AIR QUALITY AND GREENHOUSE GAS ASSESSMENT
RIX'S CREEK
CONTINUATION OF MINING PROJECT

Rix's Creek Mine

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Air Quality and Greenhouse Gas Assessment Rix's Creek Continuation of Mining Project

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EXECUTIVE SUMMARY

This assessment investigates the potential air quality effects that may arise as a result of the proposed continuation of the Rix's Creek Mine. The Rix's Creek Mine is located in the Hunter Valley, NSW and is owned and operated by Bloomfield Collieries Pty Limited.

The assessment is prepared in general accordance with the applicable regulatory requirements and guidelines and forms part of the environmental impact statement prepared for the development application. Environmental impacts are assessed against the relevant criteria for particulates, gasses and odours.

The existing environmental conditions in the area are typical of the Hunter Valley region with common wind flows aligned along a northwest to southeast flow. The ambient air quality is generally fair considering the various industrial and commercial activities of the region and along the prevailing wind axis. The assessment has focused on four indicative mine plan years chosen to represent the highest potential impacts over the life of the mining operation with reference to surrounding operations in the area which would also contribute to dust emissions in each year.

Air dispersion modelling with the CALPUFF modelling suite is utilised in conjunction with estimated emission rates for air pollutants generated by the various activities. The Project has limited its mining rate, footprint and activity in the various stages of the Project life in order to ensure that any potential particulate impacts are maintained within acceptable levels.

Best practice mitigation and management measures are considered to ameliorate any potential adverse air quality impacts and respond to government and community concerns regarding the regional air quality in the Hunter Valley.

The assessment predicts that potential dust impacts would be within acceptable criteria for all but nine receptors. All of these receptors presently experience particulate impacts above criteria. One of the receptors (R1) has a negotiated agreement with the Project, which includes continuation of acquisition rights defined in the Development Consent of October 1989. The other eight receptors are included in the acquisition zone for existing approved projects, and are not predominantly influenced by the Project.

The assessment indicates that adverse air quality impacts are unlikely to arise from diesel combustion and whilst blasting has potential to lead to impacts in the late afternoon, actual impacts would be averted with management measures that prevent blasting during potentially impacting conditions. Odour associated with bio-solids spreading was predicted to meet NSW Odour criteria at all private receptors, and operational procedures will continue to apply to minimise odorous emissions.

The estimated annual greenhouse emissions for the Project is 0.047Mt CO_2-e and equates to approximately 0.009 per cent and 0.031 per cent of the total Australian and NSW greenhouse emissions respectively.

Overall the assessment indicates that whilst adverse air quality impacts may arise at a number of already impacted sensitive receptor locations, these effects can be managed and mitigated effectively.

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for AECOM Australia Pty Ltd on behalf of Rix's Creek Mine. It provides an assessment of the potential air quality impacts associated with the proposed Rix's Creek Continuation of Mining Project.

1.1 Rix's Creek Continuation of Mining Project

1.1.1 Overview

Rix's Creek Mine (the Mine) of Rix's Creek Pty Limited, is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Mine is an open cut coal mine approximately 5 kilometres (km) north-west of Singleton in the Hunter Valley Coalfields of New South Wales (NSW). The Mine currently produces approximately 1.5 million tonnes per annum (Mtpa) of product coal from its existing operations.

Bloomfield is seeking approval for the Rix's Creek Continuation of Mining Project (hereafter referred to as the Project), which relates to the continued operation of the existing open cut coal mine. The Project would allow the Mine to continue to operate as an open cut mine and accessed via its existing infrastructure facilities.

The Project seeks to extend the life of the existing open cut mining operation at Rix's Creek until approximately 2037. The continuation of mining operations will extend in a north-westerly direction and require a modification to Mine Lease 1432 for an out of pit dump. The continuation of operations will utilise the existing mine access, Coal Handling and Preparation Plant (CHPP), coal stockpiling and rail facilities.

1.1.2 Proposed development

The Project seeks to continue the existing mining operation at the Mine and to mine on average 2.5Mtpa ROM coal and up to 4.5Mtpa ROM coal per year in some years. Mining methods will be the same as those currently employed at the Mine, being multi-seam bench open cut techniques. Run of mine (ROM) coal will continue to be processed on-site at the existing CHPP which has capacity to accept the proposed increase in throughput. Product coal will then be transported by rail to the Port of Newcastle. It is estimated that the Mine could yield a total of 32 million saleable tonnes of coal at an overburden ratio of approximately 10.5:1 before coal seams are exhausted.

The components of the proposed development comprise:

- The ongoing use of, and future additions to, the existing mine fleet;
- Use of the existing mine infrastructure facilities including the CHPP;
- Continuation of operating hours - 24 hours a day 7 days a week;
- Use of existing and new rejects and tailings emplacements;
- Rail transport of product coal to the Port of Newcastle;
- Mine closure and rehabilitation; and
- Environmental management.

