstable low wind, clear skies, hot daytime conditions	3.8	1.6
B	Unstable clear skies, daytime conditions	16.4	2.6
C	Moderately unstable moderate wind, slightly overcast daytime	20.8	3.6
D	Neutral high winds or cloudy days and nights	9.6	4.1
E	Stable moderate wind, slightly overcast night-time conditions	3.5	3.5
F	Very stable low winds, clear skies, cold night-time conditions	45.9	1.5

4.1.3.4 MIXING HEIGHT

Mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer.

Diurnal variations in mixing depths are illustrated in Figure 4-6. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise.

Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

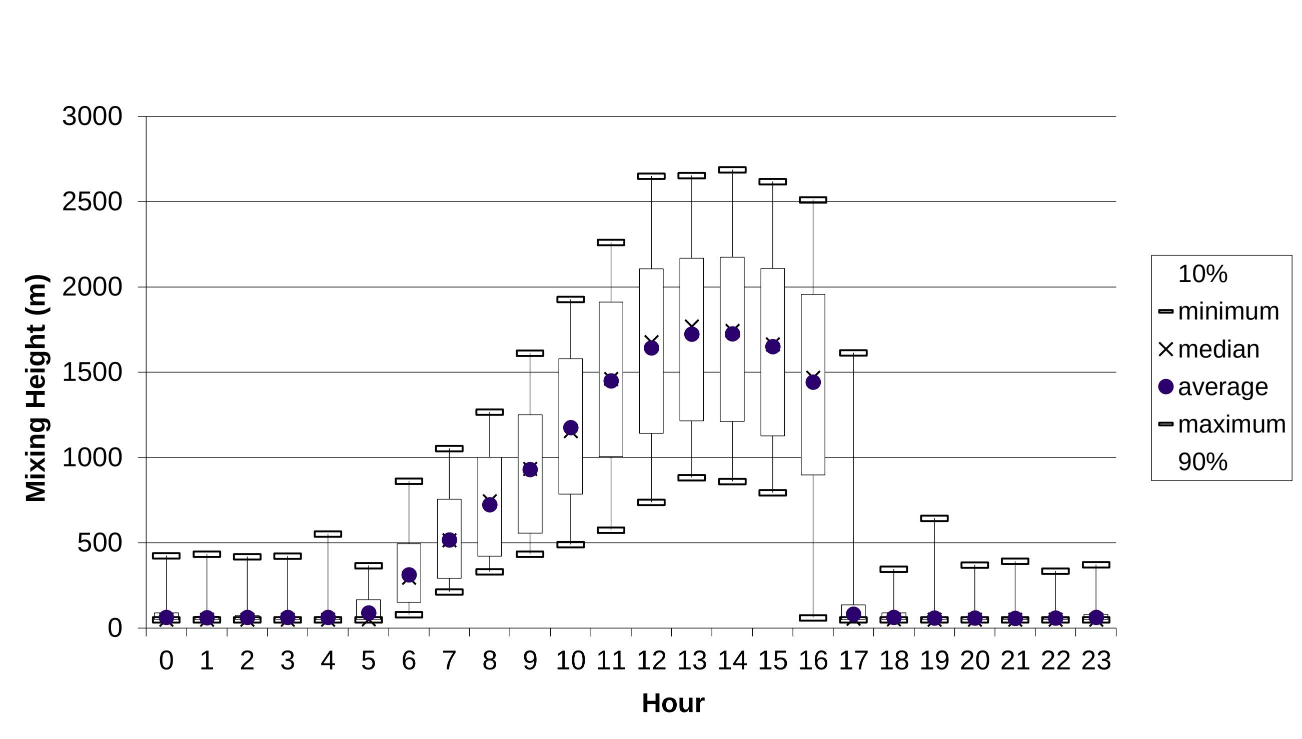


Figure 4-6: Mixing Height [TAPM-CALMET, 2017]

4.2 EXISTING AIR QUALITY

4.2.1 BACKGROUND

As discussed in Section 2.1, the Project is located in a rural setting approximately 30km by road from Darwin and 9km by road from Palmerston. Anthropogenic sources of emissions with the potential to impact upon air quality in the region include:

- Motor vehicles in Darwin and surrounding suburbs;
- Conoco Phillips gas processing plant including the gas power generation station;
- Channel Island Power Station;
- Weddell Power Station;
- Emissions from ships; and
- Inpex LNG Facility.

In addition, regional smoke from wild fires and prescribed burning activities both locally and distant have the potential to contribute to air quality pollution.

4.2.2 PALMERSTON AIR QUALITY MONITORING

The Northern Territory Environment Protection Authority (NT EPA) monitors air quality at stations in Winnellie and Palmerston. These stations monitor a number of different pollutants and collect meteorological data.

The Palmerston Air Quality Monitoring Station was established in 2010 and is located approximately 4km north of the Project site. The NT EPA describe the station as being located to provide information on airborne pollutants, which may be moving from industrial sites in the middle harbour to populations in the Palmerston area. While it is closer to the motor vehicle emission sources of Darwin, data from this station is used as a conservative representation of background air quality levels at the Project site.

Table 4-4 provides a statistical summary of the air quality monitoring data as measured at the Palmerston station in 2017, which is selected as consistent with the meteorological dataset generated for modelling. As shown in the table, the measured maximum concentrations for PM_{10} and $PM_{2.5}$ are above the relevant criteria and CO, NO_2 and SO_2 are well below the criteria. The exceedances of the $PM_{2.5}$ 24-hour standard were attributed by the NTEPA to exceptional events such as smoke from small scale local bush/grass fires or more distant large scale savannah fire activity such as hazard reduction.

Table 4-3: Statistical summary of Palmerston air quality monitoring data, 2017

Parameter	Criteria (µg/m³)	Period	Concentration Statistic (µg/m³)			
			Maximum	90th Percentile	70th Percentile	Average
PM_{10}	50	**24 Hour**	58.8	34.0	23.7	19.9
$PM_{2.5}$	25	**24 Hour**	42.3	16.3	9.2	7.6
SO_2	570	**1 Hour**	205	17.2	8.9	7.4
	230	**24 Hour**	42.3	16.2	7.9	7.4
NO_2	250	**1 Hour**	42.8	11.5	5.5	4.7

4.2.3 ASSIGNED BACKGROUND

In accordance with the guidelines set out by the Victorian Environmental Protection Authority in the State Environmental Protection Policy (Air Quality Management), the 70th percentile measured concentrations are adopted as a conservative estimation of background air quality for the Project area. Table 4-4 summarises the assigned background concentrations and compares them with the relevant criteria. As shown the annual average $PM_{2.5}$ measured background of 7.6 µg/m³ is just below the criteria of 8 µg/m³.

Table 4-4: Assigned Background Levels

Parameter	Criteria (µg/m³)		Period	Applied Background (µg/m³)
PM_{10}	50		**24 Hour**	23.7
	25		**Annual**	19.9
$PM_{2.5}$	25		**24 Hour**	9.2
	8		**Annual**	7.6
SO_2	570		**1 Hour**	1.0
	230		**24 Hour**	1.0
	57		**Annual**	0.89
NO_2	250		**1 Hour**	5.5
	62		**Annual**	4.7
Dust deposition	2[a]	4[b]	**Annual**	2

a maximum increase in deposited dust level in g/m²/month
b maximum total deposited dust level in g/m²/month

There are no significant sources of NH_3, HCl and Cl_2 in proximity to the Project site. Background levels of these pollutants are therefore estimated as negligible.

As discussed in Section 4.2.2, the background applied for the assessment is based on measurements at the NT EPA Palmerston station from 2017 to be consistent with the meteorological year modelled. While it has also been noted that the Palmerston station is sited to capture industrial emissions from Middle Harbour sources, the INPEX LNG Facility was not operational until 2018. As shown in Table 4-5, a review of the average concentration data collected at this station since 2018 shows a slight increase in data measured for most pollutants (largely attributed by the NT EPA to smoke from bushfires) and a reduction in 2020 compared with the adopted background. These measured data are consistent with the findings of the Ichthys Onshore

Gas Field Development Project Air Quality Assessment (SKM, 2010), which concluded *that the atmospheric emissions from the proposed INPEX facility will contribute to a relatively small increase in predicted ground level concentrations of* NO_X *and* SO_X*. Also, particulate matter concentrations remain well within NEPM criteria*.

Table 4-5: Average measured Palmerston air quality monitoring data, 2017 - 2020

Parameter	Average Concentration (µg/m^3)			
	2017[1]	2018	2019	2020
PM_{10}	19.9	19.7	22.0	18.1
$PM_{2.5}$	7.6	8.7	9.7	7.0
SO_2	0.89	1.1	1.7	1.2
NO_2	4.7	5.0	4.5	3.4

1. Adopted background

5 METHODOLOGY

5.1 OVERVIEW

The air quality impact assessment has been carried out based on a consideration of the *Terms of Reference for the Preparation of an Environmental Impact Statement – Darwin Refinery TNG Limited (NTEPA, 2016)* and the *NTEPA Environmental Assessment Guidelines* (NTEPA, 2018). In addition, the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* is referred to in the application of the following methodology:

- An emissions inventory of PM_{10}, $PM_{2.5}$, deposited dust, NO_2, SO_2, NH_3, HCl and Cl_2 for the proposed Project was compiled using manufacturer specification data for the operation of the Project (outlined in Section 5.2).
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model (Section 5.3).
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria described in Section 3 as part of the impact assessment. Air quality controls are applied to reduce emission rates where specified.

5.2 EMISSIONS INPUT PARAMETERS

5.2.1 EMISSIONS SCENARIOS

Emissions to air from the operational stage of the proposed Project have been included in this assessment for the routine operation data as provided by APM.

It is noted that emissions from upset conditions are not considered to be credible events because of shut down protocols in place which would be immediately identified by the continuous emissions monitoring proposed for the primary sources of stack emissions[1].

5.2.2 SOURCE EMISSIONS DATA

Point source emissions input data relevant to the modelling of air emissions for the routine operation of the Project were derived from APM supplied data[2].

Table 5-1 summarises the point source emissions data including proposed air pollution controls and the approximate locations of the sources are shown in Figure 5-1.

Fugitive dust emissions data (i.e. as area and volume sources) were derived from the Mt Peake Project Air Quality Assessment Report (GHD, 2015) for stockpiling and train unloading and loading activities (Table 5-2).

