HEGGIES

REPORT 75-1247-R1

Revision 1

Tropicana Gold Project
Air Quality Impact Assessment

PREPARED FOR

TROPICANA JOINT VENTURE

ANGLOGOLD ASHANTI AUSTRALIA

INDEPENDENCE GROUP NL

13 JULY 2009

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Tropicana Gold Project

Air Quality Impact Assessment

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EXECUTIVE SUMMARY

Heggies Pty Ltd has been commissioned by the Tropicana Joint Venture to conduct an Air Quality Impact Assessment of the proposed Tropicana Gold Project. The Project is situated approximately 330 km east-northeast of Kalgoorlie in the western region of the Great Victoria Desert, Western Australia.

Atmospheric dispersion modelling was carried out to determine the potential impact, in terms of air quality, of worst case extractive activities for the project. The dispersion model CALPUFF was utilised in screening mode using a steady state meteorological input file to conduct dispersion modelling for this assessment.

The results of the modelling indicate that concentrations of all modelled pollutants, generated by extractive operations and diesel combustion, would satisfy all applicable air quality assessment criteria at the preferred North accommodation camp. Furthermore, the proposed operations are not predicted to adversely impact upon the biological integrity of the threatened flora and fauna populations situated to the west of the Operational Area.

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1 INTRODUCTION

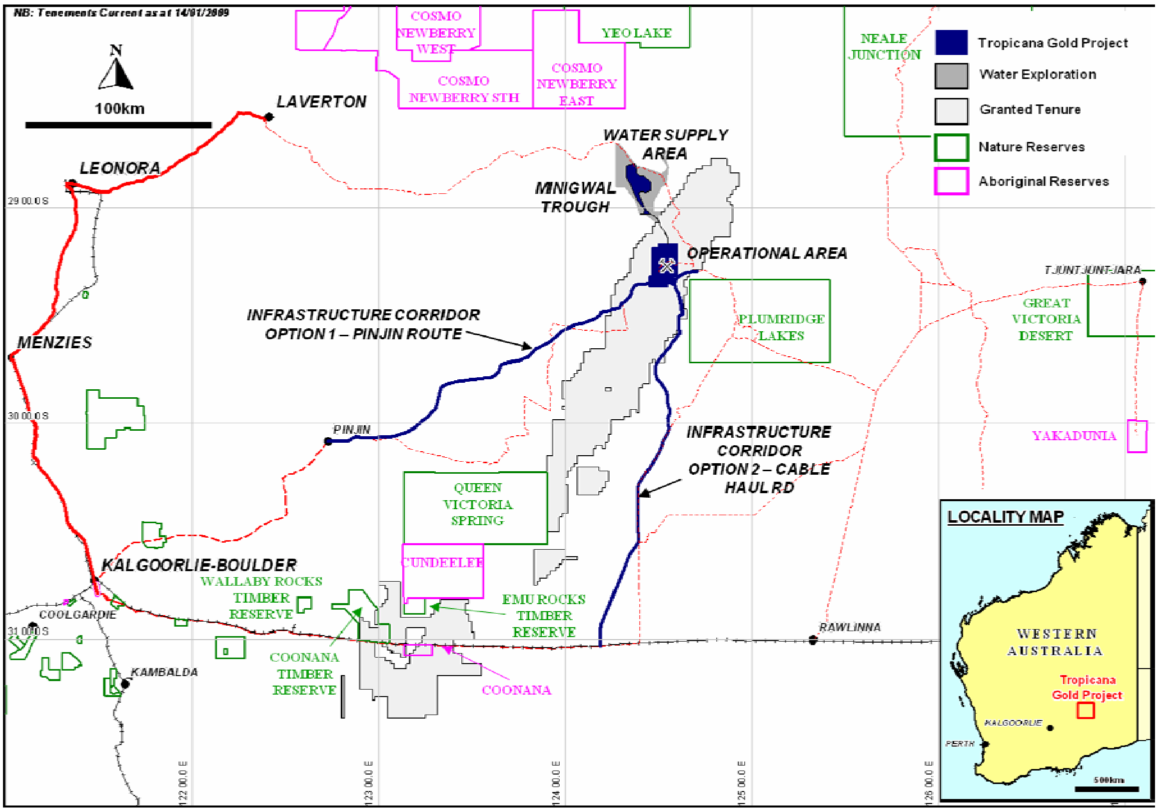
The Tropicana Joint Venture between AngloGold Ashanti Australia Limited (70%, manager) and Independence Group NL (30%) (hereafter "the JV") holds a significant area of exploration license covering a combined area of approximately 13,000 km^2, located approximately 230 km east of Laverton in the north and 200 km east of Kalgoorlie in the south , on the edge of the Yilgarn Craton in Western Australia. The JV proposes to develop the Tropicana Gold Project (hereafter, "the TGP"), an open cut gold mining and processing operation, around the Tropicana and Havana gold deposits, located 330km east north-east of Kalgoorlie on the Western edge of the Great Victoria Desert.

The JV is currently preparing a Public Environmental Review (PER) as part of the project approvals process. The JV has engaged Heggies Pty Ltd (hereafter, "Heggies") to conduct an air quality impact assessment to ensure the operation of the TGP will not adversely impact upon the health of the Project's employees and the surrounding environment.

2 PROJECT OVERVIEW AND SETTING

The location of the TGP (hereafter, "The Operational Area") is situated approximately 330 km east-northeast of Kalgoorlie in the western region of the Great Victoria Desert, Western Australia. **Figure 1** illustrates the regional setting of the TGP.

Figure 1 Regional Setting of the Tropicana Gold Project



Map Source: JV, 2009

The mining method selected for the TGP is open pit mining with conventional drill and blast techniques and a typical mining fleet, including trucks, front-end loaders and excavators. The mining fleet will include ancillary equipment, such as dozers, graders, service trucks and water trucks, necessary to construct and maintain the pit, haul roads, Run of Mine (ROM) pad, waste dump and the tailings storage facility. Ore extraction at the Operational Area will occur from a series of open pit voids.

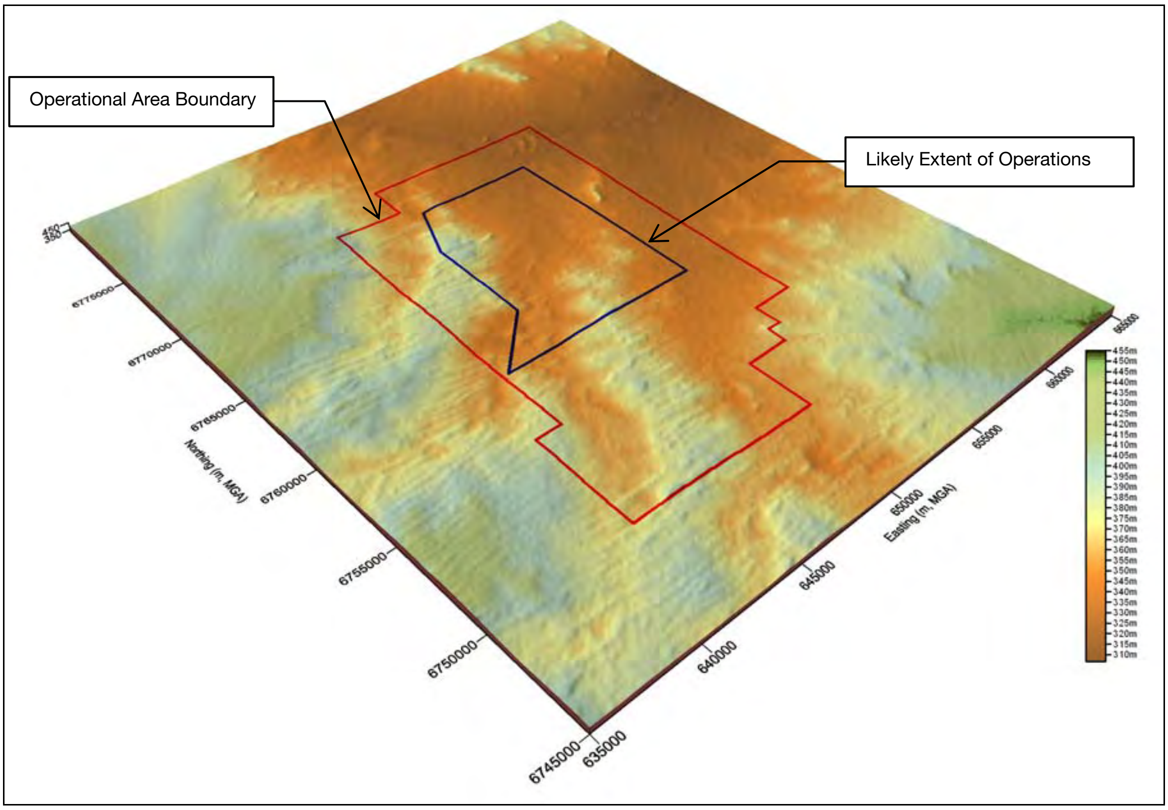
In order to provide electricity to the TGP, it is expected that an average electricity consumption of 27 MWh is required, with a peak load of 40 MWh. Electricity will be generated onsite, either through a series of diesel/gas generators or solar thermal power station, or sourced from electricity generated in Kalgoorlie and transferred to the site by overhead power lines. For the purpose of this assessment, it is assumed that 13 Cummins Engine Company QSK78-G9 diesel generators, operating at a prime load of 2.2 MW, will be in utilised.

2.1 Local Topography

The Operational Area is located within lightly undulating terrain, with an approximate altitudinal range of between 320 and 400 m AHD that increases gradually from the northeast to the southwest corner. Overall, the terrain of the greater area surrounding the Operational Area is lower to the north and east, increasing to the south and west.

A three dimensional representation of the topographical features described above is presented in **Figure 2**.

Figure 2 3-Dimensional Topography Surrounding the Operational Area



NOTE: Topography shown with vertical exaggeration of 4

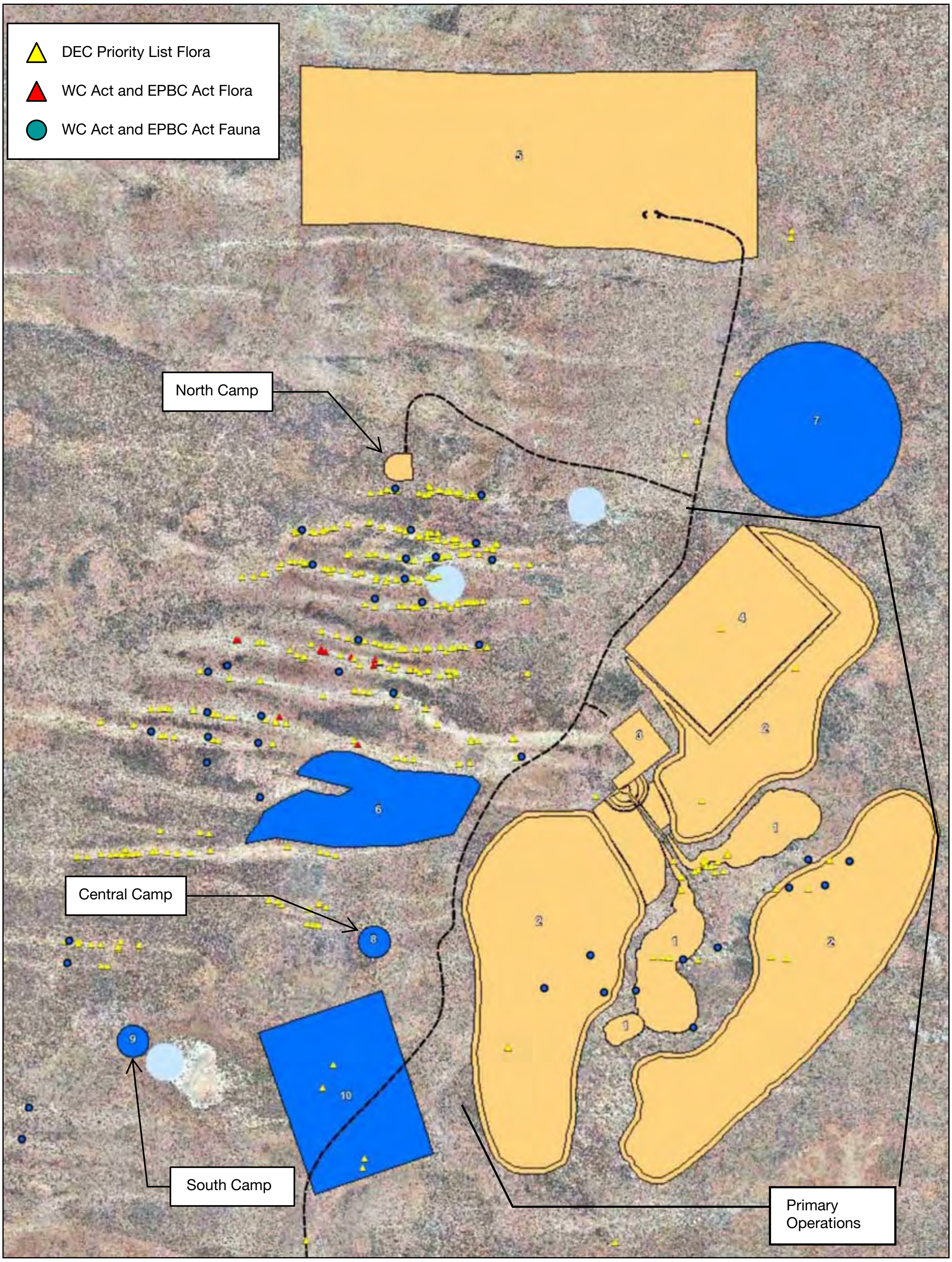
2.2 Nearest Sensitive Receptors

Dispersion modelling can be used to predict ground level air quality concentrations at the nearest potentially affected residences or sensitive receptors.

The Operational Area is situated in an isolated area with no existing nearby residences. However, mine employees will be housed at an accommodation camp which, at the time of this assessment, was still undergoing a siting evaluation. Three potential locations, situated in the north, central and southern regions to the west of the main operations at the Operational Area, are illustrated in the conceptual site plan in **Figure 3**.

In addition to the accommodation camp locations, threatened flora and fauna populations have been identified about the proposed operations at the Project Site, also illustrated in **Figure 3**. The greatest concentration of threatened flora and fauna is situated to the west of the primary operations at the Operational Area between the North and Central accommodation camp locations.

Figure 3 Conceptual Site Plan and Accommodation Camp Locations



Source: JV, 2008

3 AIR QUALITY CRITERIA

The Western Australia Department of Environment and Conservation (WA DEC) routinely adopt ambient air quality goals in the assessment of new proposals, and in the management of both local and regional ambient air quality.

As a matter of policy, WA DEC, have adopted the National Environment Protection Measure (NEPM) goals for ambient air quality. Adopting the NEPM goals is an interim approach while the WA DEC, in conjunction with the Department of Health, develop ambient air quality guidelines for WA.

The NEPM are broad framework-setting statutory instruments defined in the National Environment Protection Council (NEPC) legislation. They outline agreed national objectives for protecting or managing particular aspects of the environment.

In the absence of a NEPM standard, the WA DEC will adopt the World Health Organisation (WHO) Guidelines for Air Quality (2006). In the absence of a NEPM standard or a WHO guideline, the WA DEC will adopt goals from another jurisdiction (once it has been assessed and determined to be applicable to the WA context).

3.1 National Environment Protection Measure (NEPM)

In June 1998, the National Environment Protection Council of Environment Ministers agreed to set uniform standards for ambient air quality to apply to all States and Territories. These standards are contained in the National Environment Protection Measure (NEPM) for ambient air quality.

These NEPM goals were developed by the NEPC in 1998 to be achieved within 10 years of commencement and set standards and goals for ambient levels of “criteria pollutants”.

3.2 World Health Organisation (WHO) Guidelines for Air Quality

The World Health Organisation (WHO) have published Air Quality Guidelines for Europe which address the effect of air pollution on human health and set an international standard for health based air quality guidelines. The WHO air quality guidelines are also being used as a starting point for the derivation of legally binding limit values in the framework of the European Union Air Quality Directive.