1.2 Proposed operations relevant to the Air Quality Impact Assessment

The Air Quality Impact Assessment investigates the potential for adverse air quality impacts occurring at surrounding sensitive receptor locations as a result of the Project. Air dispersion modelling is utilised in conjunction with estimated emission rates of air pollutants and the consideration of mitigation measures in ameliorating any potential air quality impacts.

Operations on-site that result in dust emissions primarily involve the movement of material (overburden, coal rejects). Dust emissions may also arise from wind erosion of exposed surfaces with loose material. The use of explosives and diesel fuel can also result in particulate and fume emissions. All significant dust and fume emissions resulting from the proposed operations have been considered.

A range of indicative mine plan years that have been chosen to represent the worst-case conditions associated with air quality have been assessed. These scenarios have been chosen as they would most likely indicate potential impacts from the Project with regard to the amount of air emissions generated and the location of activities with reference to the surrounding sensitive receptor locations.

The predicted effects at receptors in this assessment would therefore be likely to represent the maximum extent of potential air quality impacts associated with the Project.

1.3 Purpose of the report

The purpose of this report is to provide an assessment of the maximum likely effects on air quality that may arise over the life of the proposed Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

1.3.1 Director-General's Requirements

The Rix's Creek Continuation of Mining Project Environmental Impact Statement has been prepared in accordance with Division 4.1, Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) which ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision-making process.

In preparing this Air Quality Impact Assessment, the Director-General's Requirements (DGRs) issued for the Rix's Creek Continuation of Mining Project (SSD 13_6300) on 3 March 2014 have been addressed as required by Clause 74F of the EP&A Act. The key matters raised by the Director-General for consideration in the Air Quality Impact Assessment are outlined in **Table 1-1** along with a reference to where the requirements are addressed in the report.

Table 1-1: Director-General's Environmental Assessment Requirements (SSD 13_6300)

Specific matter	General Requirements	Section
Air quality – including a detailed quantitative assessment of potential:	Construction and operational impacts on all potential receivers, with a particular focus on dust emissions (including PM_{10} and $PM_{2.5}$ emissions, and dust generation from coal transport), as well as diesel and blast fume emissions and odour emissions (from the spreading of biosolids);	This report
	Reasonable and feasible mitigation measures to minimise dust, diesel, blast fume and odour emissions, including evidence that there are no such measures available other than those proposed; and	6, 10, 12, 13
	Monitoring and management measures, in particular real-time air quality monitoring and adaptive management protocols.	6
	A quantitative assessment of potential Scope 1, 2 and 3 greenhouse gas emissions;	15

Specific matter	General Requirements	Section
Greenhouse Gases – including:	A qualitative assessment of the potential impacts of these emissions on the environment; and	15
	An assessment of reasonable and feasible measures to minimise greenhouse gas emissions and ensure energy efficiency.	15

1.3.2 NSW Environmental Protection Authority

This Air Quality Impact Assessment has been prepared in general accordance with the New South Wales (NSW) Environmental Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC, 2005**) and the specific requirements outlined in **Table 1-2** along with a reference to where the requirements are addressed in the report.

Table 1-2: NSW EPA Recommended Director-General's Requirements (SSD 13_6300)

Air Issues – Air Quality	Section
1. Assess the risk associated with potential discharge of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates to environmental harm, risk to human health and amenity.	This report
2. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to: a. proposal location; b. characteristics of the receiving environment; and c. type and quantity of pollutants emitted.	1, 3 and 4
3. Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to: a. meteorology and climate; b. topography; c. surrounding land-use; receptors; and d. ambient air quality	1, 3 and 4
4. Include a detailed description of the proposal. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided.	5 and Appendix D
5. Identification and location information of all fixed and mobile sources of dust/air emissions from the development, including from rehabilitation and potential blast fume gases, needs to be provided. The location of all emissions sources should be clearly marked on a plan for key years of the mine development. The EIS needs to identify all pollutants of concern and estimate emissions by quantity (and size for particles), source(s) and discharge point(s). Note: emissions can be classed as either: a. point (e.g. emissions from stack or vent), or b. fugitive (from wind erosion, leakages or spillages associated with loading or unloading, crushing/screening, conveyors, storage facilities, plant and yard operation, vehicle movements (dust from road, exhaust, loss from load), land clearing and construction works).	5
6. Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.	5
7. Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.	5
8. Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is sufficient uncertainty to warrant a rigorous numerical impact assessment. Air dispersion modelling must be conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005) Note: For coal mines located in the local government areas of Singleton and Muswellbrook, it is not necessary to include an assessment of deposited dust or Total Suspended Particles, but it will be necessary to provide modelling of cumulative 24 hour PM_{10} emissions.	7