[1] Email communication TNG Ltd to Animal Plant Mineral (16/12/2020)
[2] 20201014_Emissions air_R3_20201015.xlsx and 14771464B1_Emission Layout Prel – rev B.pdf

Table 5-1: Point source emissions data

ID	Stack height (m)	Stack diam (m)	Exhaust temp (°C)	Exit velocity (m/s)							Pollution Control
					HCl	Cl_2	NH_3	SO_2	NO_x	PM[a]	
PP200A	40	0.3	50	15						0.01	Compact filter
PP220B	40	0.3	50	15						0.01	Compact filter
PP200C	40	0.3	50	15						0.01	Compact filter
PP200D	25	1.8	50	15						0.01	Filter house
PP300	28.5	1.8	100	10	0.25						Scrubber with packing and circulation system
PP310	28.7	1.1	100	10	0.10						Scrubber with packing and circulation system
PP320	28.7	1.3	100	15	0.40					0.40	Filter and scrubber with packing and circulation system
PP330	38.5	1	100	10	0.08						Scrubber with packing and circulation system
PP350	33.5	1.9	100	10	0.28						Scrubber with packing and circulation system
PP360	40	1.9	90	10	0.57					0.57	Venturi scrubber and scrubber with packing and circulation system
PP360A	18	0.8	165	15	0.00					0.08	Filter
PP370A	40	1.2	90	10	0.23	0.11				0.23	Venturi scrubber and scrubber with packing and circulation system
PP370B	40	1.2	90	10	0.23	0.11				0.23	
PP370C	40	1.2	90	10	0.23	0.11				0.23	
PP370D	40	1.2	90	10	0.23	0.11				0.23	
PP370E	40	1.2	90	10	0.23	0.11				0.23	
PP370F	40	1.2	90	10	0.23	0.11				0.23	
PP370G	40	1.2	90	10	0.23	0.11				0.23	
PP370H	40	1.2	90	10	0.23	0.11				0.23	
PP370I	40	1.2	90	10	0.23	0.11				0.23	

PP370J	40	1.2	90	10	0.23	0.11				0.23	
PP370A2	20	0.7	105	15						0.06	Filter on bin
PP370B2	20	0.7	105	15						0.06	
PP370C2	20	0.7	105	15						0.06	
PP370D2	20	0.7	105	15						0.06	
PP370E2	20	0.7	105	15						0.06	
PP370F2	20	0.7	105	15						0.06	
PP370G2	20	0.7	105	15						0.06	
PP370H2	20	0.7	105	15						0.06	
PP370I2	20	0.7	105	15						0.06	
PP370J2	20	0.7	105	15						0.06	
PP380	9	0.1	70	0	1.2×10^{-5}						Scrubber with packing and circulation system
PP400	22	0.4	65	15			0.39				Venturi scrubber and scrubber with packing and circulation system
PP500	100	1.6	60	15				39.53			Multiple scrubber system
PP500A	40	0.7	65	15				1.5			Not yet detemined
PP510	10	1.3	85	15							Dust filter scrubber
PP710	25	3.9	100	15	1.79			53.8		1.79	Dust filter scrubber
PP780	20	2.7	150	15				0.43	12.88		Not yet detemined

a PM emission rate conservatively modelled as TSP, PM_{10} and $PM_{2.5}$ emissions.

Table 5-2: Fugitive source emissions data

ID	Source type	Effective height (m)	Initial sigma y (m)	Initial sigma z (m)	TSP emission rate (g/s)	PM_{10} emission rate (g/s)	$PM_{2.5}$ emission rate (g/s)
ROM	Stockpile wind erosion	10		0.5	0.4	0.2	0.04
FEL	FEL movement of stockpiles	8	2	2	0.07	0.03	0.007
UL	Truck unloading	10	2.5	2.5	0.3	0.1	0.03
TU	Train unloading						
TP	Transfer point						

a south west corner

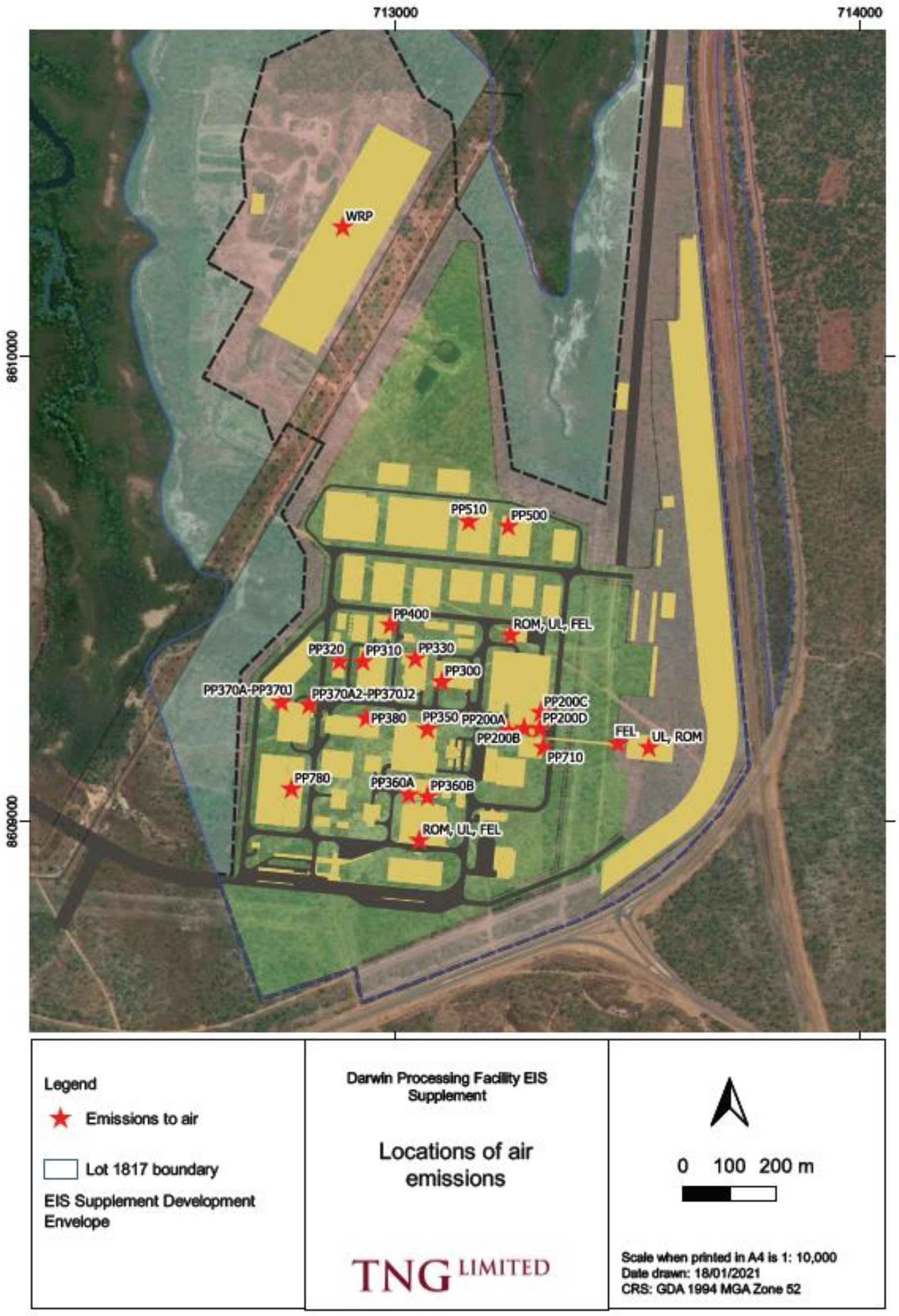


Figure 5-1: Source and building locations

5.3 MODELLING METHODOLOGY

5.3.1 TAPM

A 3-dimensional dispersion wind field model, CALPUFF, has been used to simulate the impacts from the Project. CALPUFF is an advanced non-steady-state meteorological and air quality modelling system developed and distributed by Earth Tech, Inc. The model has been approved for use in the '*Guideline on Air Quality Models*' (Barclay and Scire, 2011) as a preferred model for assessing applications involving complex meteorological conditions.

To generate the broad scale meteorological inputs to run CALPUFF, this study has used the model The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO.

TAPM was configured as follows:

- Centre coordinates – 12˚ 33.0 S, 131˚ 0.0 E;
- Dates modelled – 30 December 2015 to 31 December 2017 (including 2 start-up days);
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 41 x 41 grid points for all modelling domains;
- 25 vertical levels from 10 m to an altitude of 8000 m above sea level;
- The default TAPM databases for terrain, land use and meteorology were used in the model; and
- Data assimilation of wind direction and speed recorded at the NT EPA Palmerston Air Quality Monitoring Station.
- CALTAPM was used to generate an MM5 dataset suitable for input into the CALMET model (below).

5.3.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system.

The MM5 meteorological data is utilised in this model. The CALMET simulation was set up in accordance with the best practice guidelines for NSW (Barclay and Scire, 2011). The CALMET simulation was run as No-Obs simulation with the gridded TAPM three-dimensional wind field data from the innermost grid. CALMET then adjusts the prognostic data for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

5.3.3 CALPUFF

CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Due to the variable topography, the radius of influence of terrain features was set at 5 km while the minimum radius of influence was set as 0.1 km. The terrain data incorporated into the model had a resolution of 1 arc-second (approximately 30 m) in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'*.

5.3.4 OTHER MODELLING INPUT PARAMETERS

5.3.4.1 PARTICLE SIZE DISTRIBUTION

CALPUFF requires particle distribution data (geometric mass mean diameter, standard deviation) to compute the dispersion of particulates (*Table 5-3).*

Table 5-3: Particle size distribution data

Particle size	Mean particle diameter (µm)	Geometric standard deviation (µm)
TSP	15	2
PM_{10}	4.88	1
$PM_{2.5}$	0.89	1

5.3.4.2 BUILDING WAKE EFFECTS

Figure 5-1 shows the locations of the building incorporated into the model set up for the BPIP-PRIME building downwash algorithms.

5.3.4.3 THERMAL INERNAL BOUNDARY LAYER

The CALPUFF modelling system contains algorithms for near-source and longer-range effects, including those associated with overwater transport and coastal interaction effects, including changes in overwater boundary layer parameters, the abrupt change in meteorological conditions and plume dispersion along a coastal boundary, plume fumigation, and the option to introduce subgrid scale Thermal Internal Boundary Layers (TIBLs) into coastal grid cells.

A sub-grid scale TIBL module was adopted for the position of the coastal boundary near the site to allow the modelling at a greater spatial resolution.

5.3.4.4 SENSITIVE RECEPTORS

15 sensitive receptors representative of the closest residential (or proposed residential) receivers to the site were adopted for the modelling as follows:

- R1 to R7: Residential Receivers located in Archer and Bellamack
- R8 to R12: Residential Receivers located in Virginia
- R13: Planned future residential/urban area located in Weddell
- R14: Bladin Village – Workers Accommodation for the Bladin Point LNG Facility
- R15: Elizabeth River Boat Ramp

Figure 5-2 shows the locations of the adopted sensitive receptors (R1 to R15). It is worth noting that the proposed 'Future Weddell residential/urban area' (R13) is located approximately 2.3km south east of the site, however there are currently no plans to develop this area[3] and therefore has not been considered as part of this assessment.

[3] NT EPA Communication - Sharon Arena Animal Plant Mineral

Figure 5-2: Sensitive receptor locations adopted for the modelling assessment

5.4 NO_X TO NO_2 CONVERSION

One of the most common atmospheric chemistry issues regulatory modellers are required to address is estimating NO_2 from modelled NO_X concentrations. The most appropriate conversion method is determined on a case-by-case basis.

The most conservative approach assuming a 100% conversion is adopted here.

6 ASSESSMENT OF IMPACTS

6.1 CONSTRUCTION IMPACTS

Discharges to air (in particular, dust) during the construction phase are primarily a management issue and can be minimised with good management practices. The control of the emissions from the construction phase is discussed in Section 7.1.

6.2 OPERATIONAL IMPACTS

6.2.1 PARTICULATE IMPACTS

The ground-level predictions of dust deposition, PM_{10} and $PM_{2.5}$ for the operation of the Project in isolation and including background (cumulative) at the nearest sensitive receptors are presented in Table 6-1.

Contour plots of the predicted maximum ground-level concentrations are presented in Appendix A.

The model results show:

- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project in isolation are well below the relevant criteria.
- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project including background (cumulative) are below the relevant criteria.
- The most affected of the modelled receptors is the Bladin Village – Workers Accommodation, which is in the westerly direction from the Project and in the direction of the prevailing winds (from the east) which have the potential to carry air emissions to the receptor. It is also noted that the predictions are driven by the conservative approach adopted for the modelling which included an elevated background already close to the criteria for the annual average and a total particulate matter emission rate assigned for $PM_{2.5}$.