The WHO guidelines form part of an overall health policy for the European region which states that people in the region should, by the year 2015, live in a safer physical environment.

3.3 Goals Applicable to Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter.

In common usage, the terms “dust” and “particulates” are often used interchangeably. The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm. Some particles are large enough to be seen as dust, can only be detected with an electron microscope. In Air Quality Assessment, the term Total Suspended Particulate (TSP) refers to the fraction less than 30 µm whereas particles less than 10 µm aerodynamic diameter are referred to as PM_{10}.

The annual average goal for TSP) is given as 90 µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC) at their 92nd session in October 1981. It was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations. NHMRC goals for TSP have since been rescinded. In view of the foregoing, TSP has not been considered further in this report.

Emissions of PM_{10} are considered important pollutants due to their ability to penetrate into the respiratory system. Potential adverse health impacts associated with exposure to PM_{10} include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NEPM Ambient Air Quality Goal for PM_{10} is:

- A 24-hour maximum of 50 µg/m^3 (with five exceedances allowable per annum)

The WHO issued an Air Quality Guidelines global update in 2005 based on the outcomes of a report on a working group meeting conducted at Bonn, Germany, 18 – 20 October 2005. The working group consisted of experts in epidemiology, toxicology, air quality exposure assessment, air quality management and public policy. The working group agreed on updated guidelines for a number of pollutants, including particulate matter.

The WHO guidelines for PM_{10} are:

- 24-hour Average - 50 µg/m^3;
- Annual Average - 20 µg/m^3.

3.4 Nuisance Impacts of Fugitive Emissions

The preceding sections are concerned in large part with the health impacts of particulate matter. Nuisance impacts also need to be considered, mainly in relation to dust.

The WA DEC does not specify recommended levels for dust deposition. In New South Wales, the Department of Environment and Climate Change (NSW DECC) sets dust deposition limits in the *Approved Methods for the Modelling and Assessment of Air Pollutants* (NSW DECC, 2005). In Victoria, the Protocol for Environmental Management State Environment Protection Policy (Air Quality Management) Mining and Extractive Industries lists assessment criteria for Nuisance Dust (EPA Victoria, 2007).

Table 1 presents the NSW DECC and Victorian EPA impact assessment goals for dust fallout, showing the allowable increase in dust deposition levels over the ambient (background) level which would be acceptable so that dust nuisance could be avoided. These dust deposition goals have been applied for this assessment.

Table 1 Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

In the absence of an existing monitored ambient dust deposition level, the maximum increase in deposited dust level will be the governing goal for the project. The NSW DECC and Victorian EPA dust deposition criterion will be adopted in this assessment.

3.5 Diesel Combustion Related Emissions

The NEPM for ambient air quality also prescribes air quality guidelines for a range of pollutants typically associated with the combustion of diesel fuel, namely nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and a range of volatile organic compounds (VOCs). Diesel combustion associated with the generation of electricity and operation of the mining fleet has the potential to generate a wide range of emissions to the local air shed.

Emission rates for total VOCs are available for combustion sources, however individual compounds have applicable assessment criteria. The NEPC in 2004 published NEPM for Air Toxics. The purpose of the NEPM was to set monitoring investigation levels for air toxics. VOCs relevant to this assessment listed in the NEPM for Air Toxics are benzene, toluene and xylenes.

Liu et al (2008) have conducted a study into the speciation profiles of VOC emissions for a range of combustion sources. The study showed that for diesel fuelled vehicles, benzene, toluene and xylenes accounted for up to 6%, 8% and 5% of total VOC emissions respectively. This assessment will focus on the emissions of benzene, toluene and xylenes from total VOC emissions.

Assessment of diesel combustion emissions generated by the TGP will be limited to the modelling of NO_2, SO_2, CO, benzene, toluene and xylenes. Criteria prescribed within the NEPM for pollutants associated with fuel combustion are presented in **Table 2**.

Table 2 Air Quality Criteria – NO_2, SO_2, CO and VOCs

Pollutant	Averaging Time	Maximum Allowable Level	Source
NO_2	1 hour	0.12 ppm (246 µg/m³)	NEPM
	Annual	0.03 ppm (62 µg/m³)	
SO_2	1 hour	0.2 ppm (570 µg/m³)	NEPM
	24 hour	0.08 ppm (228 µg/m³)	
	Annual	0.02 ppm (60 µg/m³)	
CO	8-hour	9 ppm (10 mg/m³)	NEPM
Benzene	Annual Average	0.003 ppm (10 µg/m³)	NEPM for Air Toxics
Toluene	24-Hour	1 ppm (3769 µg/m³)	NEPM for Air Toxics
Xylenes	24-Hour	0.25 ppm (1086 µg/m³)	NEPM for Air Toxics

3.6 Impact on Flora and Fauna

As noted in **Section 2.2**, a number of threatened flora and fauna populations have been identified within the Operational Area. While the assessment criteria presented in the preceding sections are applicable to human health and amenity, they do not necessarily apply to flora and fauna. The Queensland Environmental Protection Authority (QEPA) has listed a range of assessment criteria for the maintenance of biological integrity in the *Environmental Protection (Air) Policy 1997*. The relevant QEPA criteria are listed in **Table 3**.

3.7 Project Specific Air Quality Goals

The air quality standards for pollutants relevant to this assessment are summarised in **Table 4** with other goals used only where an equivalent NEPM goal does not exist.

Table 3 QEPA Assessment Criteria for Maintenance of Biological Integrity

Pollutant	Averaging Time	Maximum Allowable Level
NO_2	4 hour	0.046 ppm (95 µg/m^3)
	Annual	0.01 ppm (30 µg/m^3)
Total Nitrogen Deposition	Annual	3 g/m^2
SO_2	24 hour	0.04 ppm (100 µg/m^3)
	Annual	0.02 ppm (60 µg/m^3)

Table 4 Project Ambient Air Quality Goals

Pollutant	Averaging Time	Maximum Allowable Level	Source
PM_{10}	24 Hours	50 µg/m^3	NEPM
	Annual Average	20 µg/m^3	WHO
Dust Deposition [1]	Annual	2 g/m^2/month	NSW DECC / VIC EPA
NO_2	1 hour	0.12 ppm (246 µg/m^3)	NEPM
	Annual	0.03 ppm (62 µg/m^3)	
SO_2	1 hour	0.2 ppm (570 µg/m^3)	NEPM
	24 hour	0.08 ppm (228 µg/m^3)	
	Annual	0.02 ppm (60 µg/m^3)	
CO	8-hour	9 ppm (10 mg/m^3)	NEPM
Benzene	Annual Average	0.003 ppm (10 mg/m^3)	NEPM for Air Toxics
Toluene	24-Hour	1 ppm (3.77 mg/m^3)	NEPM for Air Toxics
Xylenes	24-Hour	0.25 ppm (1.08 mg/m^3)	NEPM for Air Toxics
NO_2 #	4 hour	0.046 ppm (95 µg/m^3)	QEPA
	Annual	0.01 ppm (30 µg/m^3)	
Total Nitrogen Deposition #	Annual	3 g/m^2	QEPA
SO_2#	24 hour	0.04 ppm (100 µg/m^3)	QEPA
	Annual	0.02 ppm (60 µg/m^3)	

Note:1 Maximum Increase Allowable

Note: # Applicable to maintenance of biological integrity

4 EXISTING AMBIENT AIR QUALITY

During dry conditions project activities have the potential to generate dust and particulate matter. For the purposes of assessing the potential air quality impacts from the TGP, an estimation of existing ambient air quality is required.

The existing air quality in the vicinity of the Operational Area is associated with that of a rural arid environment. Natural sources of particulate matter, such as windblown dust from exposed surfaces, would be the main contributor in the vicinity of the TGP. In the absence of site specific background data, this report will assess the incremental increase in particulate concentrations as a result of the proposed TGP.

No dust deposition monitoring has been carried out in the vicinity of the Operational Area to determine a background dust deposition value. Therefore, in the absence of an existing ambient dust deposition level, the maximum increase in deposited dust level will be the governing goal for the TGP.

Finally, given the remote rural nature of the Operational Area, the existing concentrations of combustion related emissions are assumed to be negligible for the purposes of this assessment.

5 DISPERSION METEOROLOGY

To adequately characterise the dispersion meteorology of the study site information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The climate and meteorology of the study area was characterised based on:

- Half-hourly meteorological data for 2008 from the weather station established at within the Operational Area;
- Climate statistics obtained from the nearest historical data Bureau of Meteorology (BoM) station at Yamarna (Station Number 012219), located approximately 145 km to the northwest of the TGP; and
- Hourly meteorological data from BoM Automatic Weather Station (AWS) at Laverton (AWS Number 012219) and Leonora (AWS Number 012219), located approximately 220 km and 315 km west-northwest of the TGP respectively.

The weather station within the Operational Area, located at the existing exploration camp, was established in October 2007. The following parameters were available from this station for 2008:

- Wind Speed
- Wind Direction
- Temperature
- Relative Humidity
- Dew Point Temperature
- Precipitation
- Atmospheric Pressure
- Solar Radiation

It is noted that data was recorded at the Yamarna station between 1967 and 2008. Review of various climate maps located on the BoM website (www.bom.gov.au) has indicated that the Yamarna station is likely to be the most representative of long term meteorological conditions at the Operational Area, particularly with regard to rainfall and temperature. The AWS situated at Laverton and Leonora exhibit climates that are relatively cooler and wetter than Yamarna, and therefore the Operational Area. Consequently, the Yamarna station is considered the most appropriate for climate comparison with Operational Area conditions.

5.1 Measured Meteorological Parameters

5.1.1 Wind Regime

A summary of the 2008 annual wind behaviour for the area is presented as a wind rose in **Figure 4.** This wind rose displays occurrences of winds from all quadrants.

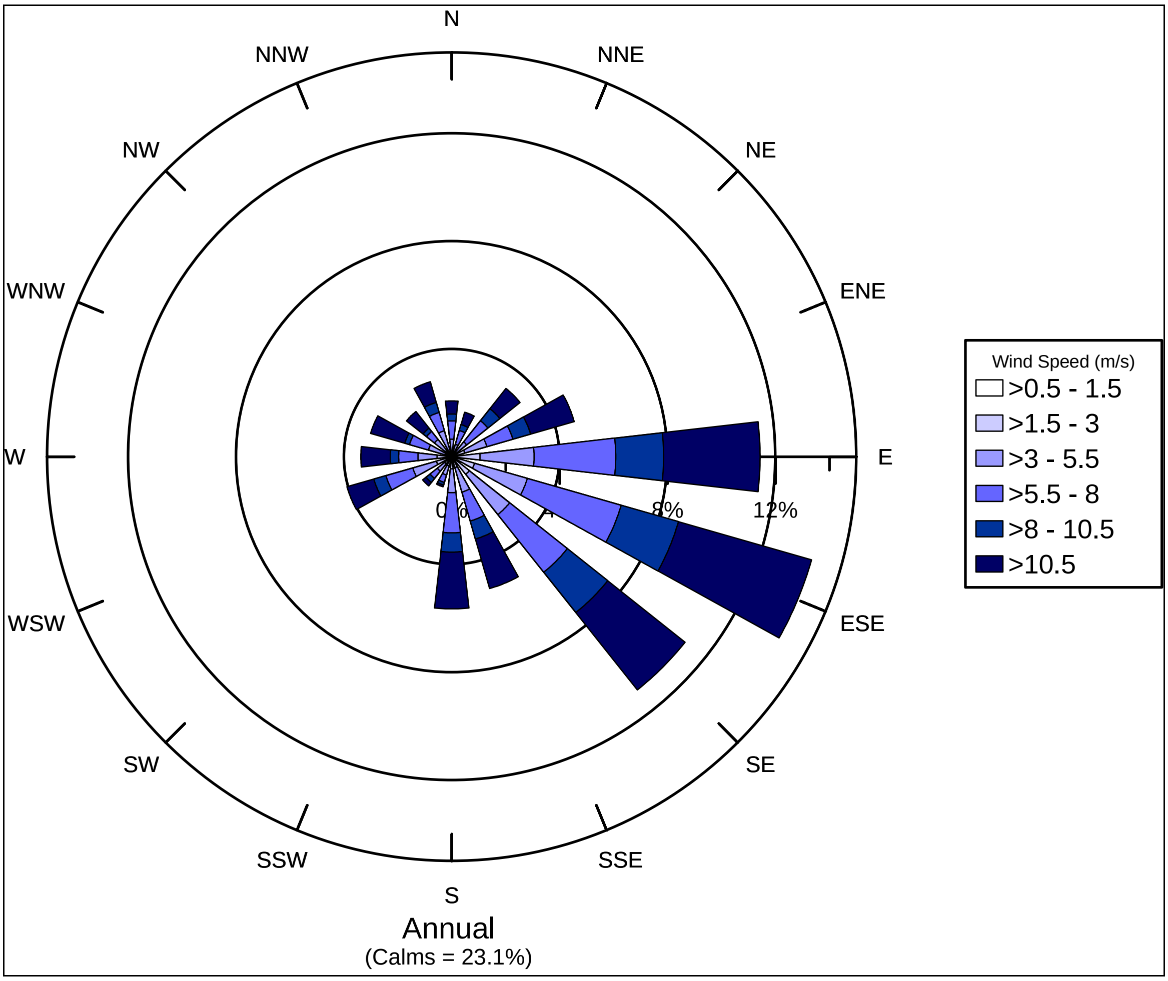
Figure 4 indicates that winds experienced at the Operational Area are predominately moderate to strong winds (between 5.5 m/s and 10.5 m/s upwards) from the east to southeast quadrant (approximately 36% combined). Calm wind conditions (wind speed less than 0.5 m/s) were recorded approximately 23% of the time throughout 2008.

The seasonal variation in wind behaviour at the Operational Area is presented in **Appendix A**. The seasonal wind roses indicate that:

- In spring, moderate to strong winds are experienced predominantly from the east to south (approximately 43% combined).

- In summer, moderate to strong winds are experienced predominantly from the east to south-southeast (approximately 68% combined).
- In autumn, moderate to strong winds are experienced predominantly from the east to southeast (approximately 31% combined).
- In winter, moderate to strong winds are experienced predominantly from the east to southeast (approximately 26% combined).

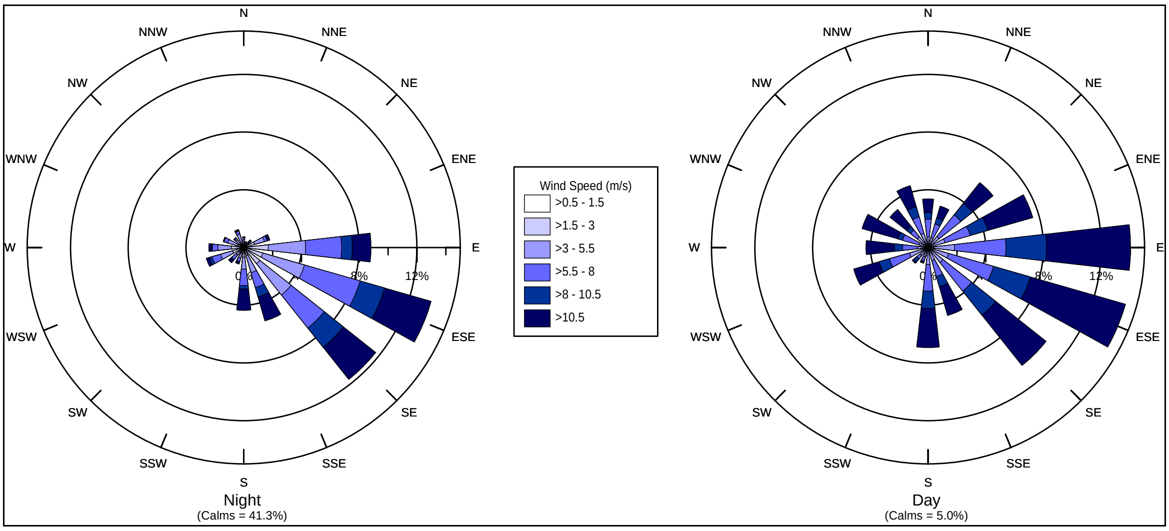
Figure 4 Annual Wind Rose for Operational Area - 2008



As the weather station at the exploration camp was only established in October 2007, it is unclear if the recorded data is representative of conditions experienced there long term. However, the 2008 wind rose recorded at the Operational Area has comparable wind speed and direction characteristics with the wind data recorded at the BoM Laverton and Leonora AWS locations in 2008, as presented in **Appendix A**. On the strength of this comparison, the 2008 wind dataset recorded at the Operational Area is considered representative.