Air Issues – Air Quality	Section
9. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997)* and the *POEO (Clean Air) Regulation (2010).*	
10. Detail emission control techniques/practices that will be employed by the proposal and demonstrate that these are best management practice, by applying the procedure outlined in *Coal Mine Particulate Matter Control Best Practice – Site-specific determination guideline* (November 2011).	6
11. Provide an assessment of the project in terms of the priorities and targets adopted under the NSW State Plan 2010 and its implementation plan Action for Air.	
12. Provide an assessment on the potential impact of blast fume and document actions to be taken to prevent the impact of blast fume.	12
Air Issues – Greenhouse gas	**Section**
1. The EA should include a comprehensive assessment of, and report on, the project's predicted greenhouse gas emissions (tCO2e). Emissions should be reported broken down by: a. direct emissions (scope 1 as defined by the Greenhouse Gas Protocol), b. indirect emission from electricity (scope 2), and c. upstream and downstream emissions (scope 3) before and after implementation of the project including annual emissions for each year of the project (construction, operation and decommissioning).	15
2. The EA should include an estimate of the greenhouse emissions intensity (per unit of production). Emissions intensity should be compared with best practice if possible.	15
3. The emissions should be estimated using an appropriate methodology, in accordance with NSW, Australian and international guidelines.	15
4. The proponent should also evaluate and report on the feasibility of measures to reduce greenhouse gas emissions.	15

1.4 Report structure

The report outlines the methodology applied in predicting and assessing potential air quality effects due to the Project. The applicable air quality criteria are described and the local setting of the Project and its surrounds is characterised.

Components of the Project which relate to air emissions are identified and the predicted outcomes of the assessment provided in tabular format and as isopleth diagrams. A discussion on the potential air quality impacts associated with the Project is also provided.

This report is structured as follows:

Section 1 Introduction – outlines the Project and presents the purpose of the report
Section 2 Air quality assessment criteria – outlines the relevant criteria for this study
Section 3 Local setting – describes the location of the Project
Section 4 Existing environment – reviews the existing environmental conditions
Section 5 Modelling scenarios – outlines the modelling scenarios assessed
Section 6 Dust mitigation and management
Section 7 Dispersion modelling approach
Section 8 Accounting for background dust levels
Section 9 Dispersion modelling results
Section 10 Assessment of diesel emissions
Section 11 Assessment of rail transport coal dust emissions
Section 12 Assessment of blast fume emissions

2 AIR QUALITY ASSESSMENT CRITERIA

2.1 Preamble

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the Project and the applicable air quality criteria.

2.2 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Mining activities generate particles in all the above size categories. The great majority of the particles generated are due to the abrasion or crushing of rock and coal and general disturbance of dusty material. These particulate emissions will generally be larger than 2.5µm as sub-2.5µm particles are usually generated through combustion processes or as secondary particles formed from chemical reactions rather than through mechanical processes that dominate emissions on mine sites.

Combustion particulate matter can be more harmful to human health as the particles have the ability to penetrate deep into the human respiratory system, due to their size and can be comprised of acidic and carcinogenic substances.

A study of the particle size distribution from mine dust sources in 1986 conducted by the State Pollution Control Commission (SPCC) of 120 samples found that $PM_{2.5}$ comprised approximately 4.7 percent (%) of the TSP, and PM_{10} comprised approximately 39.1% of the TSP in the samples (**SPCC, 1986**). The emissions of $PM_{2.5}$ occurring from mining activities are small in comparison to the total dust emissions and in practice, the concentrations of $PM_{2.5}$ in the vicinity of mining dust sources are likely to be low.

2.2.1 NSW EPA impact assessment criteria

Table 2-1 summarises the air quality goals that are relevant to this study as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC, 2005**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the Project. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 2-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90µg/m³
PM_{10}	Annual	Total	30µg/m³
	24 hour	Total	50µg/m³
Deposited dust	Annual	Incremental	2g/m²/month
		Total	4g/m²/month

Source: NSW DEC, 2005
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

2.2.2 National Environmental Protection (Ambient Air Quality) Measure

The National Environment Protection Council Act 1994 and subsequent amendments define the National Environment Protection Measure (NEPM) as instruments for setting environmental objectives in Australia.

The NEPM Ambient Air Quality Measure specifies national ambient air quality standards and goals for air pollutants including PM_{10} and $PM_{2.5}$. The standard for PM_{10} is outlined in **Table 2-2**. It is noted that the NEPM permits five days annually above the 24-hour average PM_{10} criterion to allow for bush fires and similar events. Similarly, it is normally the case that, on days where ambient dust levels are affected by such events they are excluded from assessment as per the NSW EPA criterion.