6.2.2 GASEOUS IMPACTS

The predicted ground-level concentrations of combustion gases (NO_2, SO_2) for the operation of the Project at the nearest sensitive receptors are presented in Table 6-2. The predicted ground-level concentrations of the other gases (NH_3, Cl_2 and HCl) for the operation of the Project at the nearest sensitive receptors are presented in Table 6-2.

Contour plots of the predicted maximum ground-level concentrations are presented in Appendix A.

The model results show that the maximum predicted concentrations of NO_2 and SO_2 are below the adopted criteria for all sensitive receptors modelled for the Project operating in isolation and including background. Furthermore, the maximum predicted concentrations of NH_3, Cl_2 and HCl are below the adopted criteria for all sensitive receptors modelled.

Table 6-1: Predicted maximum ground-level predictions of particles concentrations and dust deposition for the Project

	In isolation					Cumulative				
	Annual Dust Deposition (g/m^2/month)	**24 Hour PM_{10} ($\mu g/m^3$)**	**Annual PM_{10} ($\mu g/m^3$)**	**24 Hour $PM_{2.5}$ ($\mu g/m^3$)**	**Annual $PM_{2.5}$ ($\mu g/m^3$)**	**Annual Dust Deposition (g/m^2/month)**	**24 Hour PM_{10} ($\mu g/m^3$)**	**Annual PM_{10} ($\mu g/m^3$)**	**24 Hour $PM_{2.5}$ ($\mu g/m^3$)**	**Annual $PM_{2.5}$ ($\mu g/m^3$)**
R1	0.00	0.67	0.02	0.58	0.02	2.00	24.37	19.92	9.78	7.62
R2	0.00	0.66	0.02	0.57	0.02	2.00	24.36	19.92	9.77	7.62
R3	0.00	0.67	0.02	0.54	0.02	2.00	24.37	19.92	9.74	7.62
R4	0.00	0.69	0.02	0.62	0.02	2.00	24.39	19.92	9.82	7.62
R5	0.00	0.88	0.02	0.84	0.02	2.00	24.58	19.92	10.04	7.62
R6	0.00	0.70	0.02	0.69	0.02	2.00	24.40	19.92	9.89	7.62
R7	0.00	0.47	0.02	0.46	0.01	2.00	24.17	19.92	9.66	7.61
R8	0.00	1.43	0.04	1.15	0.03	2.00	25.13	19.94	10.35	7.63
R9	0.00	1.88	0.04	1.82	0.04	2.00	25.58	19.94	11.02	7.64
R10	0.00	2.37	0.06	2.33	0.05	2.00	26.07	19.96	11.53	7.65
R11	0.00	5.14	0.16	5.06	0.14	2.00	28.84	20.06	14.26	7.74
R12	0.00	3.80	0.20	3.69	0.19	2.01	27.50	20.10	12.89	7.79
R14	0.01	5.21	0.42	5.19	0.38	2.01	28.91	20.32	14.39	7.98
R15	0.01	1.01	0.04	1.12	0.03	2.01	24.71	19.94	10.32	7.63
Criteria	**2**	**50**	**25**	**25**	**8**	**4**	**50**	**25**	**25**	**8**

Table 6-2: Maximum predicted gaseous impacts (combustion)

	In isolation (µg/m³)					Cumulative (µg/m3)				
	NO_2		SO_2			NO_2		SO_2		
	1 hour	**Annual**	**1 hour**	**24 hours**	**Annual**	**1 hour**	**Annual**	**1 hour**	**24 hours**	**Annual**
R1	12.79	0.02	73.76	4.32	0.13	18.29	4.72	74.76	5.32	1.02
R2	16.00	0.02	96.53	5.32	0.14	21.50	4.72	97.53	6.32	1.03
R3	18.17	0.02	115.07	5.97	0.14	23.67	4.72	116.07	6.97	1.03
R4	17.06	0.02	109.64	5.57	0.14	22.56	4.72	110.64	6.57	1.03
R5	12.02	0.02	81.65	5.92	0.14	17.52	4.72	82.65	6.92	1.03
R6	16.61	0.02	55.72	5.44	0.12	22.11	4.72	56.72	6.44	1.01
R7	6.14	0.01	34.69	1.92	0.09	11.64	4.71	35.69	2.92	0.98
R8	6.86	0.02	41.82	4.34	0.15	12.36	4.72	42.82	5.34	1.04
R9	10.04	0.02	54.83	5.60	0.18	15.54	4.72	55.83	6.60	1.07
R10	12.32	0.03	49.30	9.80	0.26	17.82	4.73	50.30	10.80	1.15
R11	10.55	0.08	64.71	17.70	0.77	16.05	4.78	65.71	18.70	1.66
R12	15.20	0.13	56.76	18.96	0.98	20.70	4.83	57.76	19.96	1.87
R14	32.99	0.47	208.05	35.80	3.04	38.49	5.17	135.73	23.15	3.30
R15	16.89	0.03	134.73	22.15	2.41	22.39	4.73	100.91	10.27	1.12
Criteria	**250**	**62**	**570**	**230**	**57**	**250**	**62**	**570**	**230**	**57**

Table 6-3: Maximum predicted gaseous impacts (other)

	Maximum Predicted Concentration (µg/m³)		
	1 Hour Cl_2	**1 Hour HCl**	**1 Hour NH_3**
R1	2.96	9.13	2.01
R2	3.44	8.27	2.53
R3	3.77	9.31	2.74
R4	3.34	8.90	1.81
R5	4.47	9.29	2.56
R6	3.02	8.98	1.85
R7	2.58	7.50	1.46
R8	4.33	12.35	3.13
R9	5.65	15.55	3.72
R10	8.09	18.52	3.95
R11	7.03	20.02	5.31
R12	6.35	18.31	4.40
R14	11.56	30.04	7.20
R15	4.13	13.27	8.44
Criteria	**50**	**140**	**330**

7 MITIGATION

A summary of the proposed mitigation measures is provided in this section for both construction and operational phases of the Project. A recommended air quality management plan is outlined in Appendix B.

7.1 CONSTRUCTION PHASE

Measures for the management of dust emissions during the construction phase to be employed include, but not necessarily be limited to the following:

- Regular watering of active areas and stockpiles areas;
- Application of chemical suppressants on haul roads that are subject to frequent vehicle movements;
- All equipment utilised on site will be maintained in an efficient and effective manner;
- Where practicable limit vegetation and soil clearing to reflect the operational requirements; and
- Where practicable reuse cleared vegetation during the rehabilitation phase of the Project to minimise burning.

7.2 OPERATION PHASE

Fugitive dust generation at the Darwin Processing Facility during the operations phase may be managed through a combination of the following:

- Retention of sufficient moisture in the concentrate stream to maintain the concentrate at its Dust Extinction Moisture level;
- Use of water sprays or misting nozzles during stacking operations;
- Water cannons on stockpiles;
- Fogging sprays at transfer points;
- Physical enclosure of transfer points and operating equipment;
- Vanadium precipitation, drying, fusing and packaging and titanium dioxide packaging undertaken in a shed;
- Concentrate, coke and titanium dioxide product located inside multiple sheds;
- Open areas not required for vehicle access or construction may be sprayed with hydromulch or sealed through the application of dust suppressant chemicals; and
- Active road surfaces may be either sealed, treated with a dust suppressant chemical or sprayed with water.

As outlined in Table 5-1, scrubbers and filters are also proposed for the control of atmospheric emissions from multiple Project stack sources. Ongoing stack emissions monitoring is also proposed (see Appendix B) for all primary sources.

Prior to commissioning it is also recommended that stack emissions testing (including physical parameters) be carried out on these sources in accordance with the relevant Australian/ New Zealand Standards. Where relevant (i.e. where differences are identified between the manufacturer specification data and measured data), it is also recommended that the modelling assessment is repeated.

8 CONCLUSION

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the construction and operational stages of the Project and to provide recommendations to mitigate any potential impacts that might have an effect on sensitive receptors.

The results of the modelling can be summarised as follows:

- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project in isolation are well below the relevant criteria.
- All predictions of dust deposition, PM_{10} and $PM_{2.5}$ at the modelled sensitive receptors for the operation of the Project including background (cumulative) are below the relevant criteria.
- The most affected of the modelled receptors is the Bladin Village – Workers Accommodation, which is in the westerly direction from the Project and in the direction of the prevailing winds (from the east) which have the potential to carry air emissions to the receptor. It is also noted that the predictions are driven by the conservative approach adopted for the modelling which included an elevated background already close to the criteria for the annual average and a total particulate matter emission rate assigned for $PM_{2.5}$.
- The model results also show that the maximum predicted concentrations of NO_2 and SO_2 are below the adopted criteria for all sensitive receptors modelled for the Project operating in isolation and including background. Furthermore, the maximum predicted concentrations of NH_3, Cl_2 and HCl are below the adopted criteria for all sensitive receptors modelled.

Whilst elevated predictions of $PM_{2.5}$ concentrations are driven by the background levels and the conservative approach to modelling, it is recommended that an ongoing measurement program for this pollutant is undertaken at the most affected receptor location (the Bladin Village – Workers Accommodation). Furthermore, scrubbers and filters are also proposed for the control of emissions from multiple Project stack sources with ongoing stack emissions monitoring (continuous and discontinuous) proposed for all primary sources.

Overall, with the recommended control and monitoring measures in place, the Project operations are not expected to adversely impact the surrounding air environment.

9 REFERENCES

GHD, 2015. Report for TNG Limited – Mount Peake Project: 61/29057/11.

Hurley P, 2008a. TAPM V4 User Manual - CSIRO Marine and Atmospheric Research Internal Report No.5 Aspendale, Victoria: CSIRO Marine and Atmospheric Research, Canberra: CSIRO.

Hurley P, 2008b. TAPM V4 Part 1: Technical Description - CSIRO Marine and Atmospheric Research Paper No. 25 Aspendale, Victoria: CSIRO Marine and Atmospheric Research, Canberra: CSIRO.

Hurley P, 2008c. TAPM V4 Part 2: Summary of Some Verification Studies - CSIRO Marine and Atmospheric Research Paper No. 26 Aspendale, Victoria: CSIRO Marine and Atmospheric Research, Canberra: CSIRO .

NSW OEH, 2011. Generic Guidance and Optimum Model Settings for the CALPUFF modelling system for inclusion into the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW, Australia', Sydney: Offices of Environment and Heritage, New South Wales.

Olsen, D., Kohls, M. & Arney, G., 2010. Impact of Oxidation Catalysts on Exhaust NO2/NOx Ratio from Lean-Burn Natural Gas Engines. Journal of the Air & Waste Management Association, 60(7), pp. 867-874.

Scire, J. S., Strimaitis, D. G. & Yamartino, R. J., 2000. A users guide for the CALPUFF Dispersion Model (Version 5), Concord MA: Earth Tech Inc.

SKM, 2010. Ichthys Onshore Gas Field Development Project Air Quality Assessment, INPEX Document No. C036-AH-REP-0030 Rev H.