It would be expected that the wind speeds during the daylight hours in particular would be higher in a desert region like that of the Operational Area. According to Oke (2003), due to the vast diurnal variation in atmospheric conditions; including convective energy, temperature and atmospheric stability; and relatively bare surface characteristics, the daytime wind speeds would be expected to be significantly higher than night periods in desert regions. To ascertain whether this diurnal variation is reflected within the 2008 meteorological dataset recorded at the Operational Area, annual wind roses for day and night hours have been generated and presented in **Figure 5**.

Figure 5 Diurnal Variation in Wind Speed and Direction at Operational Area – 2008



It is clearly illustrated in **Figure 5** that the wind conditions experienced during the daylight hours are significantly greater in velocity and directional spread than the nocturnal hours. Therefore, it is considered that the dataset recorded at the exploration camp weather station reflects the typical desert region diurnal variation in wind speed described by Oke (2003).

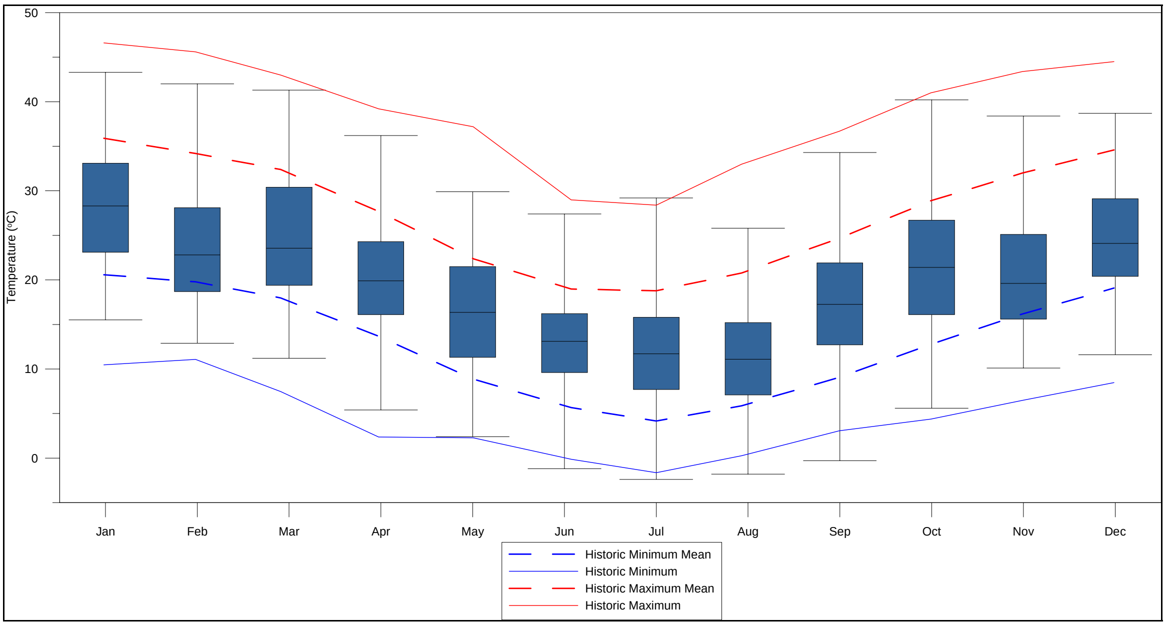
5.1.2 Temperature

Recorded temperature variance by month at the Operational Area for 2008 is presented in **Figure 6**. Additionally overlayed in **Figure 6** are the historic maximum/minimum and mean maximum/minimum temperatures recorded at the Yamarna station between 1967 and 1998.

It can be seen that the recorded temperature for the Operational Area during 2008 matches well with the historical measurements at Yamarna. It can therefore be considered that the 2008 dataset is representative of the temperature likely to be experienced in the vicinity of the Operational Area.

From analysis of the recorded historic data at Yamarna, the temperature of the Operational Area may be described as warm to hot overall. Average air temperatures during the day tend to be warm to hot, varying between 18.8°C and 20.8°C in winter and 34.2°C and 35.9°C in summer. Average air temperatures during the night tend to be very cold to warm, varying between 4.2°C and 5.9°C in winter and between 19.1°C and 20.6°C in summer.

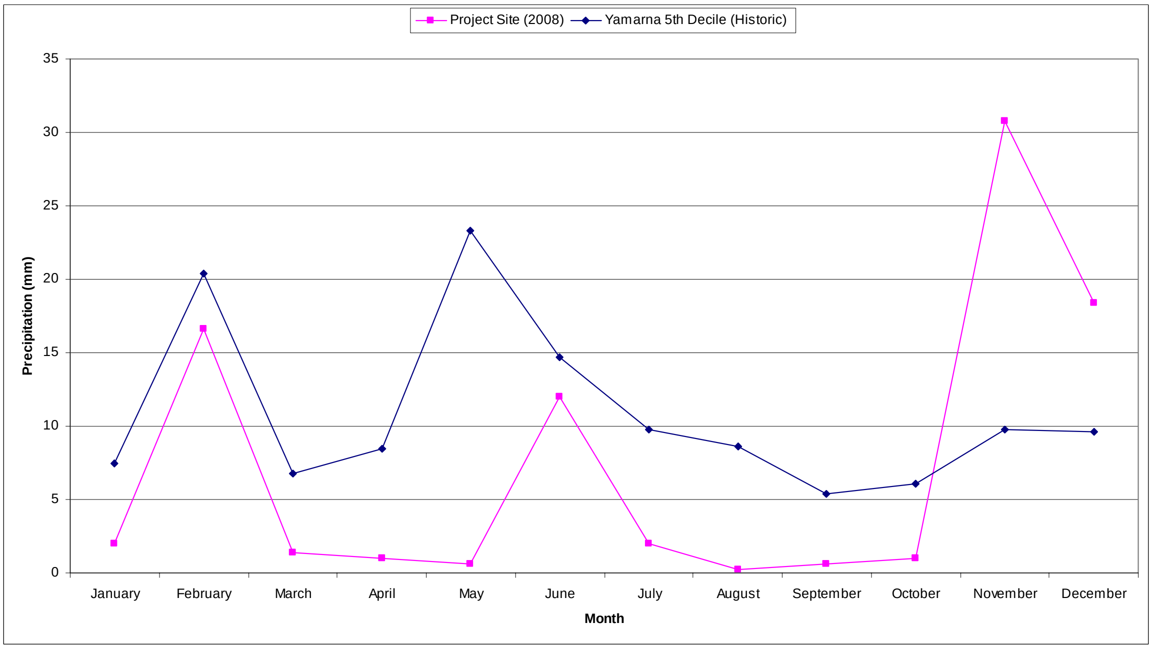
Figure 6 Monthly Temperature Variance – Operational Area (2008) and Regional Historic data (Yamarna)



5.1.3 Rainfall

Precipitation is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants. A graph displaying the recorded monthly rainfall during 2008 at the Operational Area and the median (5th decile) monthly rainfall at Yamarna is shown in **Figure 7**. The BoM regard the median (5th decile) as the best measure of typical precipitation as it allows for variability, particularly data outliers, between individual years of a dataset.

Figure 7 2008 Operational Area and Yamarna Historical Median (5th decile) Monthly Rainfall Measurements

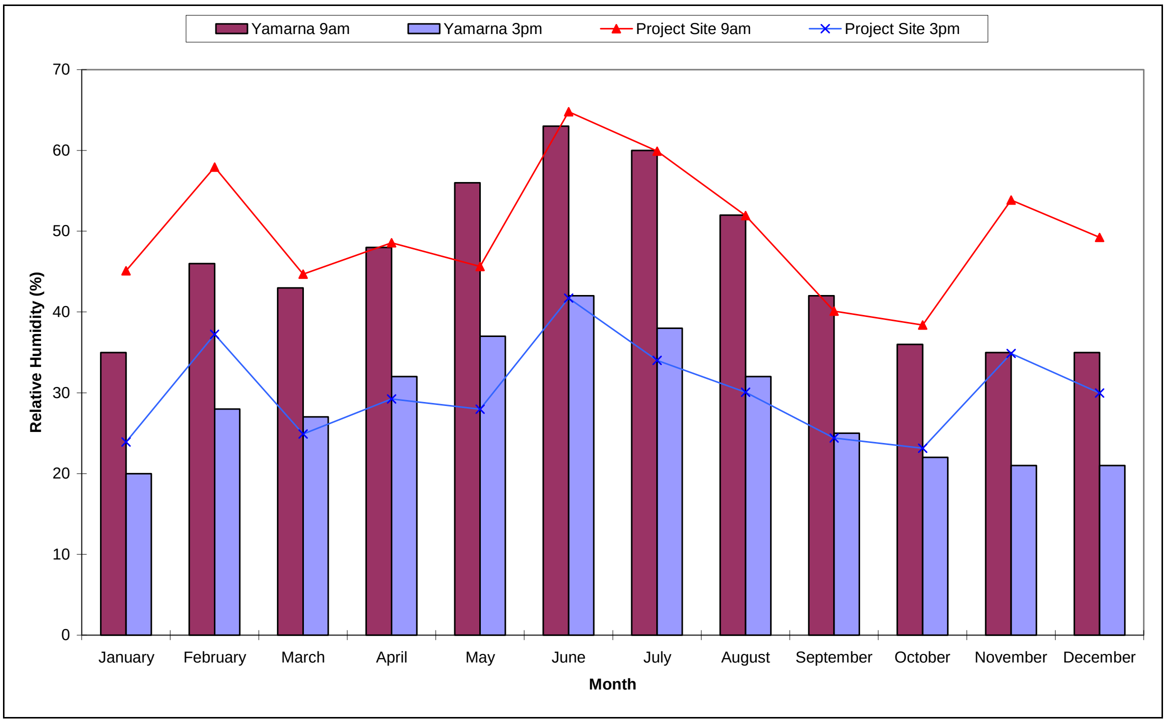


The rainfall experienced at both the Operational Area during 2008 and at Yamarna can be described as low. Approximately 144 mm of rainfall was recorded at the Operational Area during 2008, the bulk of which fell during the late spring and summer months. When compared with the median monthly rainfall recorded historically at Yamarna, the dataset recorded during 2008 at the Operational Area can be considered below the typical regional trend.

5.1.4 Relative Humidity

The mean monthly 9am and 3pm relative humidity for the Operational Area and Yamarna are presented in **Figure 8**. As can be seen, the two datasets correlate well across each month. The relative humidity for the region of the Operational Area can be described as low to moderate. The mean 9 am relative humidity varies between 38% and 65%, while the 3 pm relative humidity varies between 23% and 42% throughout 2008 at the Operational Area.

Figure 8 Mean Monthly Relative Humidity – Operational Area (2008) and Yamarna (Historic)



5.2 Additional Meteorological Parameters

In addition to the previously detailed parameters, the estimation of atmospheric stability and mixing layer height is required to characterise the pollution dispersion potential of the air shed encompassing the Operational Area. These parameters are not readily measured but can be derived from other data sources. The following sections detail the calculation of these parameters.

5.2.1 Mixing Height

Most approved approaches (eg Benkley and Schulman, 1979) for deriving the convective mixing layer involve the use of twice daily measured upper air soundings, which provide an indication of vertical temperature profile. The nearest sources of upper air data to the Operational Area are Kalgoorlie, approximately 340 km to the southwest, and Giles, approximately 590 km to the northeast. Due to the substantial separation distance between both locations, neither can be considered completely representative of the Operational Area. Furthermore, the infrequent collection of twice daily upper air soundings at both locations during 2008 has meant that the hourly interpolation of mixing height through approved methods using data from the surrounding region is not possible. Consequently, the absence of quality upper air data in the surrounding region hinders the ability to calculate hourly growth of the convective mixing layer at the Operational Area.

In order to derive a feasible and reasonable hourly varying mixing height for the Operational Area, an upper air estimation tool developed, primarily for use with the atmospheric dispersion model AERMOD, by Lakes Environmental (Thé et al, 2001) and based on the approach of Thompson (2000), has been implemented. The approach by Thompson (2000) aims to solve a series of equations for upper air parameters by relying purely on recorded surface observations.

Validation of this approach has been conducted (Thé et al (2001)) by comparison of mixing height estimated from surface observations with mixing height calculated from recorded upper air data. Results of this comparison showed that, while there was correlation between the two result sets, the mixing height estimation approach based on surface observations tended to over predict convective mixing height. While this is not ideal for the purposes of atmospheric dispersion modelling, given the nature of likely TGP-related emission sources, namely ground level releases with negligible thermal buoyancy, it is not expected that mixing height will significantly influence predicted concentrations.

Night time mixing heights were approximated using the approach of Benkley and Schulman (1979) for the mechanical mixing layer, which relies on a combination of surface friction velocity (derived from measured surface wind speed and roughness length) and the Coriolis parameter.

The diurnal variation in minimum, maximum and average mixing height calculated for the Operational Area, combining the Benkley and Schulman (1979) approach for night time mechanical mixing height and the estimation method of Thé et al (2001) for day time convective mixing height based on surface observations is presented in **Figure 9**.

It can be seen in **Figure 9** that an increase in the mixing depth during the morning, arising due to the onset of vertical mixing following sunrise, is apparent with maximum mixing heights occurring in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer. The profile presented in **Figure 9**, while derived in the absence of upper air observations, is considered appropriate for representing the likely hourly variation in mixing height that could be expected at the Operational Area, and for use in this assessment.

5.2.2 Atmospheric Stability Class

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six 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 as input into various air dispersion models.