Table 2-2: Standard and goal for PM_{10}

Pollutant	Averaging Period	Maximum concentration	Maximum allowable exceedences
PM_{10}	24 hour	50µg/m³	5 days a year

Source: NEPC, 2003

The NSW EPA currently do not have impact assessment criteria for $PM_{2.5}$ concentrations, the NEPM apply advisory reporting standards for $PM_{2.5}$ to gather sufficient data nationally to facilitate a review. The advisory reporting standards for $PM_{2.5}$ is outlined in **Table 2-3**.

As with each of the NEPM goals, these apply to the average, or general exposure of a population, rather than to "hot spot" locations.

Table 2-3: Advisory standard for $PM_{2.5}$ concentrations

Pollutant	Averaging Period	Advisory Reporting Standard
$PM_{2.5}$	24 hour	25µg/m³
	Annual	8µg/m³

Source: NEPC, 2003

2.2.3 World Health Organization Air Quality Guidelines

The World Health Organization (WHO) promulgates air quality guidelines that aim to avert potential health impacts associated with air pollution. The guidelines are based on expert evaluation of the scientific evidence and include research from low and middle income countries where air pollution levels are at their highest. The guidelines are predominantly based on $PM_{2.5}$ data from large urban cities.

Table 2-4 outlines the WHO air quality guidelines for particulate matter.

Table 2-4: WHO air quality guidelines

Pollutant	Averaging Period	Guideline level
PM_{10}	24 hour (99th percentile)	50µg/m3 *
	Annual	20µg/m3 *
$PM_{2.5}$	24 hour (99th percentile)	25µg/m^3
	Annual	10µg/m^3

Source: WHO, 2005 * Default level

WHO notes that its air quality guidelines are for $PM_{2.5}$, and that the PM_{10} guideline is only provided as a surrogate offering the same level of protection as the $PM_{2.5}$ guideline. This is done because PM_{10} is more commonly measured and there is often no $PM_{2.5}$ data available. The WHO sets the surrogate PM_{10} level at double the $PM_{2.5}$ guideline level because in most large urban cities the PM_{10} level is in fact approximately 1.25 to 2.00 times the $PM_{2.5}$ level **WHO (2005)**.

However, in the area around the Project, the PM_{10} levels are on average three times higher than the $PM_{2.5}$ levels (all data on record for Camberwell and Singleton from 2011 to 2014).

The WHO guidelines state that in areas where the fraction of $PM_{2.5}$ and PM_{10} is known, the PM_{10} level can be set to offer the same level of protection as the $PM_{2.5}$ guideline. Therefore in this situation, the WHO guideline for PM_{10} for the area would be set as an annual average of 30µg/m^3.

The WHO guideline levels apply at the 99Th percentile for short term, 24-hour average levels, (i.e. the fourth highest day of a year) permitting 3 days above the guideline level.

It is noted that the WHO guidelines which could apply in this area are generally equivalent to or less stringent than the NSW guidelines.

2.2.4 NSW Voluntary Land Acquisition and Mitigation Policy

Part of the NSW Voluntary Land Acquisition and Mitigation Policy dated 15 December 2014 and Gazetted on 19 December 2014 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedences of the criteria in **Table 2-5** at any residence or workplace. [1]

Table 2-5: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
PM10	Annual	30µg/m³*		Human health
PM10	24 hour	50µg/m³**		Human health
Total suspended particulates (TSP)	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2014)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).
**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

[1] Applies where any exceedance would be unreasonably deleterious to workers health or carrying out of the business.

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 2-6** at any residence, workplace or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Table 2-6: Particulate matter acquisition criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
PM10	Annual	30µg/m³*		Human health
PM10	24 hour	50µg/m³**		Human health
Total suspended particulates (TSP)	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2014)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).
**Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.

2.3 Other air pollutants

Emissions of other air pollutants will also potentially arise from mining operations and equipment used on-site. Emissions from flaring and diesel powered equipment generally include carbon monoxide (CO), nitrogen dioxide (NO_2) and other pollutants, such as sulphur dioxide (SO_2).

CO is a colourless, odourless and tasteless gas generated from the incomplete combustion of fuels when carbon molecules are only partially oxidised. It can reduce the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

NO_2 is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**USEPA**, **2011**). NO_X may also be generated by blasting activities. NO_2 is generally a small fraction of the total NO_X formed.

Sulfur dioxide (SO_2) is a colourless, toxic gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulphur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to have any widespread impact in NSW, and is generally only associated with large industrial activities. Due to its potential to impact on human health, sulfur is actively removed from fuel to prevent the release and formation of SO_2. The sulfur content of Australian diesel is controlled to a low level by national fuel standards. Therefore the emissions of SO_2 generated from diesel powered equipment at mine sites are generally considered to be too low to generate any significant off-site pollutant concentrations and have not been assessed further in this study.