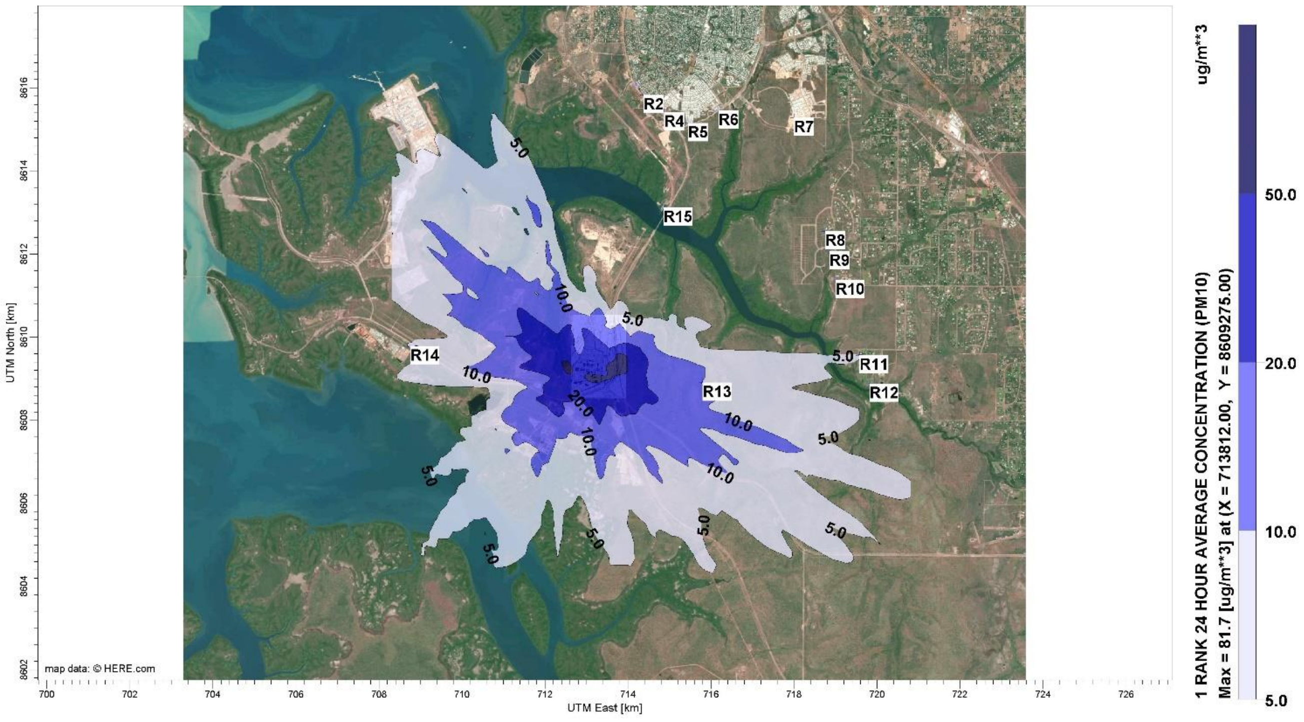
TRC, 2006. CALPUFF Version 6 User's Instructions. May 2006, Lowell, MA, USA: TRC Environmental Corp.

United States Environmental Protection Agency. (2005). *Revision to the Guidance on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions; Final Rule.* Washington: United States Environmental Protection Agency.

WRAP. (2006). *Background Document for Revisions to Fine Fraction Ratios Used fro AP-42 Fugitive Dust Emission Factors.* Colorado: WRAP.

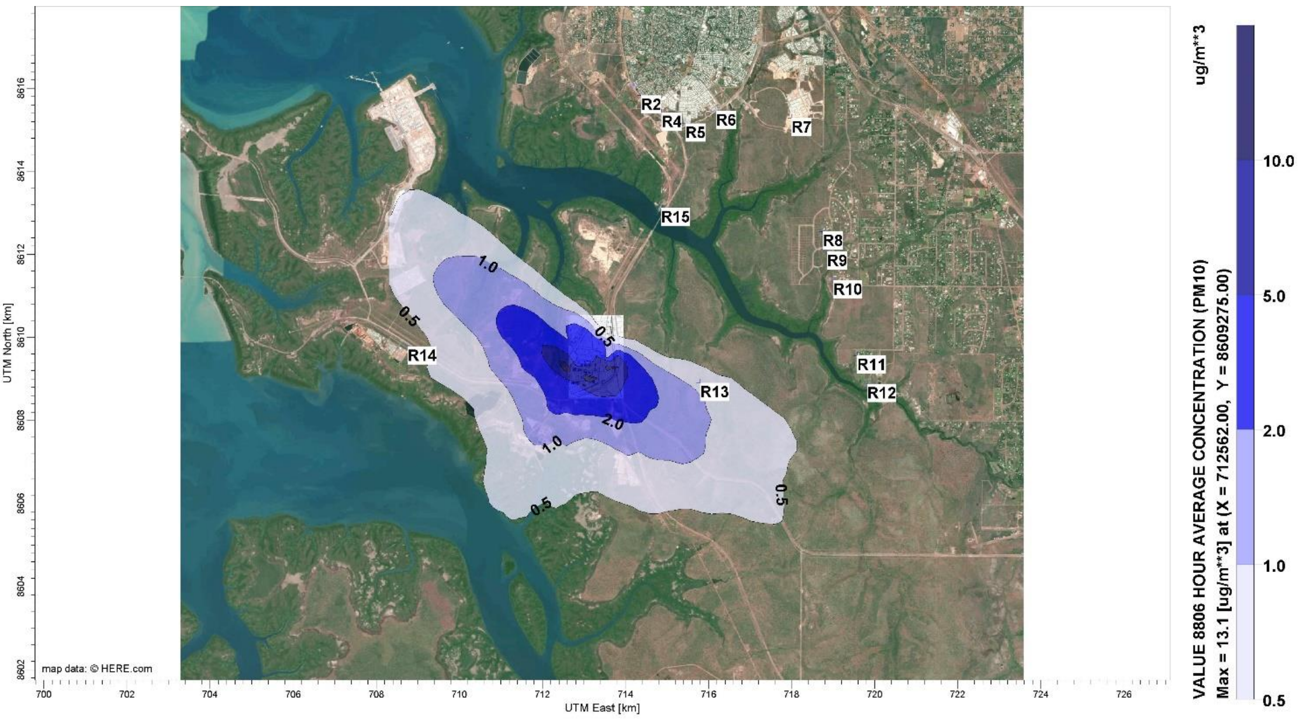
Appendix A POLLUTION PREDICTION CONTOURS

Contour plots illustrate the spatial distribution of ground-level concentrations across the modelling domain for each time period of interest. However, this process of interpolation causes a smoothing of the base data that can lead to minor differences between the contours and discrete model predictions



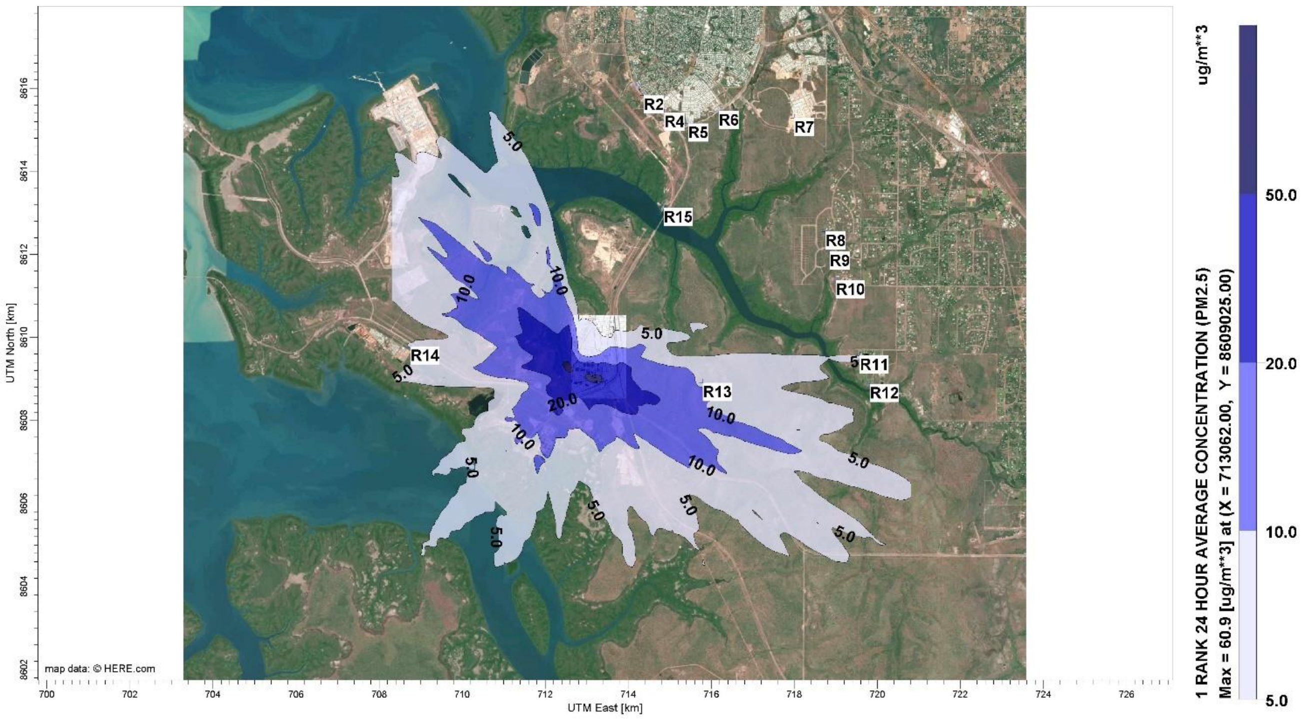
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10}	24 hour	MAX	50 µg/m^3

Scenario:
Operational stage in isolation



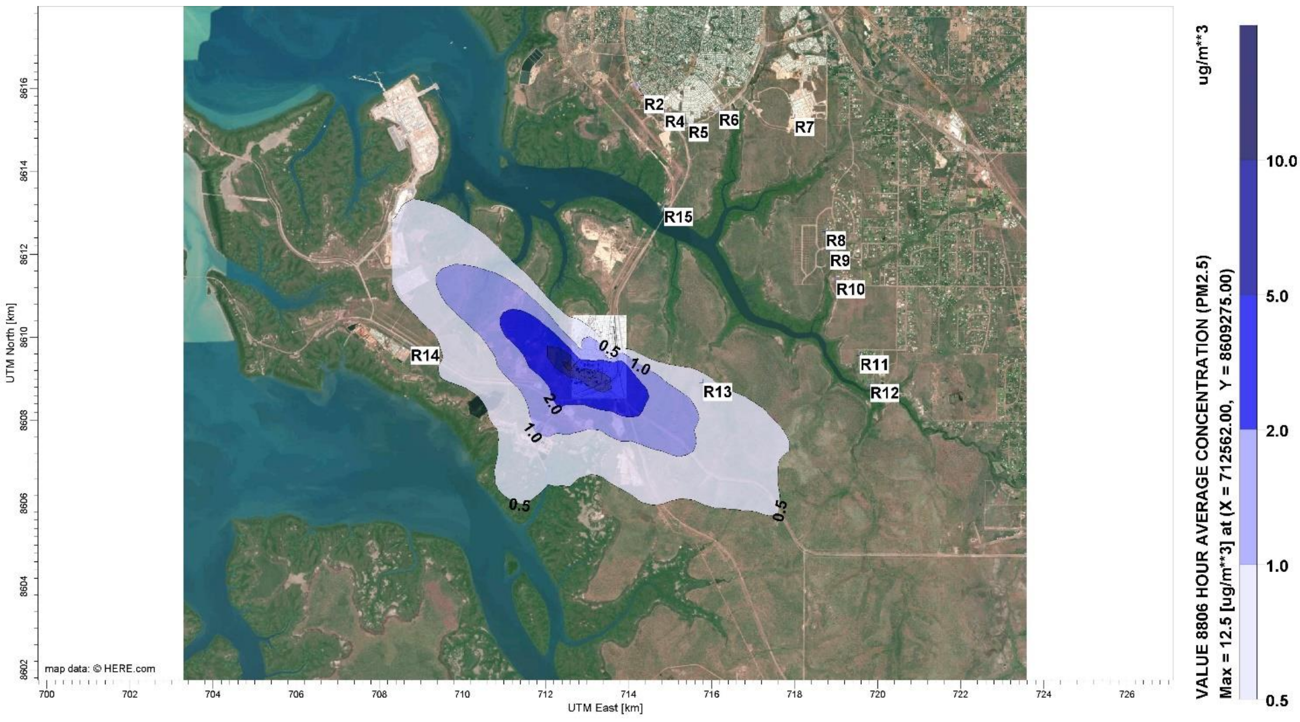
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10}	Annual	MAX	25 $\mu g/m^3$