Figure 9 Diurnal Variation in calculated mixing heights (Benkley and Schulman (1979) night time, Thé, Lee and Brode (2001) day time), Operational Area 2008

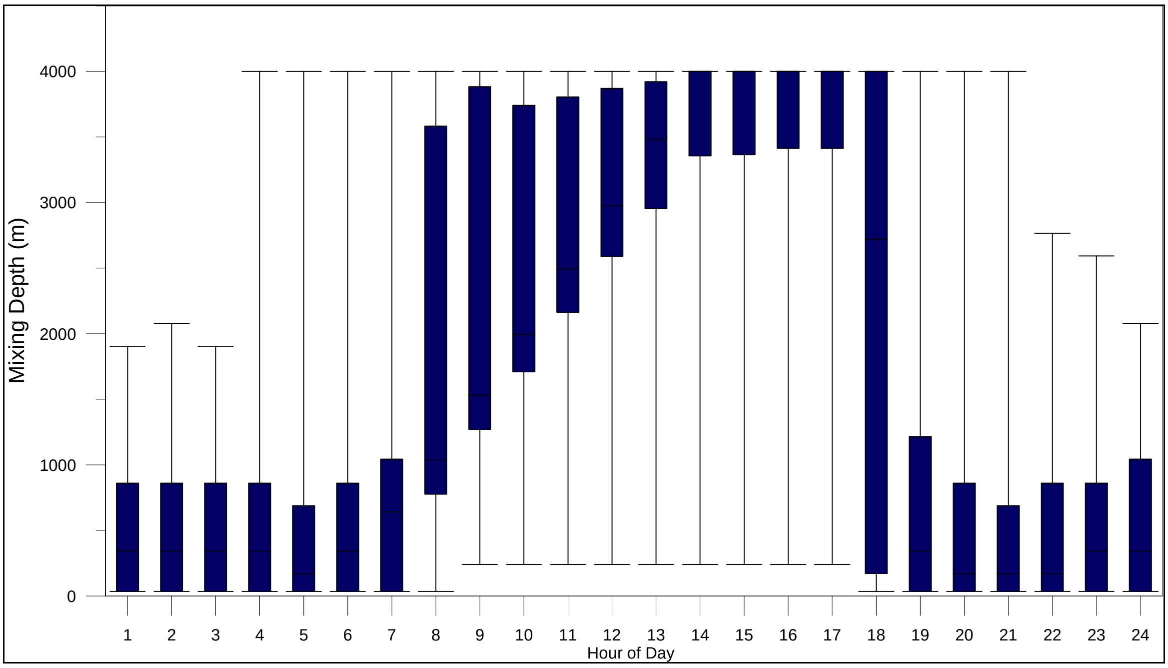


Table 5 Description of atmospheric stability classes

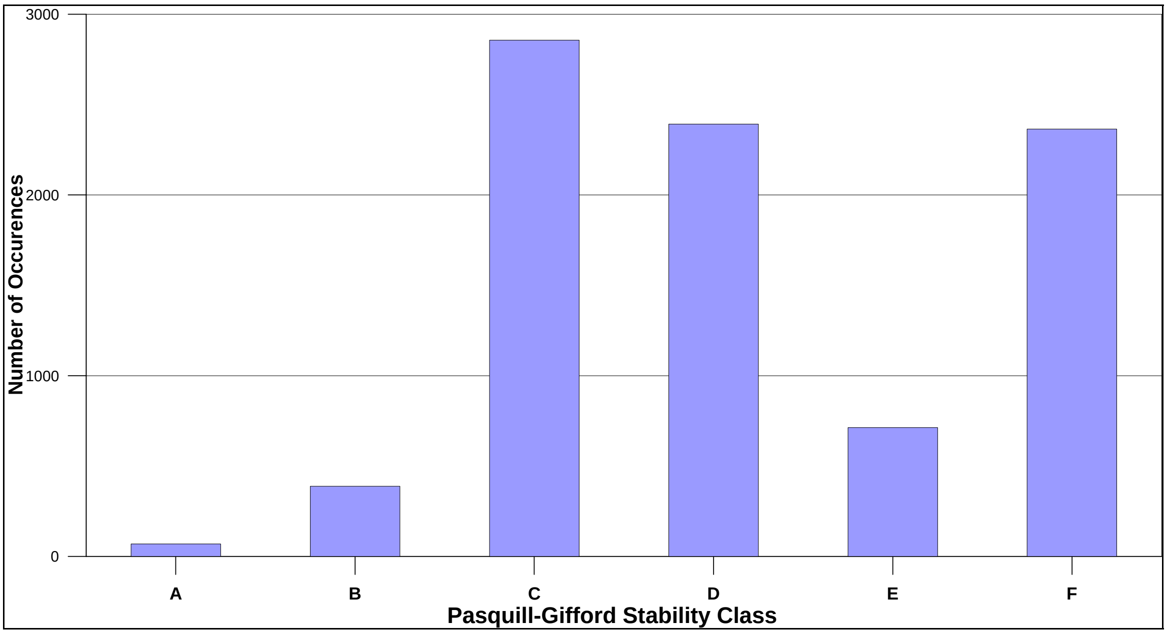
Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

Atmospheric stability class for the Operational Area has been derived using the US EPA (2000) solar radiation method during day time hours and the modified Pasquill Stability Class (Davis and Singh, 1985) during night time hours.

Cloud cover is required for both methods of stability class calculation; however no observations for the site were available. In order to estimate cloud cover in eighths, the nearest available hourly cloud observations (from the BoM AWS at Leonora) were used. Measured solar radiation at the exploration camp was implemented in the calculations.

The frequency of each stability class calculated for the Operational Area is presented in **Figure 10.** The seasonal stability class distributions for each station are included in **Appendix B.**

Figure 10 US EPA (2000) and Davis and Singh (1985) Calculated Annual Stability Class Frequency Distribution, Operational Area 2008



The results in **Figure 10** indicate a high frequency of conditions typical to Stability Class "C", "D" and "F". Stability Class "C" is indicative of moderately stable conditions provide a moderate potential for atmospheric dispersion of pollutants due convective instability. Stability Class "D" is indicative of a neutral atmosphere, while Stability Class "F" is indicative of highly stable conditions with a low potential for atmospheric dispersion of pollutants due to a low level of mechanical mixing.

The profile presented in **Figure 10** is considered acceptable considering the location and climate characteristics of the Operational Area discussed in **Section 5.1**. In particular, the desert setting is likely to experience a high level of atmospheric instability due to convective turbulence during the daylight hours due to the predominance of high wind speeds and high temperatures (accounting for "C" Stability Class), while the high percentage of clear sky conditions and low wind speeds during the night hours would lead highly stable conditions (accounting for "F" Stability Class). According to Oke (1987), the vast diurnal variation in atmospheric stability class illustrated in **Figure 10** is typical of desert settings.

5.3 Suitability of Meteorological Dataset

Based on analysis of the data presented in the preceding sections for the directly measured meteorological parameters (i.e. wind, air temperature, relative humidity and precipitation), the 2008 dataset for the Operational Area is considered representative based on comparison with historically-recorded regional data.

While the methodology used in the derivation of mixing height and atmospheric stability for the Operational Area is not ideal, it is considered appropriate in this instance given the lack of site-specific information from the Operational Area, namely regular upper air soundings for mixing height and reliable cloud observation data for atmospheric stability. The variation pattern for mixing height and atmospheric stability, presented in **Figure 9** and **Figure 10** respectively, are considered reasonable for the arid setting of the Operational Area. Finally, given the nature of the dominant pollution sources at the Operational Area (non-buoyant, ground level sources), mixing height is unlikely to have a critical bearing on predicted concentrations.

6 ATMOSPHERIC DISPERSION MODELLING

CALPUFF, a puff dispersion model suitable for use in complex atmospheric dispersion situations, can be configured in screening mode, using a single meteorological input file such as an Ausplume meteorological input file. Using CALPUFF in screening mode assumes steady state conditions with a single one dimensional wind field applied across the entire modelling domain.

This approach is not considered appropriate for non-steady state conditions, such as in coastal locations or areas of complicated terrain where non-uniform wind conditions can be expected. However, given the relatively uncomplicated terrain in the region surrounding the Operational Area, as illustrated in **Figure 2**, the assumption of steady state meteorological conditions in this assessment is considered appropriate.

The current assessment utilises the CALPUFF (Version 6.2) modelling system run in screening mode using the single point meteorological input file, comprising of the data presented and discussed in **Section 5**. The advantages of using CALPUFF in screening mode (rather than using a steady state Gaussian dispersion model such as Ausplume) is its ability to handle calm (wind speeds less than 0.5 m/s) wind conditions. Ausplume cannot handle calm conditions because of the inverse wind speed dependence within the Gaussian plume equation. Under calm conditions, Ausplume will assume a minimum wind speed which shoots the plume to the edge of the modelling grid, even though the plume may not have moved at all under actual dispersion conditions (DECC 2005).

CALPUFF can handle these low wind speed conditions and will grow a plume by diffusion alone under zero wind speed conditions. Given the high percentage of calm conditions within the 2008 meteorological dataset recorded at the Operational Area (approximately 23%), the use of CALPUFF in screening mode in place of Ausplume is considered appropriate in this assessment.

6.1 Site Establishment Phase

The construction phase will comprise a series of different operations including vegetation clearing, topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, etc. Each of these operations has potential for dust generation. The relatively short-term nature of site construction activities means that the potential for dust generation varies significantly from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This is in contrast to emissions associated with the operational phase of the Project, which are either relatively steady or follow a discernible annual cycle.

It is unlikely that the emissions generated during the site establishment phase would be of greater significance than those of the operational phase. Indeed, the operational phase of the Project contains the majority of activities that are likely to occur during the site establishment phase plus operations related to the extraction, transportation and processing of ore. Therefore, the site establishment phase of the Project is deemed to possess a lesser impact potential than the operational phase and has not been considered further in this assessment.

6.2 Operational Phase

A review has been carried out of the potential particulate-generating activities expected to be associated with the operational phase of the Project. The following activities have been identified for emission estimation and inclusion in the source inventory and dispersion simulations:

- Blast hole drilling and blasting of waste rock and ore in Open Cut Pits
- Excavators within the Tropicana and Havana Open Cut Pits
- Dozers on the waste material landforms

- Movement of heavy vehicles on unsealed roads within the site
- Use of grader on haul routes
- Truck unloading to crusher (85% direct tip) and front end loader loading crusher (remaining 15%)
- Crushing and screening
- General handling, transferring and conveying at processing plant
- Wind erosion from raw material and product stockpiles, open pit, waste rock dump and tailings facility

6.3 Emissions Factors

In general, default emission factors have been used as contained in Table 1 and Table 2 of the *Emission Estimation Technique Manual for Mining, Version 2.3*, (hereafter, "EETMM") (Environment Australia, 2001).

Table 6 presents the emission factors for the key atmospheric pollutants used in the dispersion modelling carried out for this assessment. These estimate the emissions expected under worse case operating conditions at full production. **Appendix C** presents the full emissions inventory, including the assumptions and emissions controls applied. It is noted that TSP emission factors are used to derive the rate of dust deposition.

Table 6 Particulate Emission Factors for Air Quality Dispersion Modelling

Activity (Type of Source)	TSP Emission Factor[1]	PM_{10} Emission Factor	Emission Factor Units
Drilling	0.59	0.31	kg/hole
Blasting	1291	671	kg/blast
Excavator	0.0003	0.0002	kg/t
Grader	1.08	0.34	kg/VKT
Trucks Unloading	0.002	0.001	kg/t
Haul Truck Wheel Dust	2.9	0.6	kg/VKT
Dozers	6.0	1.0	kg/hr
Primary Crushing	0.01	0.004	kg/t
Secondary Crushing	0.03	0.012	kg/t
Loading Crusher	0.002	0.001	kg/t
Wind Erosion (Various)	0.02	0.01	kg/ha/hr

Note 1: Total Particulate emission factor is used to derive the rate of dust deposition
Note 2: VKT = Vehicle Kilometre Travelled

The depth of the open cut pits (approximately 350 m) and the associated emissions pit retention potential is not reflected in the dispersion modelling. Lowndes et al (2008) illustrated through a combination of emissions calculations and high-resolution, multi-scale predictive modelling through computational fluid dynamics methods that complex wind flow can occur within an open-cut mine. Furthermore, Lowndes et al (2008) identified that over a range of particle sizes, wind direction and extraction depths, the escaping fraction from an open-cut pit was approximately 50% of total emissions. This value has been applied to all emissions within the open-cut pits within the Operational Area in an attempt to account for the depth of the mining operations.

In some instances, the moisture content of materials at the Operational Area is not adequately reflected within the default emission factors contained in the EETMM, and the equations given in either Table 1 of the EETMM document or USEPA AP-42 documentation were therefore used to derive representative emission factors. The following emission factors were derived using this method.

6.3.1 Bulldozer

$$EF = k \times \frac{s^{1.2}}{M^{1.3}} \text{ kg/h}$$

where k=2.6 for TSP and 0.34 for PM_{10}, s = silt content and M = moisture content.

6.3.2 Miscellaneous Handling (Excavator, FEL, loading/unloading of material)

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2}\right)^{-1.4} \text{ kg/t}$$

where k=0.74 for TSP and 0.35 for PM_{10}, U = mean wind speed and M = moisture content.

6.3.3 Grader Operation

$$EF = 0.0034 \times S^{k} \text{ kg/VKT}$$

where k=2.5 for TSP and 2 for PM_{10}, S = average vehicle speed.

It is noted that given the significant difference between the daily and annual grader operations and haul truck movement, both in total kilometres travelled and hourly operation, grader operations have not been included in this modelling assessment.

6.3.4 Blasting

$$EF = 344 \times \frac{A^{0.8}}{M^{1.9} \times D^{1.8}} \text{ kg/blast}$$

where A = Blast area, M = moisture content and D = depth of blast holes. PM_{10} is 52% of TSP.

6.3.5 Haul truck wheel dust (USEPA AP-42)

The emission factor for wheel generated dust is estimated from the USEPA emission equation for Wheel Generated Dust from Unpaved Roads (2003).

$$EF = k \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} \times \left(\frac{281.9}{1000}\right) \text{ kg/VKT}$$

where k=4.9 for TSP and 1.5 for PM_{10}, s = silt content and W = vehicle gross mass.

6.3.6 Wind Erosion

Hourly-varying wind erosion from exposed surfaces was estimated using the USEPA AP-42 approach for determining wind erosion (Chapter 13, Section 13.2.5 Industrial Wind Erosion). Site specific particle friction threshold velocity data for the Operational Area has been adopted from the *Wind Erosion Potential of Reconstructed Landforms* report compiled by Landloch Pty Ltd (Landloch, 2008) for the Project. The total wind erosion potential for the modelling period is presented in **Table 6**.

6.4 Combustion Emissions

Atmospheric emissions of CO, oxides of nitrogen (NO_X), SO_2 and Total VOCs (TVOCs) from fuel combustion within the Operational Area were modelled using the following information.

Peak annual diesel consumption for the complete TGP mining fleet of 26.9 ML has been used to estimate diesel fuel combustion related emissions. In the absence of fuel breakdown data, the maximum emission factors across all listed equipment type listed in Table 4 of the NPI EETMM for each pollutant was used to calculate total annual emissions of CO, NO_X, SO_2 and TVOCs per litre of diesel fuel consumed. This total emission rate was then divided amongst the various source locations used in the particulate matter modelling. Combustion emissions for each component of the mining process have been placed at the corresponding locations selected in the particulate modelling assessment within the Operational Area.

Emissions of PM_{10}, CO, NO_X, SO_2 and TVOCs from the onsite diesel generators have been estimated using the emissions specifications for the Cummins Engine Company QSK78-G9 diesel generator engine under prime power conditions. Each of the 13 diesel generators have been represented in the dispersion modelling process as point sources, with source configuration listed in **Table 7**, as per the manufacturer's specifications.

Table 8 presents the emission rates associated with diesel fuel combustion at the Operational Area.

Table 7 Diesel Generator Source Parameters

Parameter	
Stack Height (m)	3
Stack Diameter (m)	0.5
Stack Flow Rate (m^3/min)	487
Exit Temperature (°C)	438
Number of Generators	13

Table 8 Operational Area Diesel Combustion Emission Rates

Component	Emission Rate (g/s)				
	PM_{10}	CO	NO_X	SO_2	TVOCs
Mobile Plant (by source)	N/A	0.064	0.169	0.007	0.023
Diesel Generators	0.017	0.197	6.519	0.086	0.120

N/A – Emission rate not applicable. As per Note 1 of Table 4 of the EETMM, mining activity emission factors within the EETMM account for PM_{10} emissions associated with diesel combustion.

6.4.1 Nitrogen Dioxide Concentrations from Oxides of Nitrogen Emissions

In order to predict ambient concentrations of NO_2 from total emissions of NO_X generated by the combustion of diesel at the Operational Area, it is assumed that 10% of total NO_X emissions are emitted as primary NO_2. Based on Janssen et al (1988), which states that 5% of total NO_X emissions from fossil fuel burning power stations is NO_2, this assumption is considered conservative for the estimation of emitted NO_2.

Typically, NO_2 forms in the atmosphere further afield from the point of emission, typically following the interaction with ambient concentrations of ozone and VOCs and the influence of sunlight. In the absence of ambient ozone concentrations and the assumption of negligible existing VOC concentrations, the use of 10% of NO_X emissions as NO_2 in the modelling approach is considered suitable for the assessment of ambient concentrations of NO_2.