Table 2-7 summarises the air quality goals for CO and NO_2 considered in this report.

Table 2-7: NSW EPA air quality impact assessment criteria of air toxics

Pollutant	Averaging period	Criterion
Carbon monoxide (CO)	15 minute	100mg/m²
	1 hour	30mg/m²
	8 hour	10mg/m²
Nitrogen dioxide (NO_2)	1 hour	246µg/m³
	Annual	62µg/m³

Source: NSW DEC, 2005
mg/m³ = milligrams per cubic metre

2.4 Odour

2.4.1 Introduction

Odour in a regulatory context needs to be considered in two similar, but different ways depending on the situation.

NSW legislation prohibits emissions that cause offensive odour to occur at any off-site receptor. Offensive odour is evaluated in the field by authorised officers, who are obliged to consider the odour in the context of its receiving environment, frequency, duration, character etc. and to determine whether the odour would interfere with the comfort and repose of the normal person unreasonably. In this context, the concept of offensive odour is applied to operational facilities and relates to actual emissions in the air.

However, in the approval and planning process for proposed new operations or modifications to existing projects, no actual odour exists and it is necessary to consider hypothetical odour. In this context, odour concentrations are used and are defined in odour units. The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose. Thus, by definition, odour less than an odour unit (1 OU), would not be detectable to most people.

The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The *Technical Framework* (NSW DEC, 2006) sets out a framework specifically to deal with such issues.

It needs to be noted that the term "odour" refers to complex mixtures of odours, and not "pure" odour arising from a single chemical. Odour from a single, known chemical rarely occurs (when it does, it is best to consider that specific chemical in terms of its concentration in the air). In most situations odour will be comprised of a cocktail of many substances that is referred to as a complex mixture of odour, or more simply odour.

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point that such odour reaches surrounding receptors. This approach allows the air dispersion model to produce results in terms of odour units.

The NSW criteria for acceptable levels of odour range from 2 to 7OU, with the more stringent 2OU criteria applicable to densely populated urban areas and the 7OU criteria applicable to sparsely populated rural areas, as outlined below.

2.4.2 Complex Mixtures of Odorous Air Pollutants

Table 2-8 presents the assessment criteria as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC, 2005**). This criterion has been refined to take into account population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 2-8: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Source: NSW DEC, 2005

The NSW odour goals are based on the risk of odour impact within the general population of a given area. In sparsely populated areas, the criteria assume there is a lower risk that some individuals within the community would find the odour unacceptable, hence higher criteria apply.

Peak-to-mean factors are applied to account for any odour fluctuation above and below the mean odour level of the 1-hour averaging time. The criteria in **Table 2-8** are compared with modelled results that include peaking factors to account for the time-averaging limitations of air dispersion models. The peak-to-mean factors developed by Katestone Scientific Pty Ltd (1995; 1998) for the NSW EPA are applied to convert the modelled (1-hour) averaging time to 1-second peak concentrations.

A summary of the peak-to-mean values is provided in **Appendix A**.

3 LOCAL SETTING

The Project is located in the Hunter Valley region of NSW, approximately 5 kilometres (km) northwest of Singleton and 3.5km southeast of Camberwell (see **Figure 3-1**). The area surrounding the Project is typically comprised of various open cut and underground coal mining operations, agricultural operations, industrial and commercial activities and a mix of rural residences and urban residential areas.

Figure 3-1 presents the location of the Project in relation to privately-owned and mine-owned sensitive receptors of relevance to this assessment. **Appendix B** provides a detailed list of all the sensitive receptor locations considered in this report.