Scenario:
Operational stage in isolation



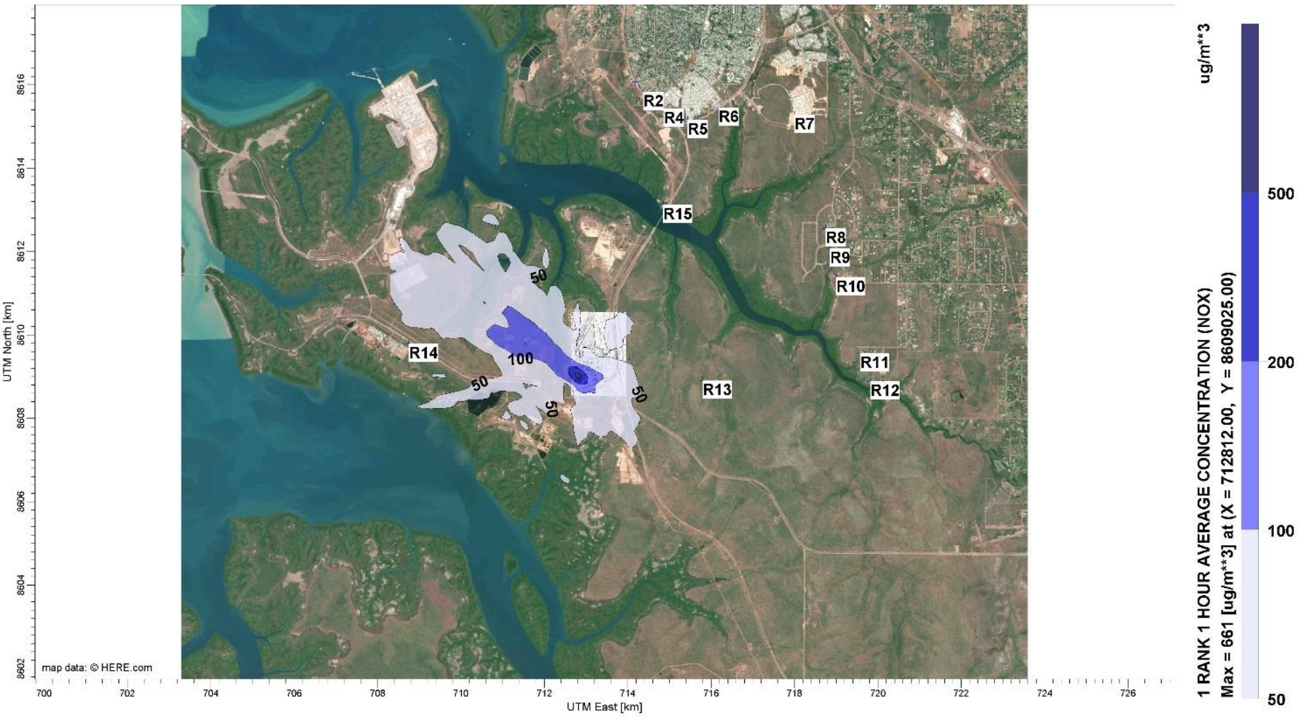
Pollutant: $PM_{2.5}$	**Averaging Period:** 24 hour	**Percentile:** MAX	**Criteria:** 25 µg/m^3

Scenario:
Operational stage in isolation



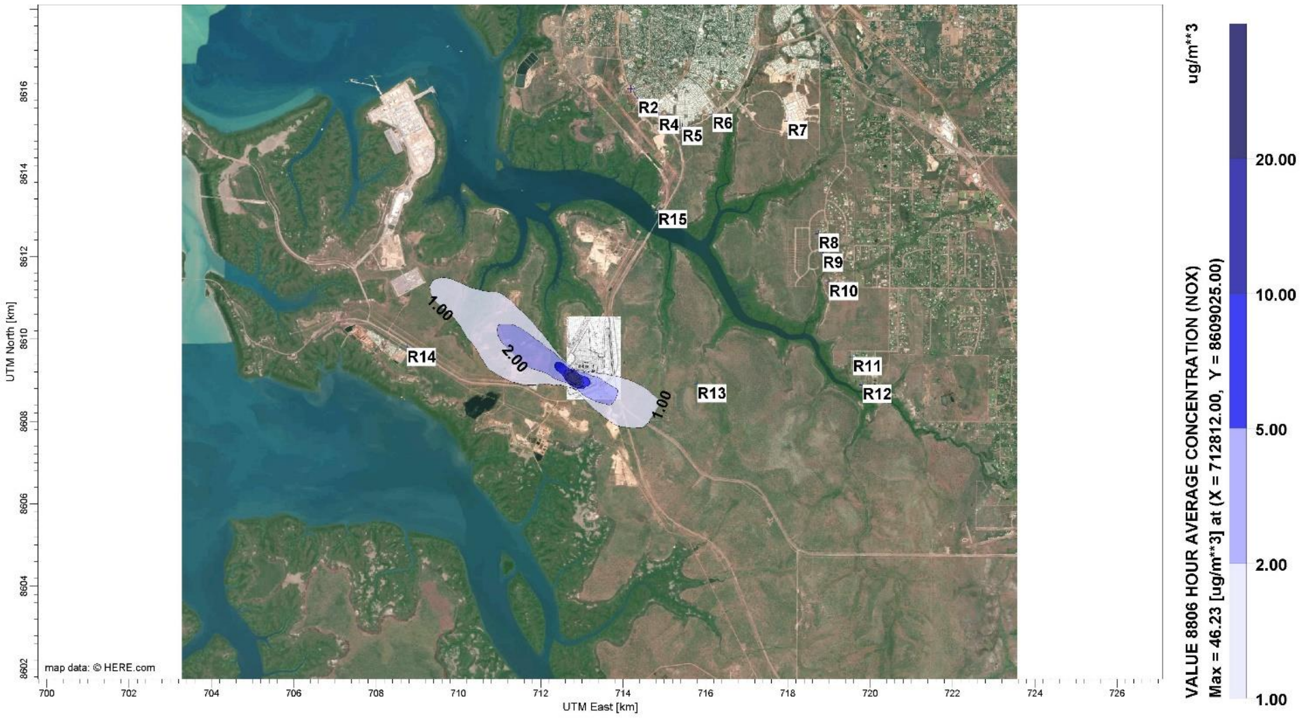
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	Annual	MAX	8 µg/m³

Scenario:
Operational stage in isolation



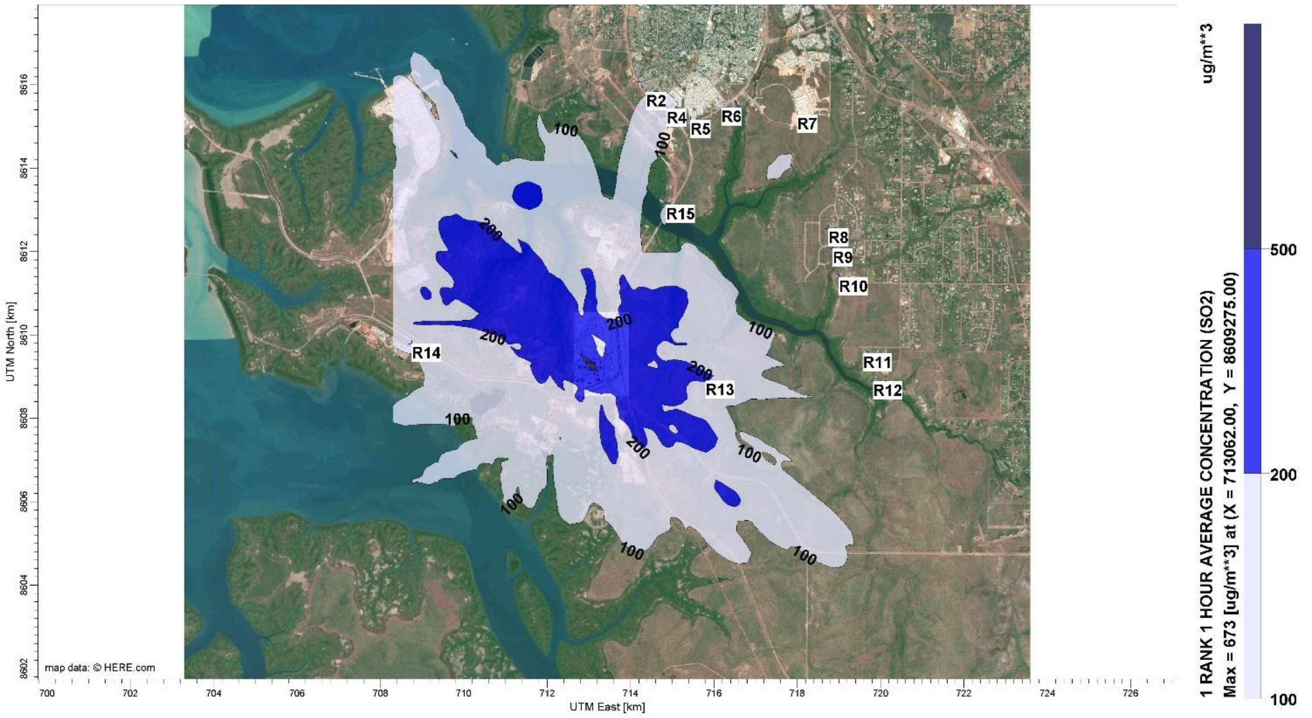
Pollutant:	Averaging Period:	Percentile:	Criteria:
NO_x	1 hour	MAX	250 µg/m^3