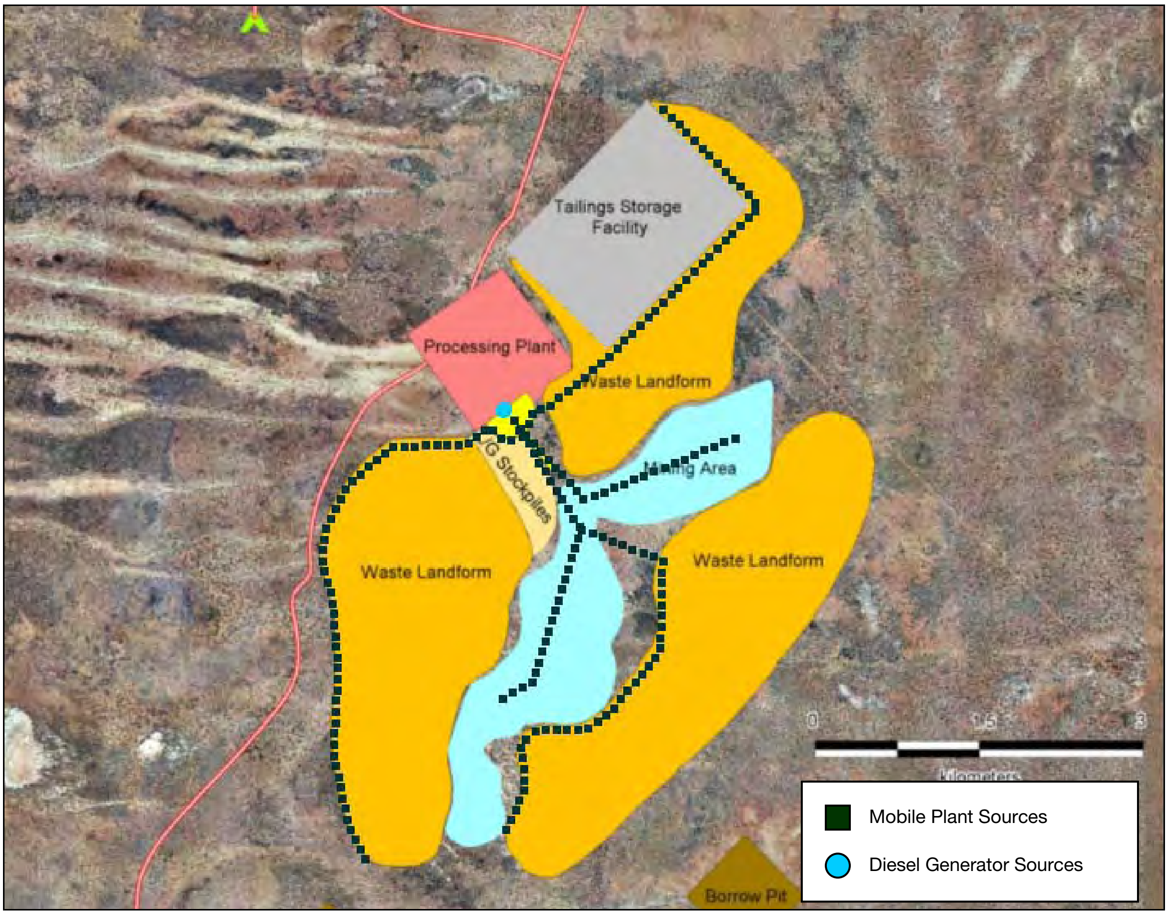
6.4.2 Speciation of Total Volatile Organic Compound Emissions

As stated in **Section 3.5**, 6%, 8% and 5% of TVOC emissions will be assumed as emissions of benzene, toluene and xylenes respectively, based on the findings of Liu et al (2008).

6.5 Source Locations

The locations of each of the emissions sources associated with the Project are presented in **Figure 11**.

Figure 11 Emission Source Locations



7 MODELLING ASSESSMENT RESULTS

7.1 24-hour and Annual Average PM_{10}

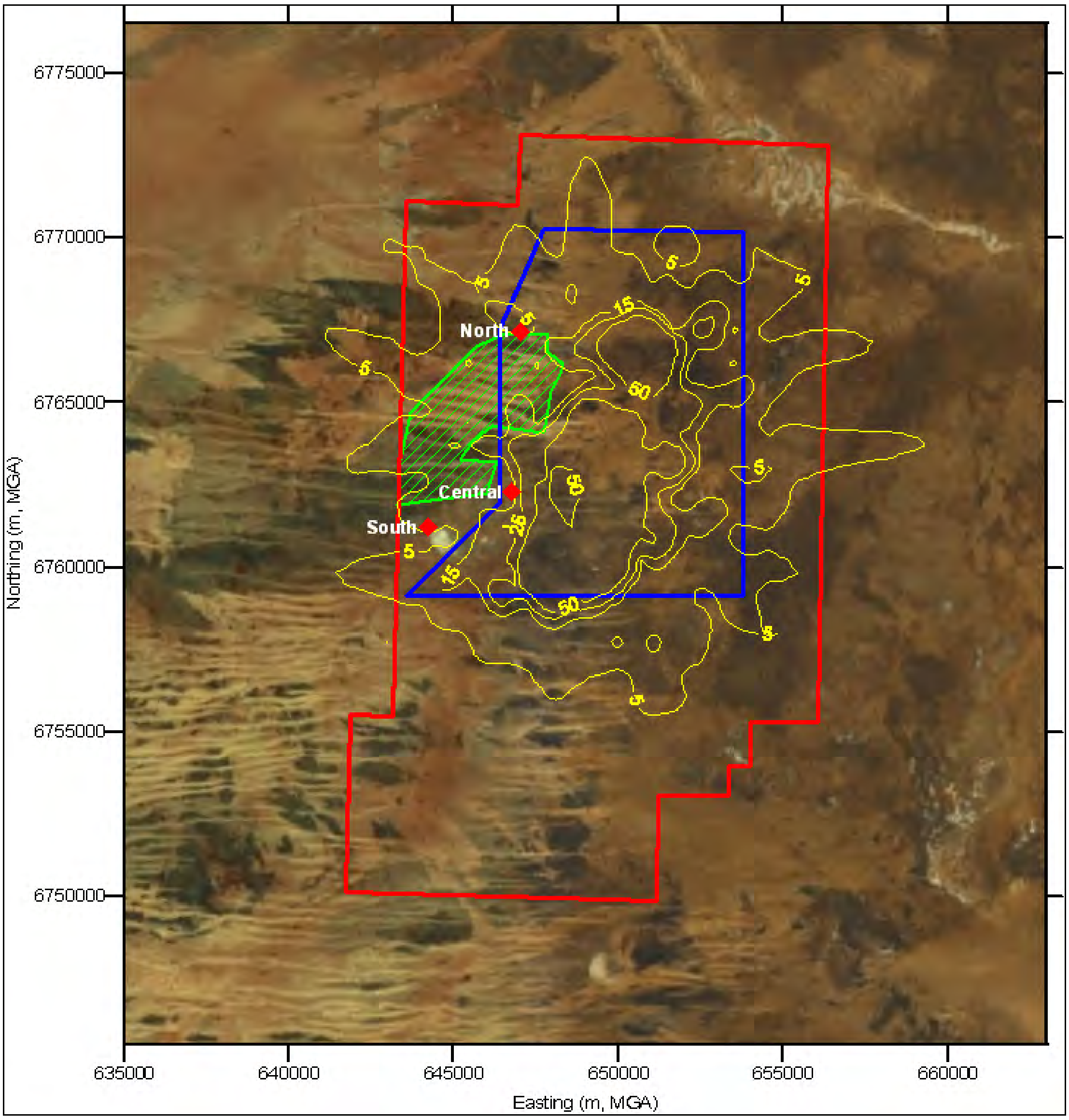
Table 9 shows the results of the CALPUFF predictions for the maximum 24-hour average and annual average PM_{10} concentrations at each of the 3 accommodation camp locations, using the emission rates detailed in **Appendix C**. Predicted isopleth plots for 24-hour and annual average PM_{10} concentrations are presented in **Figure 12** and **Figure 13** respectively.

Table 9 Predicted Maximum 24-Hour Average and Annual Average PM_{10} Concentrations

Camp Location	Averaging Times	PM_{10} Concentrations – µg/m³	
		Increment	**Project Goal**
North	24 hour	2.1	50
	Annual	0.4	20
Central	24 hour	11.1	50
	Annual	5.1	20
South	24 hour	6.3	50
	Annual	1.2	20

As can be seen in **Table 9**, **Figure 12** and **Figure 13**, the predicted incremental 24-hour and annual average PM_{10} concentrations satisfy the relevant assessment criteria at the three accommodation camp locations.

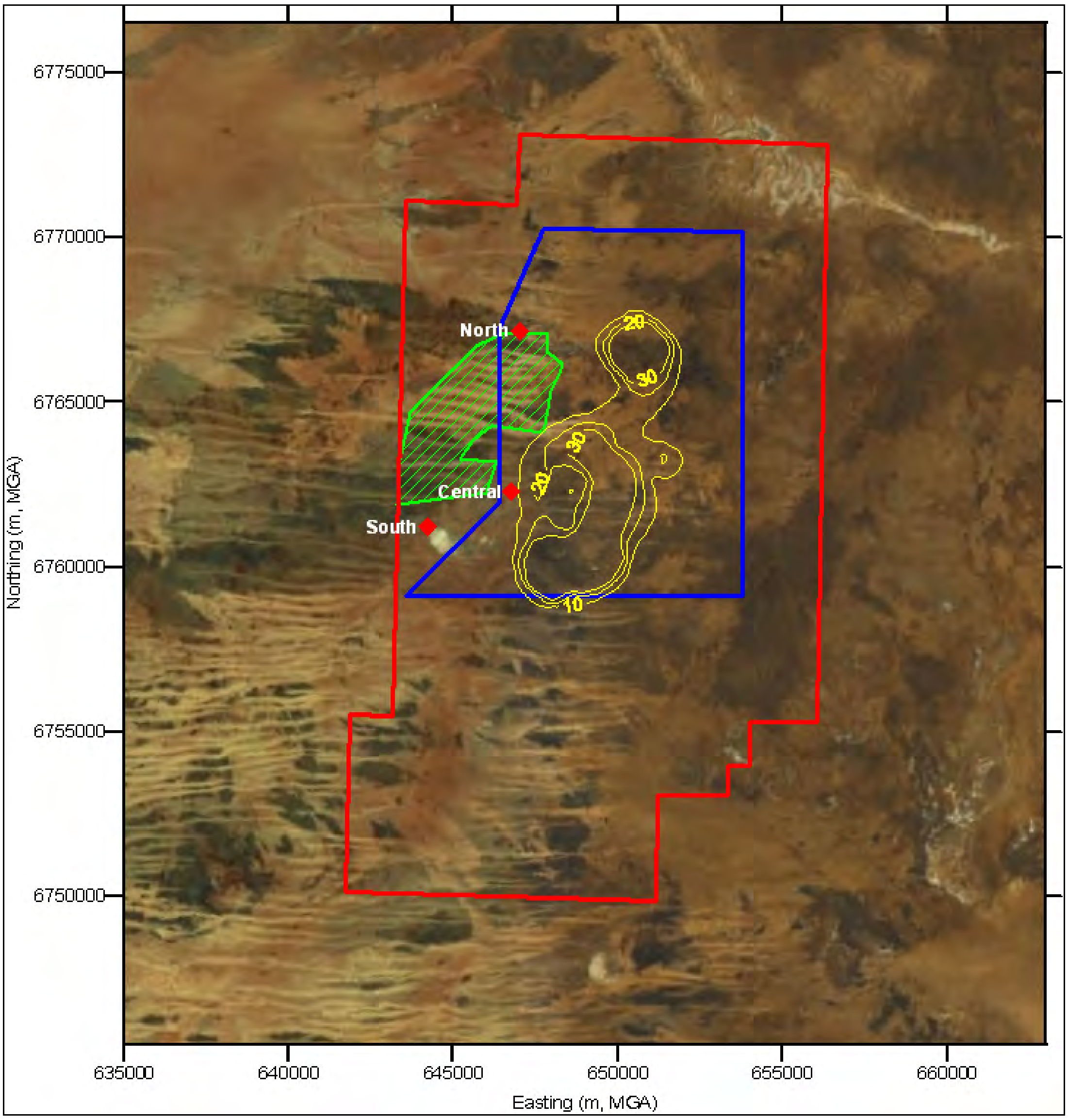
Figure 12 Maximum Predicted Incremental 24-hour Average PM_{10} Concentrations ($\mu g/m^3$)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations

Note: Assessment Criterion: 50 $\mu g/m^3$

Figure 13 Predicted Incremental Annual Average PM_{10} Concentrations (µg/m³)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations
Note: Assessment Criterion: 20 µg/m³

7.2 Dust Deposition

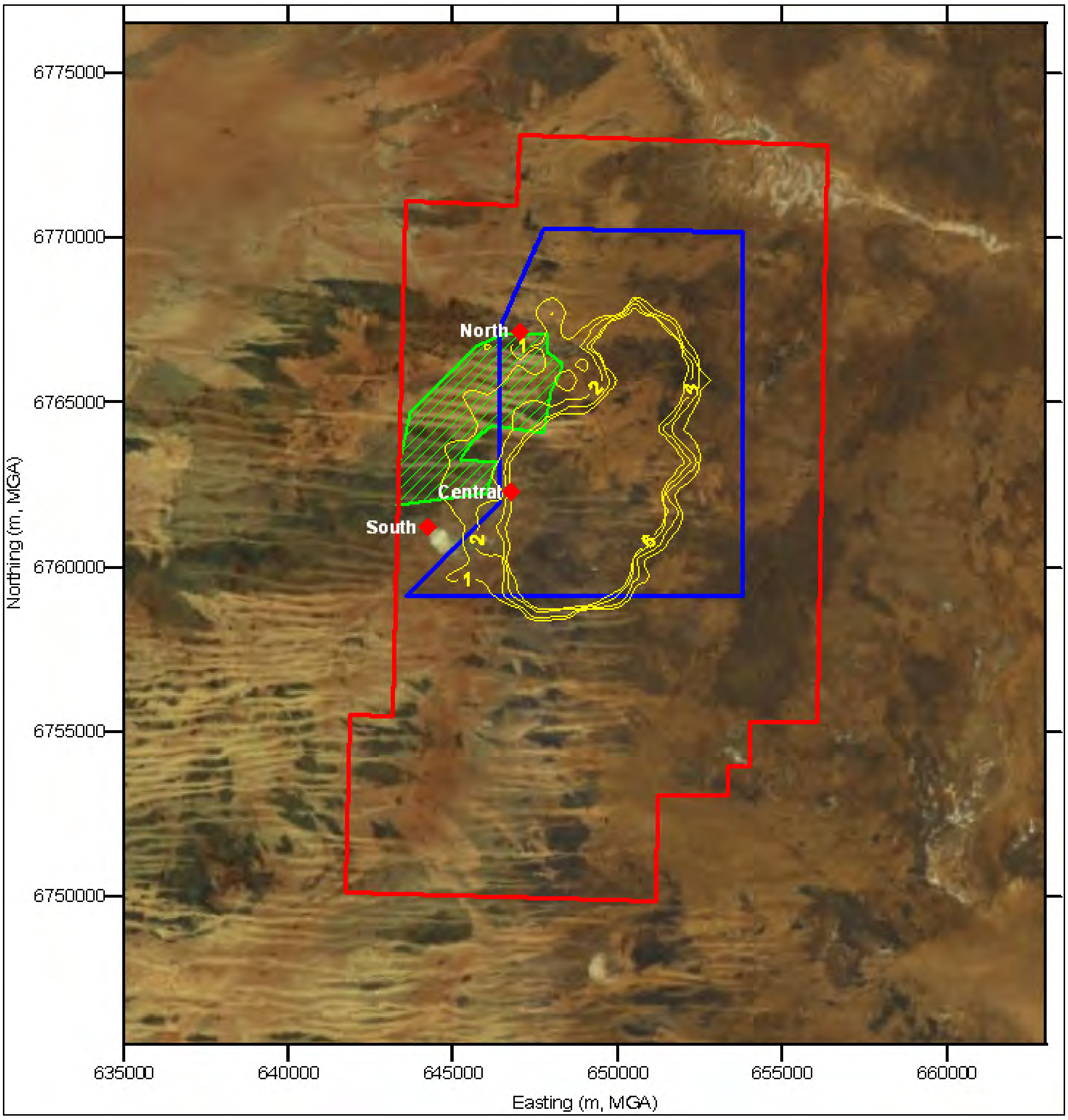
Table 10 shows the results of the CALPUFF predictions for dust deposition from the Operational Area, using the emission rates calculated in **Appendix C**, at each of the identified receptors. The results show the mean average monthly dust deposition predicted at the accommodation camp locations over a one-year time frame. Predicted isopleths for dust deposition about the Operational Area are presented in **Figure 12**.