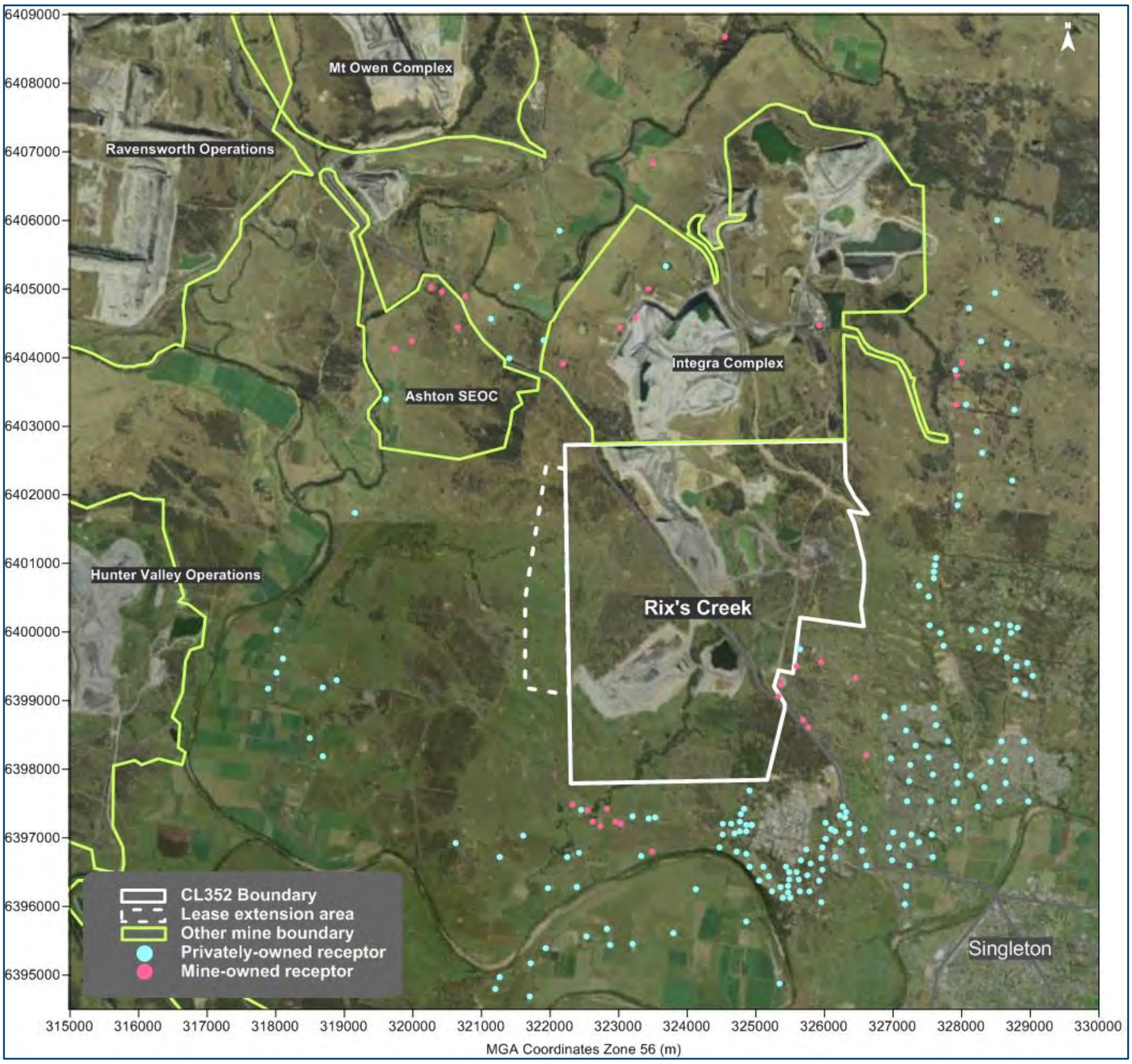

Figure 3-1: Project location

Figure 3-2 presents a three-dimensional visualisation of the topography in the vicinity of the Project. The surrounding topography is characterised to the northwest and southeast of the Project area with the Hunter Valley region, separated by the mountainous features of the Barrington Tops National Park and Wollemi National Park. These topographical features play a significant role in defining the local wind flow area which occurs along the axis of the valley in a northeast and southwest flow.