Scenario:
Operational stage in isolation



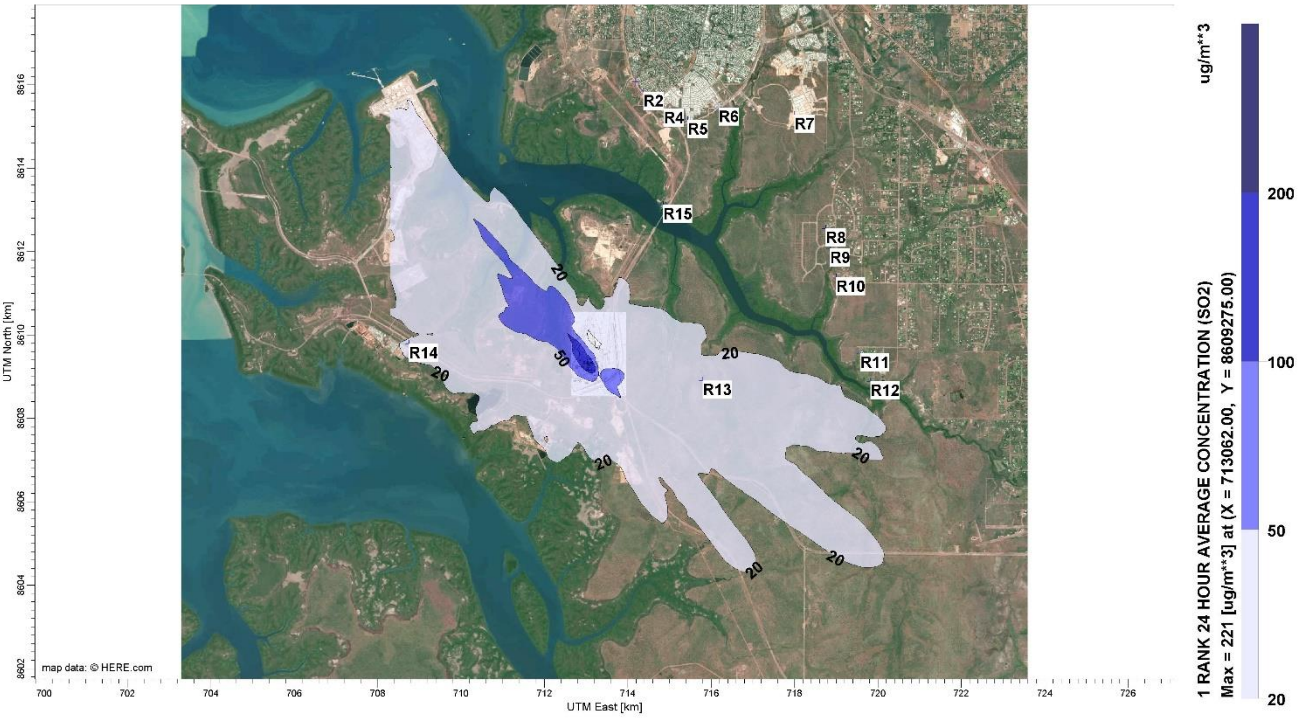
Pollutant:	Averaging Period:	Percentile:	Criteria:
NO_x	Annual	MAX	62 µg/m^3

Scenario:
Operational stage in isolation



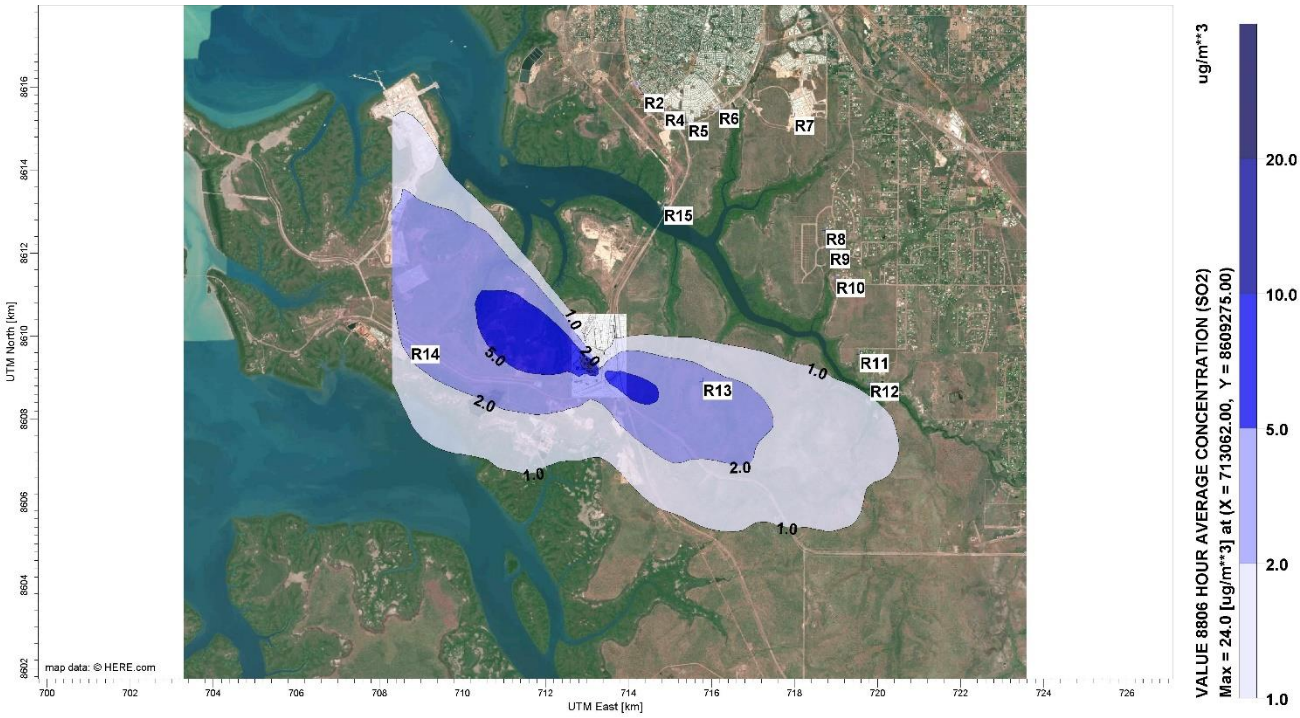
Pollutant:	Averaging Period:	Percentile:	Criteria:
SO_2	1 hour	MAX	570 μg/m^3

Scenario:
Operational stage in isolation



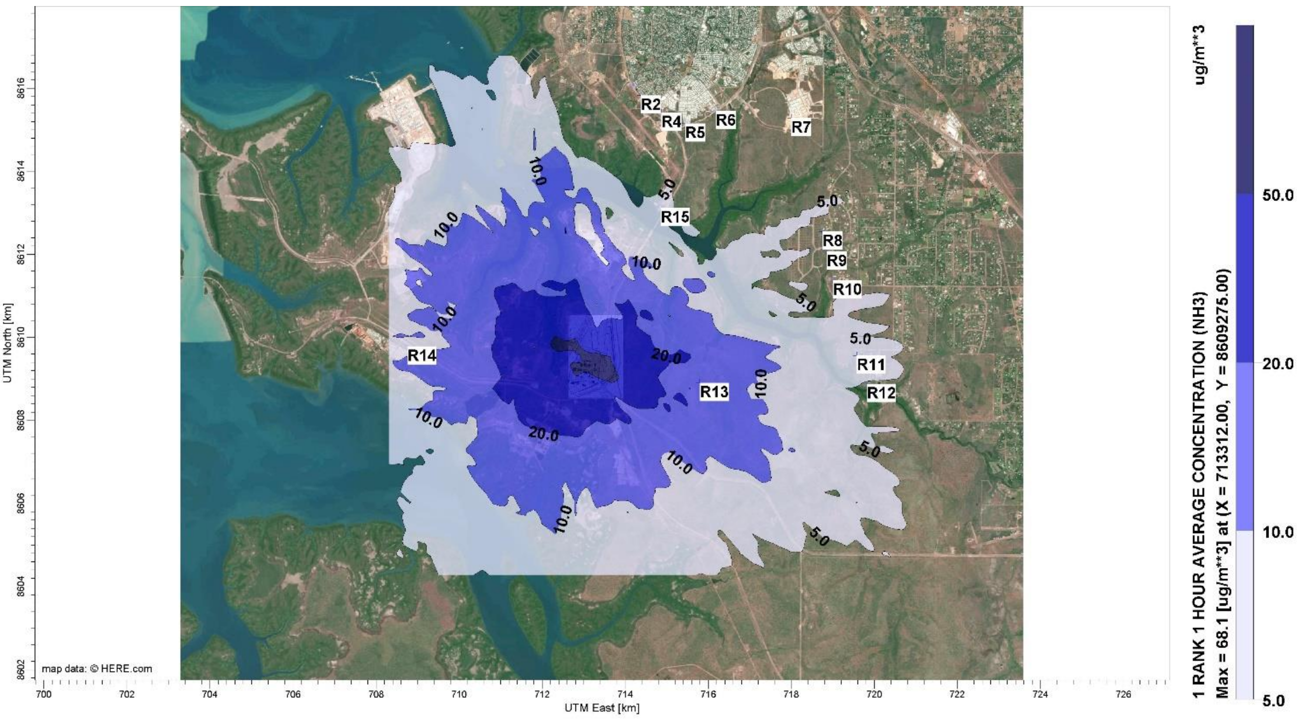
Pollutant: SO_2	Averaging Period: 24 hour	Percentile: MAX	Criteria: 230 µg/m^3

Scenario:
Operational stage in isolation



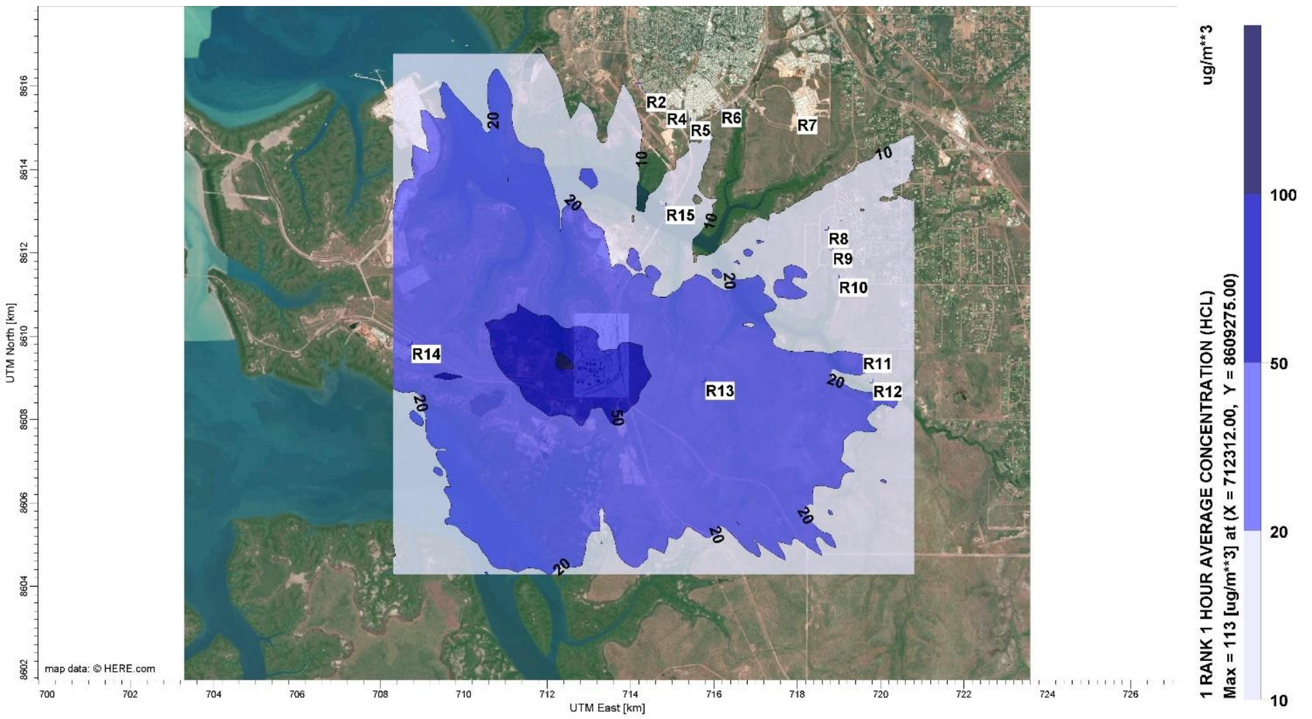
Pollutant:	Averaging Period:	Percentile:	Criteria:
SO_2	Annual	MAX	57 µg/m^3