The results presented in **Table 10** indicate that the mean monthly incremental dust deposition associated with the Project are predicted to satisfy the dust deposition assessment criterion at the North and South camp locations, while exceeding at the Central camp location.

Table 10 Predicted Dust Deposition Levels

Camp Location	Dust Deposition – g/m²/month	
	Increment	Project Goal
North	0.3	2
Central	5.1	2
South	0.8	2

Figure 14 Predicted Incremental Dust Deposition (g/m²/month)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations

Note: Assessment Criterion: 2g/m²/month

7.2.1 Potential for Dust Impacts on Flora and Fauna

Various studies have examined the impact of dust contamination on plants and livestock (Lillie, 1970; Lodge *et al.*, 1981; Yang, 1988; Mentor Consulting, 1993; Environment Canada, 1998; Hunt, 2003).

Effects on vegetation can occur due to physical smothering of the leaf surface which results in reduced light transmissions and hence reduced photosynthesis and physical blocking of stomata through particle lodging resulting in a decrease in stomatal resistance. Depending on the particle composition, effects could also include direct chemical effects or indirect effects on soil pH and ionic composition. Yang (1988) noted that dust deposition levels of 0.75 to 1.5g/m²/day (i.e. 22 to 45 g/m²/month) would not result in adverse effects on plant production. Decreased respiration rates were noted to occur for cereals when cement dust deposition rates exceeded 7 g/m²/day (Environment Canada, 1998).

Mentor Consulting (1993), as quoted in Hunt (2003), undertook grazing trials in NSW with dairy cattle. The trails were designed to determine the impact of coal mine dust contamination of pasture on pasture intake, grazing behaviour and milk production of dairy cattle. Coal dust added to a pasture equivalent to 8g/m²/day had no effect on pasture palatability or cattle production. Hunt (2003) cites a study by Marek and Hais (1970) which investigated dust inhalation and ingestion of contaminated pastures by dairy cattle. According to this study, production levels were reduced by about 10% when deposition levels reached 48 to 96 g/m²/month but not detectable at lower dust deposition rates.

Documented dose response thresholds given for potential impacts on vegetation, including sensitive natural vegetation and crops, and livestock are orders of magnitude higher than were predicted to occur in the areas of identified threatened flora and fauna situated about the Operational Area. Dust emissions from the Operational Area are therefore not expected to be associated with any significant impacts on surrounding flora and fauna. While the fauna populations are not likely to be livestock, the studies referenced here are considered acceptable for use in this assessment.

7.3 Nitrogen Dioxide

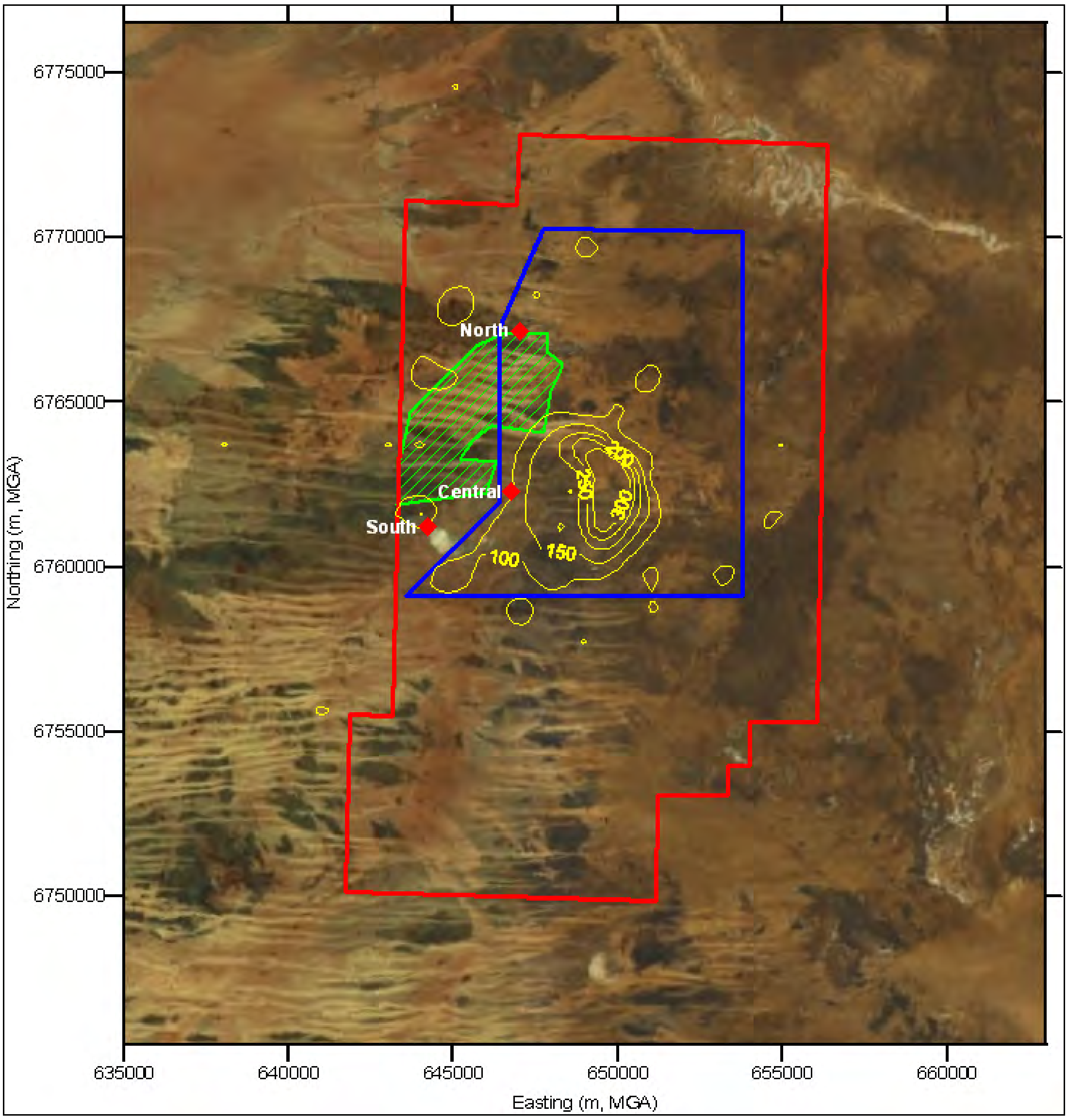
Table 11 shows the results of the CALPUFF predictions for 1-hour and annual average incremental NO_2 concentrations (based on the assumption of 10% NO_X emissions as NO_2) at each of the three accommodation camp locations.

Table 11 Predicted Maximum 1-Hour and Annual Average NO_2 Concentrations

Camp Location	Averaging Times	NO_2 Concentrations – µg/m³	
		Increment	Project Goal
North	1 hour	52.2	246
	Annual	4.7	62
Central	1 hour	89.2	246
	Annual	13.2	62
South	1 hour	98.4	246
	Annual	4.4	62

The results in **Table 11** indicate that the predicted NO_2 concentrations are within the project goal of 246 µg/m³ (1-hour) and 62 µg/m³ (annual average) at all camp locations. **Figure 15** and **Figure 16** illustrate the predicted 1-hour and annual average NO_2 concentration isopleths about the Operational Area respectively.

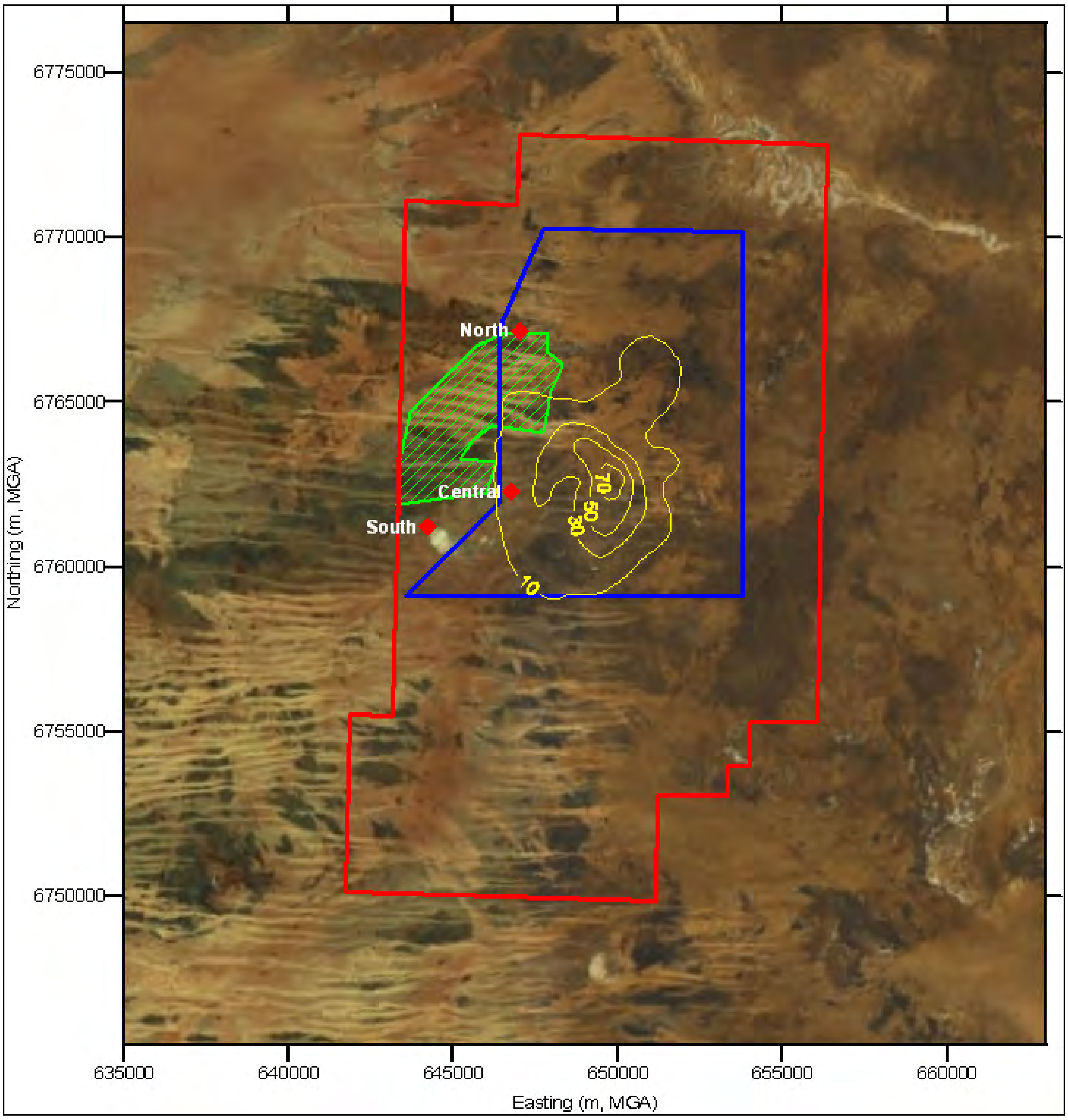
Figure 15 Predicted Incremental 1-hour Average NO_2 Concentrations (µg/m³)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations

Note: Assessment Criterion: 246 µg/m³

Figure 16 Predicted Incremental Annual Average NO_2 Concentrations (µg/m³)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations

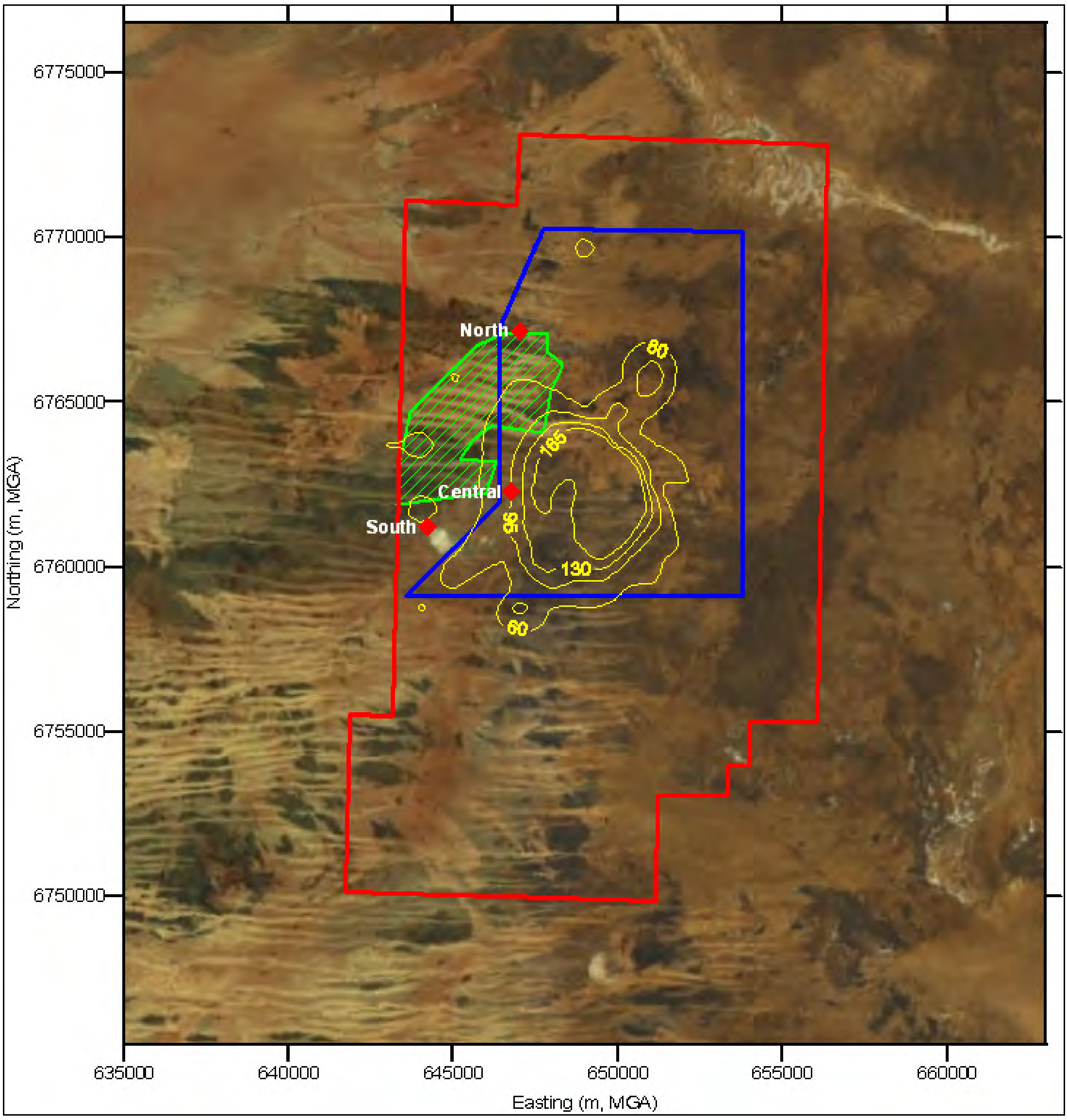
Note: Assessment Criterion: 62 µg/m³

7.3.1 Impact on Flora and Fauna

In addition to assessment of NO_2 concentrations at the accommodation camp locations, 4-hour and annual average NO_2 concentrations and annual total nitrogen deposition levels have been assessed to identify potential impacts on the surrounding threatened flora and fauna populations. **Figure 17** and **Figure 18** illustrate the predicted extent of 4-hour average NO_2 concentrations and annual total nitrogen deposition levels respectively. **Figure 16** presents the annual average NO_2 isopleths.