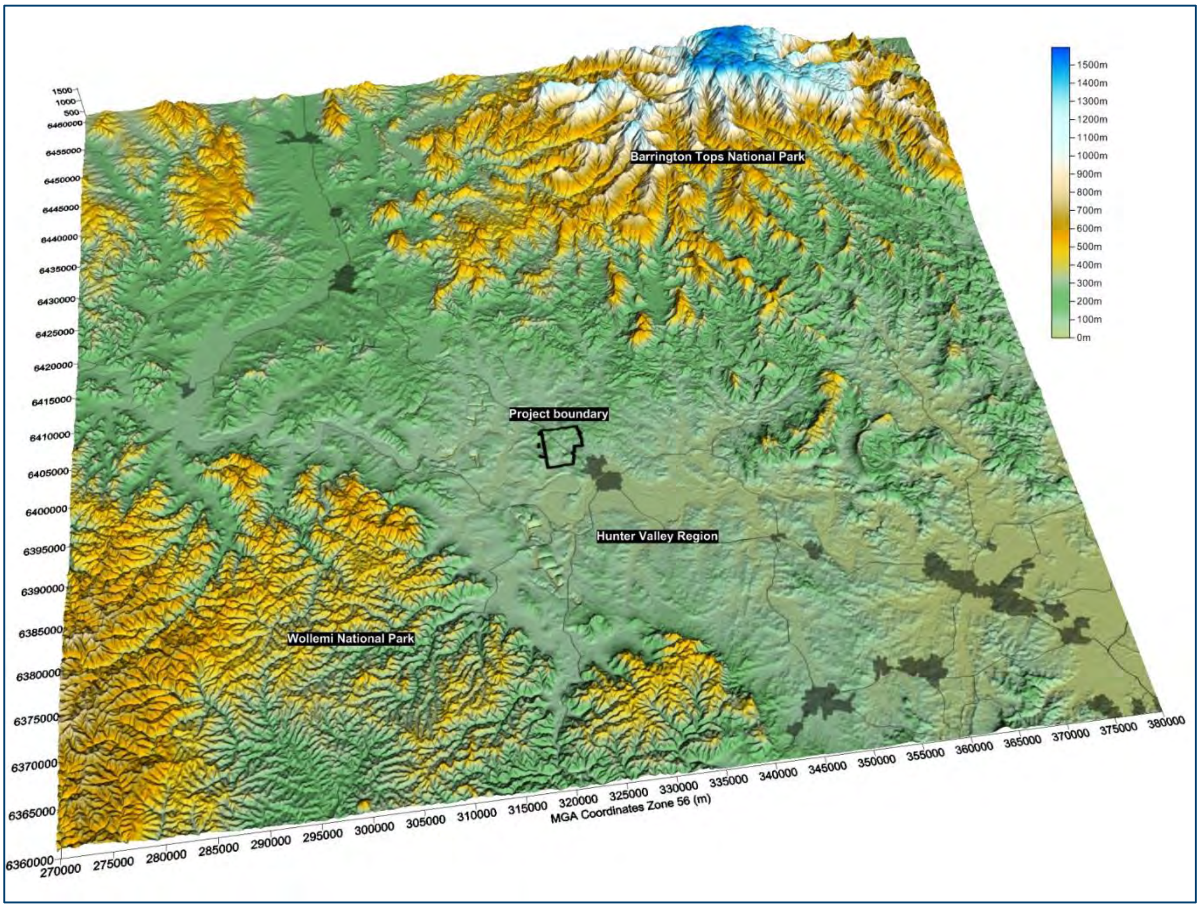

Figure 3-2: Topography surrounding the Project

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

4.1 Local climate

Long term climate data collected at the Bureau of Meteorology (BoM) station, Jerrys Plains Post Office (Station Number 061086), is used to characterise the local climate in the proximity of the Project. The Jerrys Plains Post Office is located approximately 20km west of the Project.

Table 4-1 and **Figure 4-1** present a summary of data from the Jerrys Plains Post Office over a 45 to 128 year period for the various meteorological parameters.

The data indicates that January is the hottest month with a mean maximum temperature of 31.8°C and July is the coldest month with a mean minimum temperature of 3.8°C.

Relative humidity levels exhibit some variability over the day and seasonal fluctuations. Mean 9am relative humidity levels range from 59 per cent in October to 80 per cent in June. Mean 3pm relative humidity levels vary from 42 per cent in October to December to 54 per cent in June.

Rainfall peaks during the summer months and declines during winter. The data show January is the wettest month with an average rainfall of 77.1mm over 6.4 days and August is the driest month with an average rainfall of 36.1mm over 5.2 days.

Wind speeds tend to have a greater spread between the 9am and 3pm conditions during the warmer months compared to the colder months. The mean 9am wind speeds range from 8.6km/h in April to 11.7km/h in September. The mean 3pm wind speeds vary from 11.0km/h in May to 14.7km/h in September.

Table 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (°C)	31.8	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.3	29.1	31.2
Mean min. temperature (°C)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7
Rainfall												
Rainfall (mm)	77.1	73.1	59.7	44.0	40.7	48.1	43.4	36.1	41.7	51.9	61.9	67.5
Mean No. of rain days (≥1mm)	6.4	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.8	6.3	6.3
9am conditions												
Mean temperature (°C)	23.4	22.7	21.2	18.0	13.6	10.6	9.4	11.4	15.3	19.0	21.1	23.0
Mean relative humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61
Mean wind speed (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9
3pm conditions												
Mean temperature (°C)	29.8	28.9	27.2	24.1	20.1	17.1	16.4	18.2	21.2	24.2	26.9	29.0
Mean relative humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42
Mean wind speed (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2