Scenario:
Operational stage in isolation



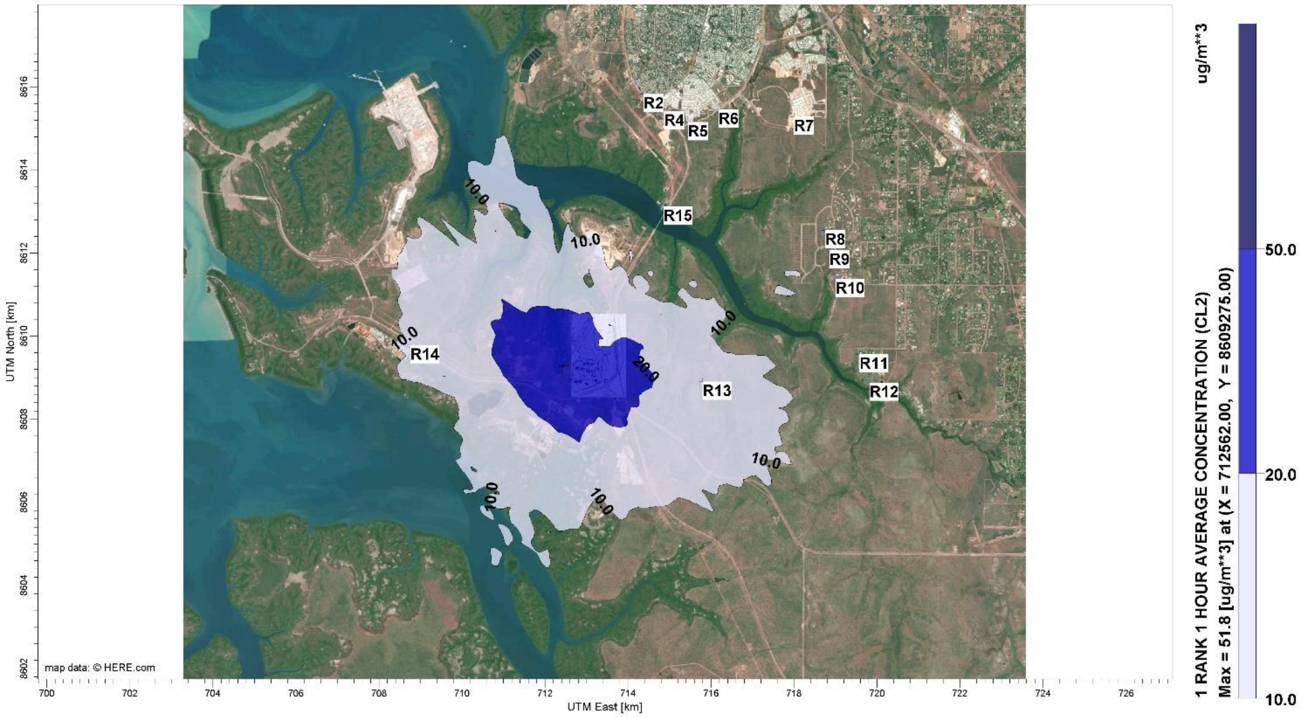
Pollutant:	Averaging Period:	Percentile:	Criteria:
NH_3	1 Hour	MAX	330 µg/m^3

Scenario:
Operational stage in isolation



Pollutant:	Averaging Period:	Percentile:	Criteria:
HCl	1 Hour	MAX	140 µg/m^3

Scenario:
Operational stage in isolation



Pollutant:	Averaging Period:	Percentile:	Criteria:
Cl_2	1 Hour	MAX	50 µg/m^3

Scenario:
Operational stage in isolation

Appendix B Air Quality Management Plan

Purpose and Scope

The purpose of the Plan is to:

- Comply with the expected conditions of the Approval;
- Provide a description of the measures to be implemented to mitigate air quality impacts; and
- Provide employees and/or contractors with a clear and concise description of their responsibilities in relation to air quality management during the operation of the Project.

Objectives

The Air Quality Management objectives of the Plan are to ensure that appropriate procedures and programs of work are in place to:

- Maintain an air quality monitoring system which can assess the air quality impact on surrounding sensitive receivers and performance against the legislative air pollution requirements;
- Detail the controls to be implemented to minimise air pollutant generation from the site recognising that cumulative air quality is a key issue for the local community;
- Manage air quality related community complaints in a timely and effective manner; and
- Provide management commitments and strategies for dealing with air quality related issues.

Air Quality Management Controls

In order to mitigate any potential air quality impacts from the Project, a number of air quality management controls will be implemented throughout the life of the operation (Table B-1).

Change Management

Any significant change to operations, facilities, plant equipment and/or production processes will be assessed for impacts in air quality. The following items shall be recorded:

- Identify the change;
- Assess the potential risks associated with the change and develop a risk management plan;
- Approve the change subject to the risk management plan;
- Communicate and implement the change and risk management actions;
- Monitor and evaluate the change and risk management plan; and
- Document the change management process.

Training

General awareness training is provided to all new employees and contractors as part of the general induction program.

Stack Emissions Monitoring

Stack emissions testing is to be carried out on the primary sources as identified in Table B-1 in accordance with the relevant Australian/ New Zealand Standards.

Air Quality Monitoring Program

Whilst elevated predictions of $PM_{2.5}$ concentrations are driven by the background levels and the conservative approach to modelling, it is recommended that an ongoing measurement program for this pollutant is undertaken at the most affected receptor location (the Bladin Village – Workers Accommodation. Continuous monitoring for $PM_{2.5}$ is proposed in the vicinity of the Bladin Village receptor in accordance with the relevant Australian/ New Zealand Standard:

- $PM_{2.5}$ to be monitored in accordance with the most recent version of either
  - *AS/NZS 3580.9.12:2013 Methods for Sampling and Analysis of Air. Method 9.12: Determination of Suspended Particulate Matter – PM2.5 Beta Attenuation Monitor*, or
  - *AS/NZS 3580.9.13:2013 Methods for Sampling and Analysis of Air. Part 9.13: Determination of Suspended Particulate Matter–PM2.5 Continuous Direct Mass Method using a Tapered Element Oscillating Microbalance Monitor*.

In addition, in the event of a dust related complaint, campaign monitoring be undertaken in the vicinity of the location of the complaint as follows:

- PM_{10} to be monitored in accordance with the most recent version of either:
  - *Australian Standard AS 3580.9.6 - Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 high volume sampler with size-selective inlet – Gravimetric method, or*
  - *Australian Standard AS 3580.9.9 - Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 low volume sampler—Gravimetric method;*
- $PM_{2.5}$ to be monitored in accordance with the most recent version of *AS/NZS 3580.9.10 - Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—$PM_{2.5}$ low volume sampler—Gravimetric method; and*

Community Complaints

Community complaints management includes receipt of complaints, investigation, implementation of appropriate remedial action, and feedback to the complainant as well as communication to site management or personnel and notification to external bodies, such as the EPA.

Accountabilities

A generic list of roles and accountabilities for employees and contractors in relation to the Air Quality Management Plan are outlined in Table B-2 and will be incorporated into the Project's environmental licence conditions as required.

Table B-1: Proposed air pollution controls and emissions monitoring strategy

ID	Pollution Control	Monitoring
PP200A	Compact filter	-
PP220B	Compact filter	-
PP200C	Compact filter	-
PP200D	Filter house	-
PP300	Scrubber with packing and circulation system	Annual emissions testing
PP310	Scrubber with packing and circulation system	Annual emissions testing
PP320	Filter and scrubber with packing and circulation system	Annual emissions testing
PP330	Scrubber with packing and circulation system	Annual emissions testing
PP350	Scrubber with packing and circulation system	Annual emissions testing
PP360	Venturi scrubber and scrubber with packing and circulation	Annual emissions testing
PP360	Filter	Annual emissions testing
PP370A PP370B PP370C PP370D PP370E PP370F PP370G PP370H PP370I PP370J	Venturi scrubber and scrubber with packing and circulation system	Annual emissions testing
PP370A2 PP370B2 PP370C2 PP370D2 PP370E2 PP370F2 PP370G2 PP370H2 PP370I2 PP370J2	Filter on bin	-
PP380	Scrubber with packing and circulation system	-
PP400	Venturi scrubber and scrubber with packing and circulation	Annual emissions testing
PP500	Multiple scrubber system	Continuous emissions measurement
PP500A	Not yet detemined	Continuous emissions measurement
PP510	Dust filter scrubber	-
PP710	Dust filter scrubber	Continuous emissions measurement
PP780	Not yet detemined	-

Table B-2: Proposed roles and responsibilities

Person Responsible	Responsibilities
Operations Manager	• Approve appropriate resources for the implementation of this Plan. • Ensure the effective implementation of strategies designed to reduce air quality impacts from the operation. • Ensure air quality issues are reported in accordance with legal requirements. • Authorise internal reporting requirements of this plan.
Environment and Community Manager/Officer	• Provide that sufficient resources are allocated for the implementation of this program. • Identify air quality risks and impacts to the environment and assess resources required to mitigate identified risks and impacts within the site. • Ensure that the air quality management controls are implemented in accordance with this Plan. • Ensure that the results of monitoring are evaluated and reported to senior management and to relevant personnel for consideration as part of ongoing mine planning. • Ensure any potential or actual air quality is reported in accordance with legal requirements and the corporate standard. • Provide visible and proactive leadership in relation to the air quality management. • Ensure that operational changes consider the potential air quality impacts to any adjacent private landowners. • Ensure monitoring equipment is operated in accordance with relevant industry standards and protocols.
Managers, Supervisor, and Task Coordinators	• Provide that sufficient resources are allocated for the implementation of this Plan, as required. • Ensure adequate resources are budgeted for in relation to air quality. • Ensure that operational changes consider the potential impacts of dust emissions from the Project on the surrounding environment. • Monitor that team members and contractors carry out work appropriate monitoring and maintenance tasks. • Ensure any potential or actual air quality emissions are controlled. • Conduct daily inspections of the work area to monitor compliance with this plan. • Provide input to management on the adequacy and effectiveness of this plan. • Ensure the effective implementation of strategies designed to reduce air quality impacts from the Project. • Provide visible and proactive leadership in relation to air quality management. • Ensure personnel working at the operation are aware of the air quality management obligations whilst working.
All employees and Contractors	• Ensure the effective implementation of this Plan with respect to their work area. • Ensure any potential or actual air quality management issues, including environmental incidents, are reported to the Project Manager or Supervisor. • Ensure equipment (relevant to task/area of responsibility) is maintained and operated in a proper and efficient manner. • Where practicable, prevent the tracking of material onto sealed roads by washing material off vehicles prior to exiting site.

AIR QUALITY ASSESSMENT REVIEW

Darwin Magnetite Processing Facility

Prepared for:

TNG Ltd

SLR Ref: 620.30306.00000-R01
Version No: -v0.1
January 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 2, 15 Astor Terrace
Spring Hill QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

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

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30306.00000-R01-v0.1	22 January 2021	G Starke	K Lawrence	
620.30306.00000-R01-v0.1	22 January 2021	G Starke	K Lawrence	

CONTENTS

DOCUMENT REFERENCES

TABLES

1 Introduction

SLR Consulting Pty Ltd (SLR) was commissioned by Animal, Plant Mineral Pty Ltd (APM) to conduct an independent peer review of the Air Quality Assessment (AQA) (VIPAC, 2020) report for a proposed magnetite concentrate processing facility to be located in Middle Arm, Darwin Harbour.

The proposed facility proposes to process up to 770,000 tonnes per annum of magnetite concentrate to produce vanadium pentoxide, titanium dioxide pigment and iron, which will be railed from Mount Peake Project. The product will be exported from the East Arm Wharf.