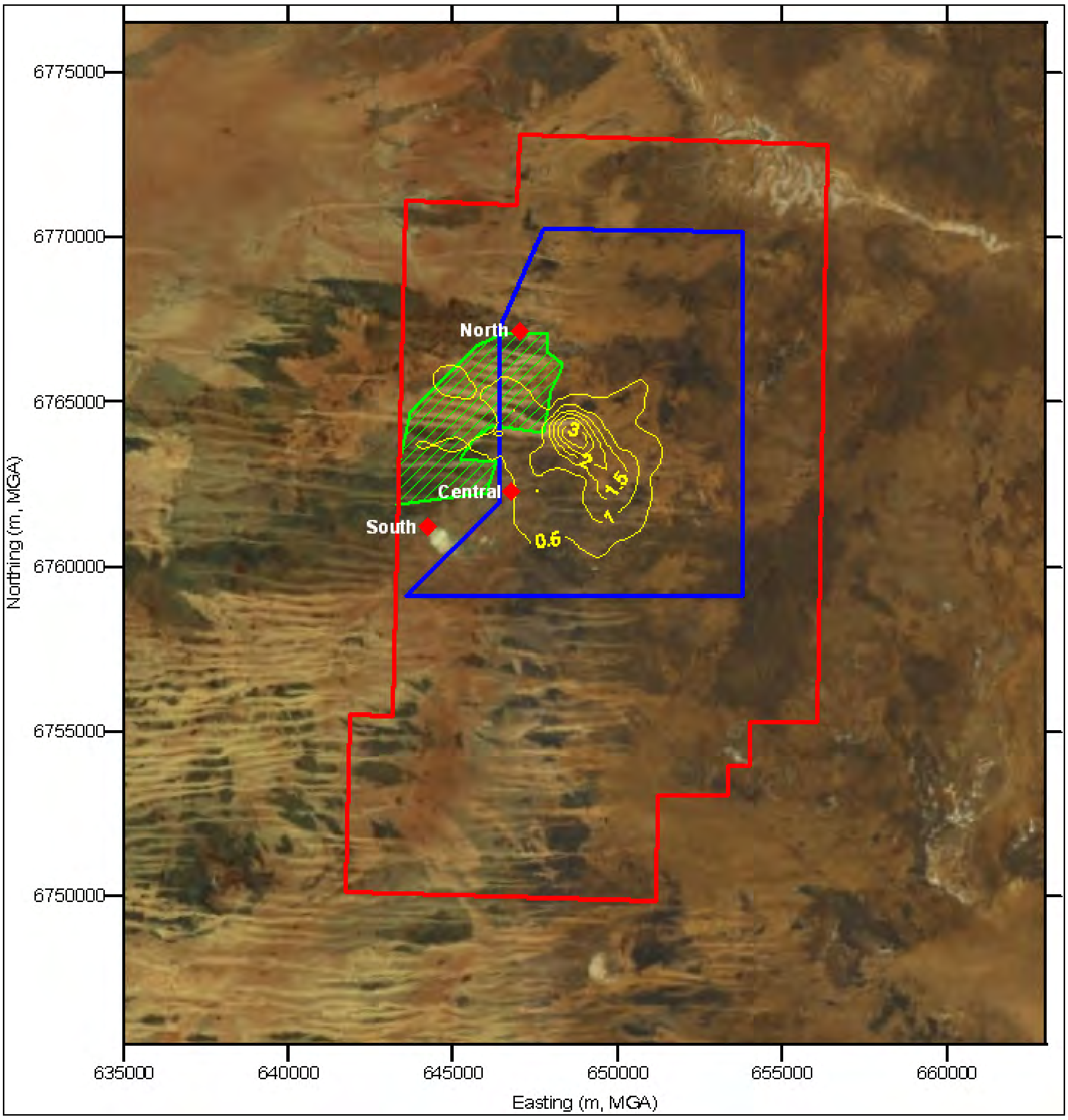
As can be seen in **Figure 16** and **Figure 18**, the predicted annual average NO_2 concentrations and total nitrogen deposition levels at the surrounding flora and fauna locations are below the relevant assessment criteria. **Figure 17** shows that the 4-hour average NO_2 concentration is predicted to exceed the assessment criterion of 95 μg/m^3 at the eastern-most edge of the primary threatened flora and fauna zone. Consequently, the biological integrity of the threatened flora and fauna populations has a slight potential to be impacted by NO_2 emissions generated by the TGP.

Figure 17 Predicted Incremental 4-hour Average NO_2 Concentrations (μg/m^3)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations
Note: Assessment Criterion: 95 μg/m^3

Figure 18 Predicted Incremental Annual Average Total Nitrogen Deposition (g/m²)



Note: Green hashed area indicates primary zone of identified threatened flora and fauna populations

Note: Criteria = 3 g/m^2

7.4 Sulphur Dioxide

Table 12 shows the results of the CALPUFF predictions for the 1-hour, 24-hour and annual average SO_2 concentrations predicted at each of the three accommodation camps.

Table 12 Predicted Incremental 1-Hour, 24-Hour and Annual Average SO_2 Concentrations

Camp Location	Averaging Times	SO_2 Concentrations – µg/m³	
		Increment	**Project Goal**
North	1 hour	18.2	570
	24 hour	8.8	228
	Annual	2.0	60
Central	1 hour	39.3	570
	24 hour	21.7	228
	Annual	5.8	60
South	1 hour	22.0	570
	24 hour	8.2	228
	Annual	1.8	60

The results in **Table 12** indicate that the predicted SO_2 concentrations are within the project goal of 570 µg/m³ (1-hour maximum), 228 µg/m³ (24-hour maximum) and 60 µg/m³ (annual average) at all accommodation camps.

7.4.1 Impact on Flora and Fauna

In addition to assessment of SO_2 concentrations at the accommodation camp locations, the QEPA 24-hour and annual average assessment criteria for maintenance of biological integrity needs to be applied at the identified threatened flora and fauna locations.

On the basis of the predicted 24-hour and annual average concentrations at the North and Central accommodation camps listed in **Table 12**, which are well below the QEPA criteria, it is clear that there is unlikely to be an impact on the biological integrity of the surrounding threatened flora and fauna populations.

7.5 Carbon Monoxide

Table 13 shows the results of the CALPUFF predictions for incremental 8-hour average CO concentrations at each of the three accommodation camps.

Table 13 Predicted Maximum 8-Hour Average CO Concentrations

Camp Location	Averaging Time	CO Concentrations – mg/m³	
		Increment	**Project Goal**
North	8 hour	0.1	10
Central	8 hour	0.3	10
South	8 hour	0.1	10

The results in **Table 13** indicate that the predicted CO concentrations are within the project goal of 10 mg/m³ (8-hour maximum) at all accommodation camps.

7.6 Volatile Organic Compounds

As stated in **Section 3.5**, emissions of speciated VOCs from the TGP (benzene, toluene and xylenes) have been assessed. **Table 14** shows the results of the CALPUFF predictions for these three air toxics at each of the three accommodation camps.

Table 14 Predicted VOC Concentrations – Benzene, Toluene and Xylenes

Camp Location	Air Toxic	Averaging Time	Concentrations – mg/m^3	
			Increment	Project Goal
North	Benzene	Annual	0.0004	0.01
	Toluene	24 hour	0.002	3.77
	Xylenes	24 hour	0.001	1.08
Central	Benzene	Annual	0.001	0.01
	Toluene	24 hour	0.005	3.77
	Xylenes	24 hour	0.003	1.08
South	Benzene	Annual	0.0003	0.01
	Toluene	24 hour	0.002	3.77
	Xylenes	24 hour	0.001	1.08

The results in **Table 14** indicate that the predicted concentrations for benzene, toluene and xylenes are well within the relevant project goal at all accommodation camp locations.

8 CONCLUSION

Atmospheric dispersion modelling was carried out for this assessment to quantitatively determine the impact, in terms of particulate matter and diesel combustion related emissions, of worst case operations of the proposed Tropicana Gold Project, on proposed accommodation camp locations and identified threatened flora and fauna populations.

Model predictions have indicated that emissions of particulate matter and diesel combustion-related pollutants generated by the operation of the TGP would satisfy all relevant assessment criteria at all three proposed accommodation camp locations, excluding monthly dust deposition at the Central camp. It is considered that, on the basis of the dispersion modelling conducted within this report, the North accommodation camp location would be the least impacted upon by the operation of the TGP.

No significant impacts are likely for the surrounding identified threatened flora and fauna populations, based on the adopted QEPA criteria for the maintenance of biological integrity.

Primary sources of particulate matter at the TGP were the movement of haulage trucks, the processing area and wind erosion from exposed areas. It is considered that these three key components should be the focus of management strategies for the reduction of particulate matter generation from onsite operations

It is noted that a worst-case scenario was modelled, in terms of particulate emission rates and operational conditions. Of particular note, no accounting for the potential influence of dispersion of any TGP-related landforms or open-cut pit depth have been included, short of adjusting emissions at the point of generation. As a result, all predictions in the assessment should be viewed as conservatively high, with levels expected to be lower than those modelled during normal functioning of the TGP.

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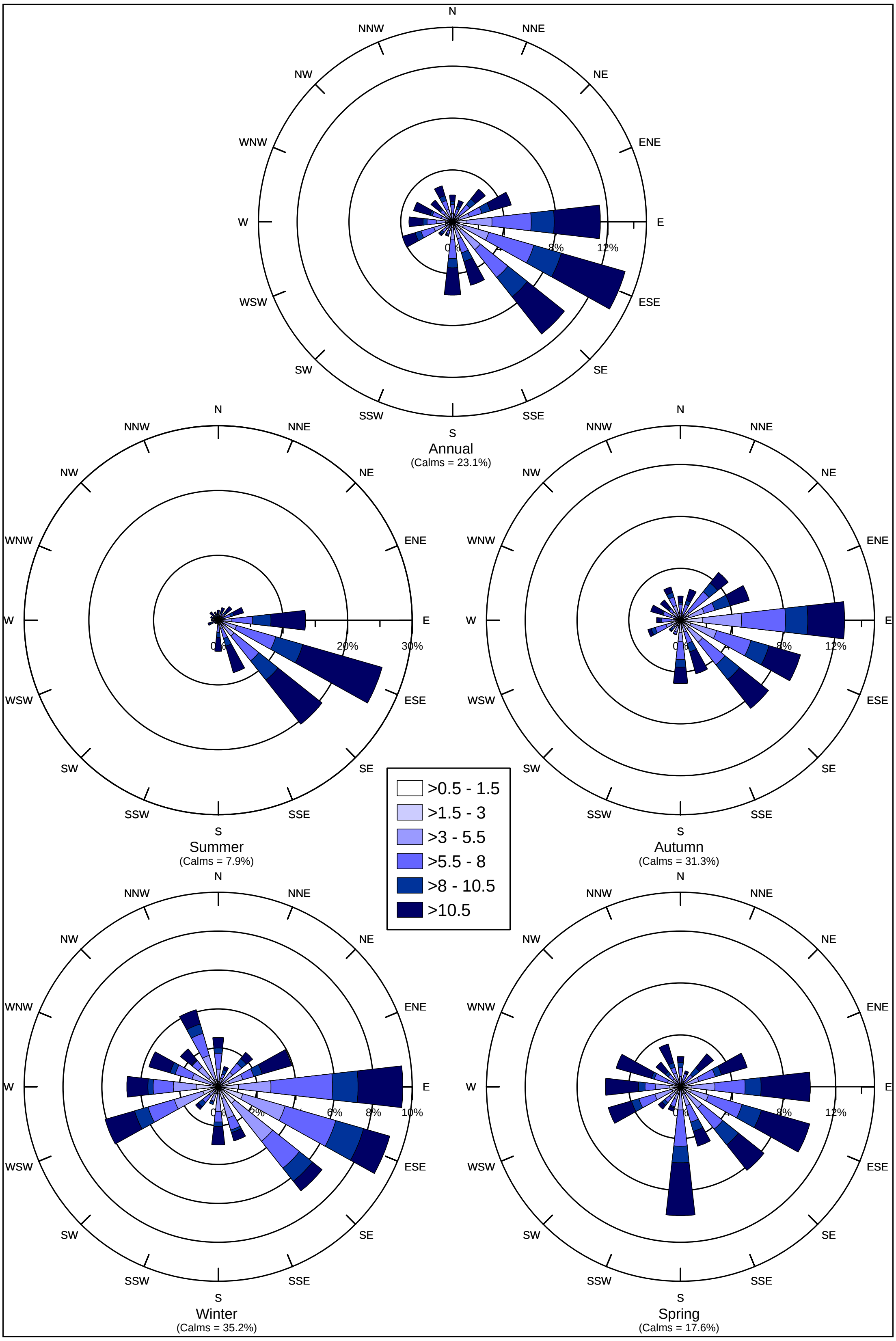
10 GLOSSARY

AHD	Australian Height Datum
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CO	Carbon Monoxide
DECC	NSW Department of the Environment and Climate Change
EETMM	Emission Estimation Technique Manual for Mining, Version 2.3
$g/m^2/month$	Grams per square meter per month
Heggies	Heggies Pty Ltd
JV	The Joint Venture
µg	Microgram (g x 10^{-6})
m^3	Cubic meter
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO_X	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
PER	Public Environmental Review
PM_{10}	Particulate matter less than 10microns in aerodynamic diameter
TGP	Tropicana Gold Project
QEPA	Queensland Environment Protection Authority
ROM	Run Of Mine
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulate
TVOC	Total Volatile Organic Compounds
USEPA	United States Environmental Protection Agency
VKT	Vehicle Kilometres Travelled
WA DEC	Western Australia Department of Environment and Conservation
WHO	World Health Organisation