The key sources of air emissions during the operations phase may include:

- Fugitive dust from:
    - Stockpiles and exposed areas
    - Transfer points
    - Wheel-generated dust from unsealed roads
- Stack emissions from the Processing Facility including:
    - Vapour scrubbers
    - Kiln Off-gas
    - MEE Off Gas
    - Power Generation

To conduct this peer review, the following information has been considered:

- *Darwin Magnetite Processing Facility EIS Noise & Air*, prepared by APM for TNG Ltd, Air Quality Assessment, dated 21 December 2020.
- National Environment Protection Measure for Ambient Air Quality (NEPC, 2016)
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2017)
- Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the ‘Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia’ (Scire, 2011)

2 Scope of Review

The independent peer review has considered the following against the requirements of relevant guidance documents:

- Appropriateness of assessment criteria;
- Meteorological data and modelled weather conditions;
- Appropriateness of the emissions inventory;
- Appropriateness of the model methodology and model inputs;
- Ambient background concentrations; and
- Predicted cumulative concentrations of air pollutants at sensitive locations.

Additionally, Appendix A of the Northern Territory Government (NTG) *Comments on the Draft Environmental Impact Statement to Address in the Supplement* (NTG, 2020) identified the items in **Table 1** relating to air quality that have also been reviewed.

Table 1 NTG Comments on the Draft Environmental Impact Statement to Address in the Supplement

Air Quality and Greenhouse Gases		
1. Elizabeth River boat ramp	The Elizabeth River boat ramp is considered to be a sensitive receptor but was not included as such in the Draft EIS (including Appendix U).	Provide maximum predicted gaseous impacts (ground level concentrations; as per Appendix U Tables 6-2 and 6-3) of combustion gases and other gases at the Elizabeth River boat ramp.
2. Pollution prediction contours	The stated air quality goals for chloride (Cl_2) of 50 µg/m^3 and hydrochloric acid (HCl) of 140 µg/m^3 (Table 3-1 of Appendix U) are incorrectly indicated for an averaging time of annual. The averaging time for these criteria, as prescribed in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, is 1 hour.	Provide an update of the pollution prediction contours (Appendix A) and maximum predicted gaseous impacts (Table 6-3) for chloride (Cl_2) and hydrochloric acid (HCl), based on an averaging time of 1 hour, as prescribed in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

Air Quality and Greenhouse Gases		
3. Air quality assessment	It is unclear from the Draft EIS if air quality goals are suitable for avoiding impacts to air quality and if the air quality modelling and derived predictions are sufficiently robust to enable the incorporation of design features for mitigating significant impacts. Not all data required for the modelling of air emissions from the operation of the Project was available.	Present a third-party qualified person review of the Proposals Air Quality Assessment to: A. assess the suitability of the input data used for the model and the suitability of the air quality goals B. assess confidence in the model and its predictions C. provide recommendations for an air emissions monitoring program to regulate operational emissions from the Proposal D. provide recommendations on contingency options for reducing emissions if necessary after commissioning or start-up of operations

3 Review Findings

The summary table in Attachment A of this report outlines the findings of the peer review. The observations have been categorised as:

Significance	Description
Comment only	Observation only
Low	Issues identified are not likely to change the conclusions of the report
Medium	Issues identified may have the potential to change the conclusions of the report
High	Issues identified have the potential to change the conclusions of the report

The review highlighted one issues of medium concern in the AQIA and supporting documentation for the proposed development. The key issues identified to be of medium significance is summarised below, with the relevant table references noted in brackets.

- Train unloading, transfer points and wheel generated dust from unpaved roads may not have been accounted for in the emission inventory and hence dispersion modelling. These sources should be checked for relevancy and if required the model be updated to include these sources (**item 5.1**).

In addition to the above comments, it is noted that justification of the modelling year **(Item 3.3)** was not provided in the assessment and if the emission inventory is incomplete or needs modification then the mitigation measures in Section 7.2 also need to be reviewed for completeness (I**tem 10.1)**. Disclosure of some of the modelling detail would also assist in providing confidence in the dispersion modelling outcomes **(Item 3.4, 6.3 and 7.2).**

Table 2 Summary of Review Findings

ID	Reference	Comment	Significance
Pollutants Assessment			
1.1	Section 2.3	The assessment identified suspended particulate, deposited dust, nitrogen dioxide, ammonia, sulfur dioxide, chlorine and hydrogen chloride as pollutants of interest. The review did not identify any other pollutants of concern.	Comment only
Selection of air quality criteria			
2.1	Section 3	The assessment has adopted ambient air quality criteria from the latest versions of the *National Environment Protection (Ambient Air Quality) Measure* and the New South Wales Environmental Protection Agency's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. NTG's comment that the stated air quality goals for chloride (Cl_2) of 50 µg/m³ and hydrochloric acid (HCl) of 140 µg/m³, as prescribed in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, are 1 hour criteria not annual averages. The assessment has been updated to provide an assessment based on the correct averaging period for these pollutants.	Comment only
Meteorological modelling			
3.1	Section 5.3.1, page 26	The TAPM model was used to compile a meteorological dataset for the development site. The TAPM model is considered appropriate for use in the assessment.	Comment only
3.2	Section 4, page 12	TAPM was run with four nested grids at 41 x 41 at 30 km, 10 km, 3 km and 1 km grid spacing. Observational data from the nearby NT EPA Palmerston Air Quality Monitoring Station was assimilated into the model. This is considered appropriate.	Comment only
3.3	Section 4.3 page 15	Modelling was performed for the 2017 calendar year. No clear justification is provided for this year being representative of typical (or worst case) meteorological conditions for the area.	Low

ID	Reference	Comment	Significance
		SLR notes that the TAPM-predicted 9:00am and 3:00pm wind patterns at the development site for 2017 (Figure 4-5) compare well with the long term (1942-2019) 9:00am and 3:00pm wind patterns recorded at Darwin Airport 16 km to the north (Figure 4-2), despite the differences in location, indicating that the wind speeds and wind directions for 2017 can be considered representative of long term weather patterns for the region. It would have been preferable however for monthly temperature data, wind speed frequency plots and the annual and seasonal wind roses (all hours) for Darwin Airport for 2017 to be compared against long term plots and wind roses for the same location to justify the year selected.	
3.4	Section 4	No details on the land use data used in TAPM were provided. It is assumed that the TAPM default values were used. This would be an acceptable approach but should be confirmed.	Low
3.5	Section 4.1.3.3, page 18	The predicted stability classes, Table 4-2, show appropriate distributions across the classes.	Comment only
3.6	Section 4.1.3.4, page 19	The predicted mixing heights, Figure 4-6, show appropriate building of the mixing heights across daytime periods with a rapid collapse in the late afternoon, as would be expected.	Comment only
Background Concentrations of Pollutants			
4.1	Section 4.2.3, Page 20	Background air pollutant concentrations have been appropriately identified and applied using the Palmerston Air Quality Monitoring Station which was established in 2010 and is located approximately 4km north of the Project site. The assessment correctly identifies that this station is likely to be more impacted by motor vehicle activity than the project site and hence is likely to give a conservative representation of the background concentrations.	Comment only
Methodology			
4.1	Section 5.1, Page 22	Missing link in dot point 3 of paragraph 1, page 22. 'Section 0'.	Comment only
Identification of air emission sources			
5.1	Section 5.2.2, page 22	The emission sources identified in paragraph 5 on page 22 include "*stockpiling and train unloading and loading activities*" and "transfer points and wheel generated dust from unsealed roads" are identified in the executive summary (paragraph 8, Page 8). However, the emission sources identified in Table 5-2 are: • Stockpile wind erosion • FEL movement of stockpiles	Medium

ID	Reference	Comment	Significance
		• Truck unloading There is therefore some inconsistency between the identified emission sources and the modelled emissions, including train loading/unloading and wheel-generated dust appearing to have been missed from the emission inventory. Transfer points also are not represented in the emission inventory but as these are identified as being enclosed in section 7.2 these are unlikely to have a significant impact on the outcomes of the assessment. Note Section 7.2 indicates that haul roads will be either sealed or treated, however some dust generation can still be expected to occur.	
Emission Estimation			
6.1	Section 5.2.2, page 22	Emission estimates for point source emissions have been accurately transferred from the provided spreadsheet *'20201014_Emissions air_R3_20201015.xlsx'* and *'14771464B1_Emission Layout Prel – rev B.pdf'*. These data were supplied by APM, but the basis of this data is not identified so the appropriateness of these emission rates cannot be commented on. (see issue 6.3)	Comment only
6.2	Section 5.2.2, page 22	Fugitive dust emission factors and activity data from Table 5-2 are appropriate for these sources.	Comment only
6.3	Section 5.2.2, page 22	As per NTG comments, not all information required to assess the appropriateness of the emission estimates used in the air dispersion modelling (in particular the fugitive emissions from the processing plant) has been made available for review. The sources not provided, based on experience are not likely to change the outcomes of the assessment.	Low
Receptors			
7.1	Section 5.3.4.4, page 27,	The sensitive receptors identified adequately represent the potentially impacted community, noting that NTG have already identified that the Elizabeth River boat ramp is required to be included as a sensitive receptor. Based on the location of this receptor and the results presented, neither exceedances or other compliance issues are expected for this receptor.	Comment only
Dispersion modelling			
7.1	Section 5.1, page 22	The modelling was performed using CALPUFF. NT does not provide guidance on which dispersion model to use but the use of CALPUFF is consistent with other similar projects in the region.	Comment only

ID	Reference	Comment	Significance
7.2	Section 5.3.3 Page 26	The CALPUFF dispersion modelling is identified as having been conducted in accordance with '*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia*' (Scire, 2011). No evidence was provided to support this statement, but this methodology is considered best practice.	Low
NO_X to NO_2 conversion			
8.1	Section 5.4, page 28	No NO_X to NO_2 conversion was applied to the modelling results and all NO_X predictions were assumed to be in form of NO_2. This is a very conservative approach.	Comment only
Results			
9.1	Section 6.1, page 29	Construction dust impacts have been identified as being controlled with good management practices. SLR agrees that these transient impacts can be managed by appropriate management plans.	Comment only
9.2	Table 6-1, Table 6-2 and Table 6-3	Results for predicted particulate concentrations, deposited dust, combustion gas concentrations and other gaseous emission concentrations all fall well below the adopted project criteria at the nearest sensitive receptors. Provided that appropriate evidence can be provided to address the issues identified in this review no compliance issues are identified.	Comment only
Mitigation measures			
10.1	Section 7, page 33	The mitigation measures provided in Section 7 seem appropriate to the activities identified in Table 5-2. If clarification of the emission sources identifies that train unloading and/or wheel generated dust from unpaved roads should be included in the dispersion modelling, then additional mitigation measures such as: • Full enclosure of train unloading; or • Undercar unloading, may also be required. Note: mitigation measures for transfer points and unpaved roads are already proposed in the assessment.	Low

4 Bibliography

NEPC. (2016). *National Environment Protection Measure for Ambient Air Quality.* National Environment Protection Council.

NSW EPA. (2017, January). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.* New South Wales Environment Protection Authority.

NTG. (2020). *COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT TO ADDRESS IN THE SUPPLEMENT* . Darwin: Northern Territory Government.

Scire, J. &. (2011, March). Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants inNSW, Australia'. Atmospheric Studies Group, TRC Environmental Corporation.

VIPAC. (2020). *Darwin Magnetite Processing Facility EIS Noise & Air Air Quality Assessment.* Brisbane: Vipac Engineers & Scientists .

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628