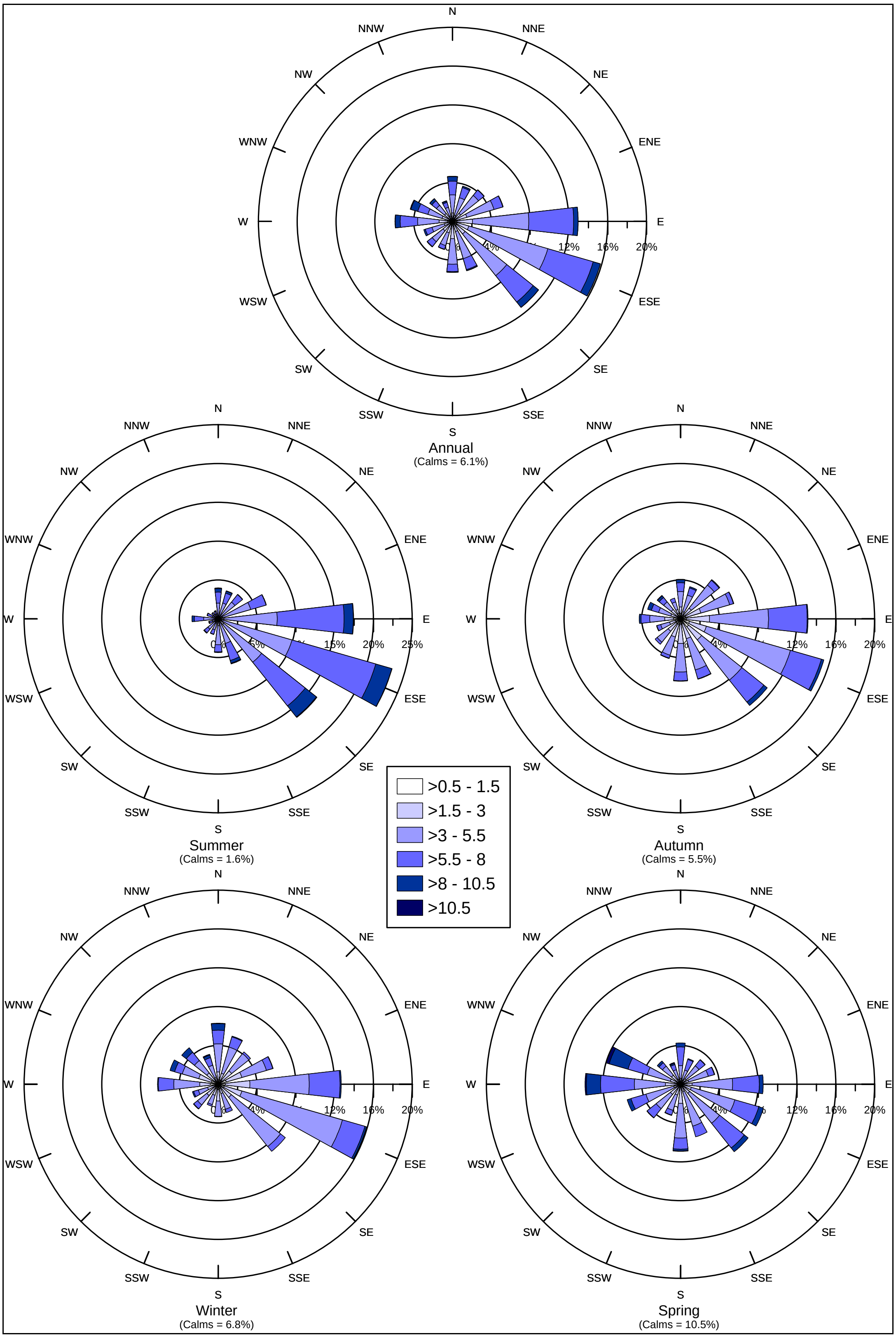
SEASONAL WIND ROSES – OPERATIONAL AREA, LEONORA AND LAVERTON, 2008

Figure A1 Operational Area 2008



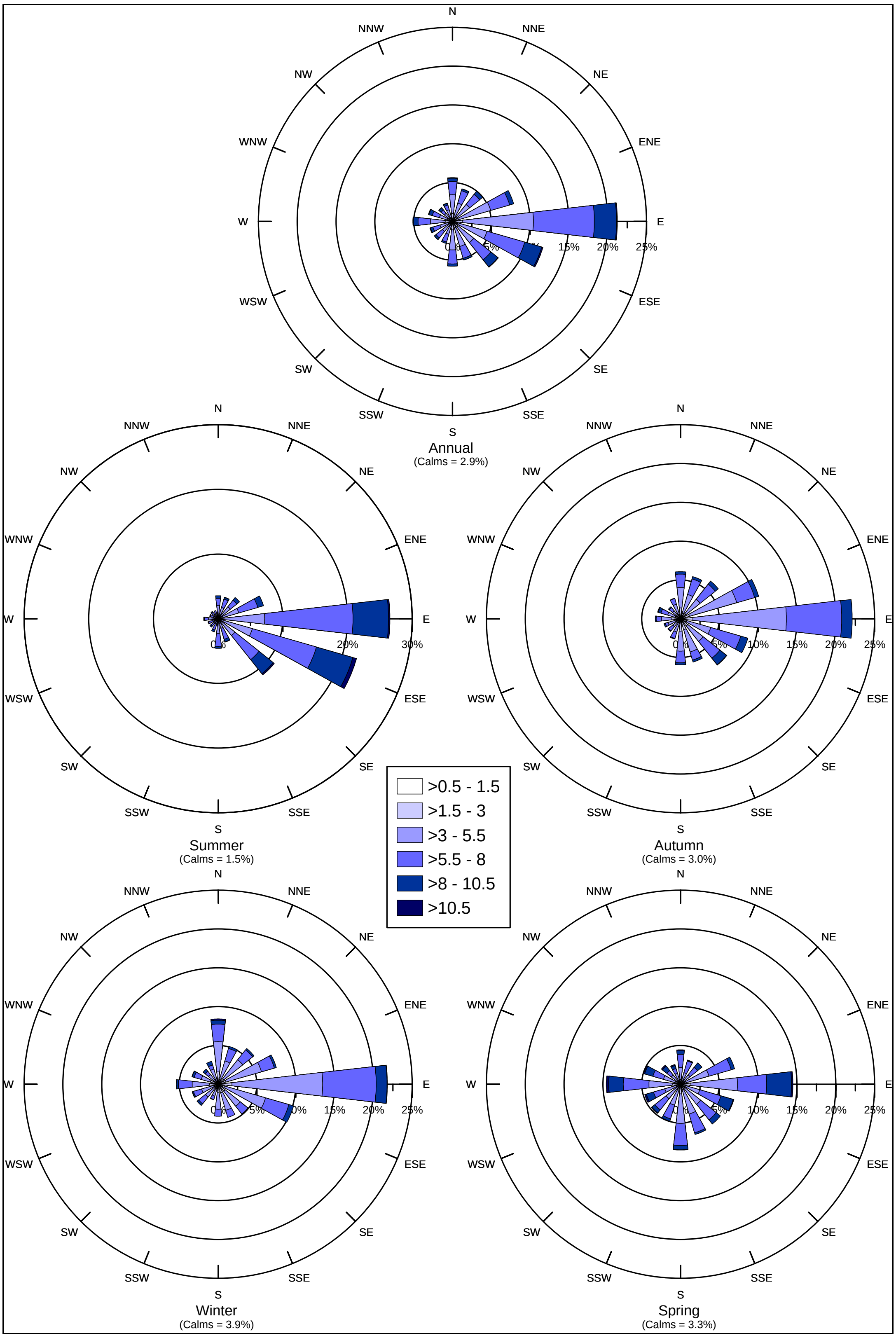
SEASONAL WIND ROSES – OPERATIONAL AREA, LEONORA AND LAVERTON, 2008

Figure A2 Leonora 2008

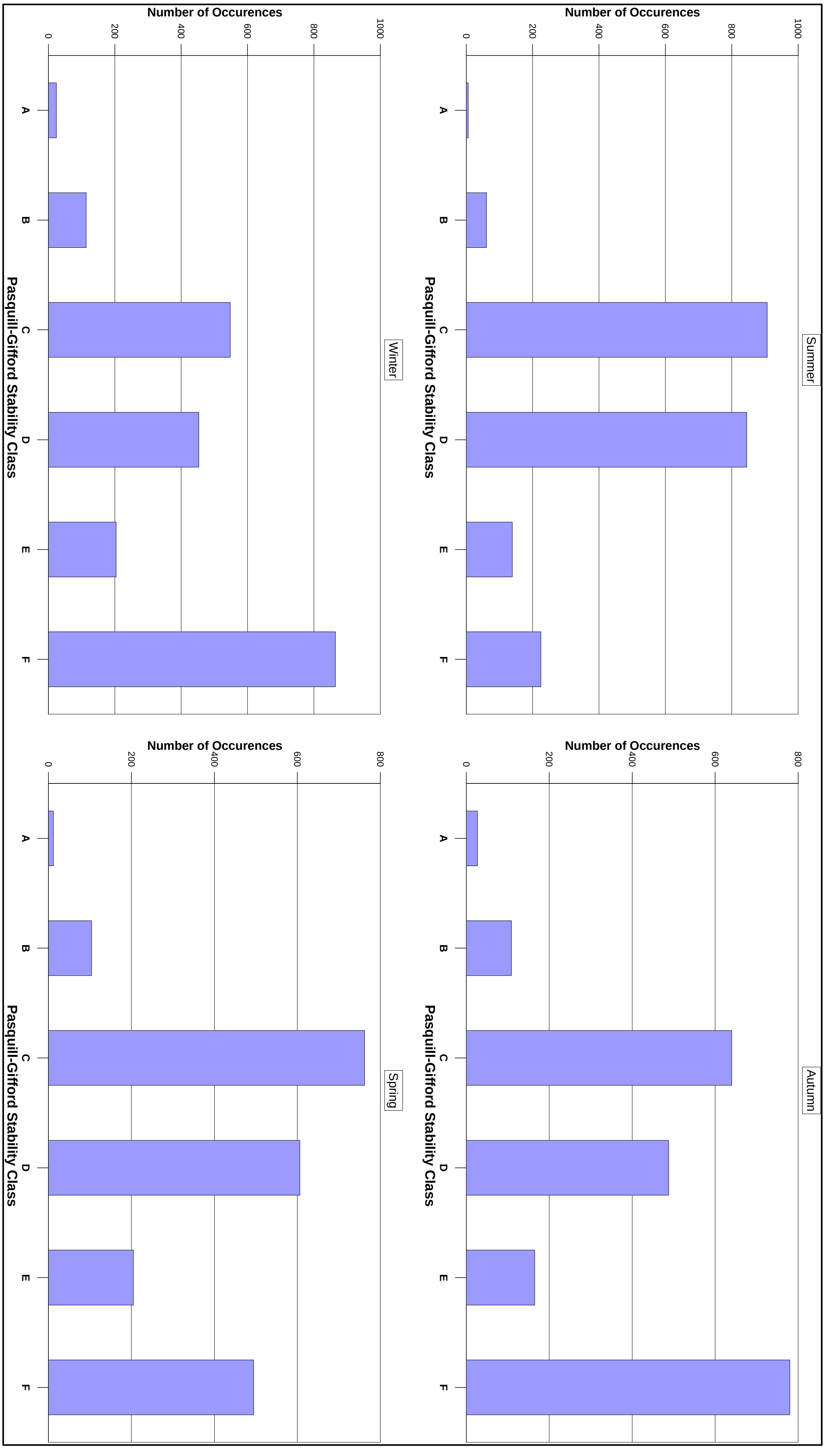


SEASONAL WIND ROSES – OPERATIONAL AREA, LEONORA AND LAVERTON, 2008

Figure A3 Laverton 2008



SEASONAL STABILITY CLASS - OPERATIONAL AREA, 2008



EMISSIONS INVENTORY

75-1247 Tropicana Gold Project	TSP Emission Factor	PM10 Emission Factor	Emission Factor Units	*Activity Rate*	TSP Dust Emisisons (t/year)	PM10 Dust Emisisons (t/year)	Notes	Variable		Mine Working Days	Modelled Working hours	TSP Emission Rate (mg/s)	PM10 Emission Rate (mg/s)	TSP Emission Flux (mg/s/m2)	PM10 Emission Flux (mg/s/m2)
Extraction Activities															
Drilling	0.59	0.31	kg/hole	40000 holes/year	24	12	Assumes 200 holes drilled per day with 200 blasts occuring per year. Dust control systems combination of fabric filters and saline water, assume 90% effectiveness. 50% Pit Retention.	17	Holes Drilled / Hour	350	24	139	73	N/A	N/A
Blasting	1291	671	kg/blast	200 blasts/year	129	128	Assumes 200 blasts per year or 17 per month (No dust control) 50% Pit Retention.	1	Blast / Day	350	1	179309	93241	2.5103	1.3054
Excavators (3) (Havana and Tropicana Pits - Ore Mining)	0.0003	0.0002	kg/t	68 Mtpa	12	11	Ore + WR + Marginal tpa, perodic watering down of the mining face 25% of the time. 50% Pit Retention.	16151	Tonnes / Hour	350	12	581	275	N/A	N/A
Excavators (2) (Havana and Tropicana Pits - Loading Trucks)	0.000	0.0002	kg/t	68 Mtpa	12	11	Ore + WR + Marginal tpa 50% Pit Retention.	16151	Tonnes / Hour	350	24	581	275	N/A	N/A
				TOTAL	**176**	**161**									
Processing Plant															
Primary Crusher	0.010	0.004	kg/t	7 Mtpa	35	14	Control - Mechanical dust extraction and water sprays - assume 80% efficiency	1667	Tonnes / Hour	350	12	463	185	N/A	N/A
Secondary Crusher	0.030	0.012	kg/t	7 Mtpa	105	42	Control - Mechanical dust extraction and water sprays - assume 80% efficiency	1667	Tonnes / Hour	350	12	1389	556	N/A	N/A
				TOTAL	**140**	**56**									
Materials Handling															
Trucks Unloading to ROM stockpile	0.002	0.0011	kg/t	2.1 Mtpa	4	2	Assumes 30% of Ore dumped at ROM Control - 20% for water sprays (from site experience), flooding the ore fingers will provide up to 4% moisture and reduce the dust by 80%	500	Tonnes / Hour	350	14	67	32	N/A	N/A
Trucks Unloading to Crusher	0.002	0.0011	kg/t	4.9 Mtpa	9	4	Assumes 70% of Ore unloaded direct to Crusher Control - Open hopper with winder break and dust sprays using hypersaline water assume 50% effectiveness based on SDGM.	1167	Tonnes / Hour	350	12	273	129	N/A	N/A
Wheel Loader (FEL) loading Crusher	0.002	0.0011	kg/t	2.1 Mtpa	4	2	Assumes 20% control for water sprays (from site experience), because the ore has been flooded, the dust is very low assume 80% effectiveness	500	Tonnes / Hour	350	12	67	32	N/A	N/A
Dozers (7) on Waste Rock Dumps - 1, 2 and 3	6.0	1.0	kg/h	8400 hours/year	50	8	Assumes dozer operates for 24 hours a day	24.0	Hours / Day	350	24	1659	267	N/A	N/A
Trucks Unloading to Waste Rock Dumps 1, 2 and 3	0.002	0.0011	kg/t	60 Mtpa	116	55	Control - 20% for water sprays (from site experience)	4788	Tonnes / Hour	350	24	2561	1211	N/A	N/A
				TOTAL	**183**	**71**									
Wheel Generated Dust															
29 sources - Hauling (Havana Pit to ROM/Processing Plant/Marginal Stockpile)	2.9	0.6	kg/VKT	87857 km/year	26	6	Emissions calculated by taking the round trip distances and multiplying by the number of trucks required to transport the annual throughput quantity. 7 Mtpa total Ore/Marginal material assumed to be mined equally from Havana and Tropicana Pits. Waste Rock (60 Mtpa) assumed to be taken equally to each Waste Rock Dump (1/3 per route). An emission reduction of 90% is applied for the water trucks based on information supplied by the Proponent. Haulage assumed to occur 24 hours per day	10	VKT/Hour	350	12	29	6	N/A	N/A
24 Sources - Hauling (Tropicana Pit to ROM/Processing Plant/Marginal Stockpile)	2.9	0.6	kg/VKT	73114 km/year	22	5		9	VKT/Hour	350	12	29	6	N/A	N/A
81 Sources - Hauling (Havana to Waste Rock Dump 1)	2.9	0.6	kg/VKT	1303006 km/year	383	82		155	VKT/Hour	350	24	157	34	N/A	N/A
65 Sources - Hauling (Tropicana to Waste Rock Dump 2)	2.9	0.6	kg/VKT	1049823 km/year	309	66		125	VKT/Hour	350	24	157	34	N/A	N/A
58 Sources - Hauling (Havana to Waste Rock Dump 3)	2.9	0.6	kg/VKT	936938 km/year	276	59		112	VKT/Hour	350	24	157	34	N/A	N/A
Graders (2) on Haulage routes	1.1	0.3	kg/VKT	17500	2	1		15	VKT/Hour	350	5	6	2	N/A	N/A
				TOTAL	**1017**	**218**									
Wind Entrainment															
Waste Rock Dump 1	0.02	0.01	kg/ha/hr	476 ha	83	42	Assumed continuous rehabilitation - 1/5 of total landform exposed to wind erosion	95	Hectares	365	24	N/A	N/A	Variable by hour of the year	
Waste Rock Dump 2	0.02	0.01	kg/ha/hr	286 ha	50	25	Assumed continuous rehabilitation - 1/5 of total landform exposed to wind erosion	57	Hectares	365	24	N/A	N/A		
Waste Rock Dump 3	0.02	0.01	kg/ha/hr	545 ha	95	48	Assumed continuous rehabilitation - 1/5 of total landform exposed to wind erosion	109	Hectares	365	24	N/A	N/A		
ROM	0.02	0.01	kg/ha/hr	10 ha	2	1		10	Hectares	365	24	N/A	N/A		
Marginal Stockpiles	0.02	0.01	kg/ha/hr	40 ha	7	4		40	Hectares	365	24	N/A	N/A		
Stockpiles in pit	0.02	0.01	kg/ha/hr	40 ha	7	4		40	Hectares	365	24	N/A	N/A		
In pit erosion (Havana, Tropicana)	0.02	0.01	kg/ha/hr	400 ha	70	35	Assumed 1/5 exposed to wind erosion	100	Hectares	365	24	N/A	N/A		
				TOTAL	**315**	**157**									