Source: **Bureau of Meteorology, 2014**

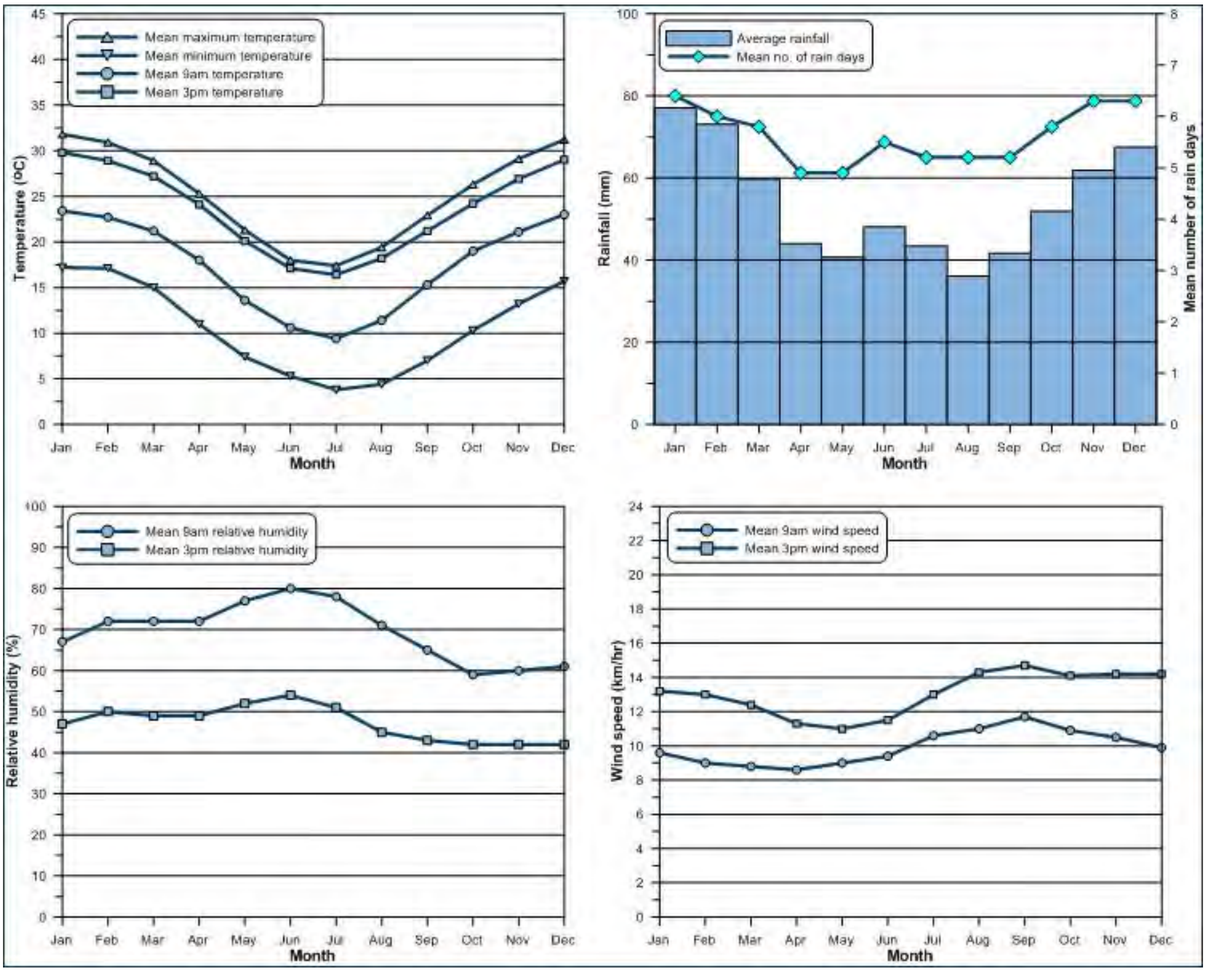

Figure 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

4.2 Local meteorological conditions

Rix's Creek mine operate a 10m meteorological station to assist with environmental management of site operations and have since commissioned a new weather station in 2014 which is located toward the western portion of the mining operations. The location of these stations is shown in **Figure 4-2**.

Annual and seasonal windroses prepared from data collected at the old weather station for the 2012 calendar period are presented in **Figure 4-3**. A windrose based on the available data collected at the new weather station is presented in **Figure 4-4**.

Analysis of the windroses in **Figure 4-3** shows that the most common winds on an annual basis are from the east-southeast and the northwest sectors. Very few winds originate from the northeast and southwest quadrants. This wind distribution pattern is as expected of the area considering the location of the station in relation to local features and the wider topographical characteristics.

In the summertime the wind predominately occurs from the east-southeast and southeast. During autumn, winds from northwest and east-southeast dominate the distribution and it appears similar to the annual distribution. In winter, winds from the northwest and west-northwest dominate the distribution. During spring, winds are seen to occur from east-southeast, west-northwest and northwest with few winds from the other directions.

The windrose in **Figure 4-4** generally shows winds originating from the northwest and west-northwest with fewer winds from the south-southeast and southeast. The available data indicate the weather station is recording data expected of the location.

Figure 4-2: Rix's Creek meteorological station locations

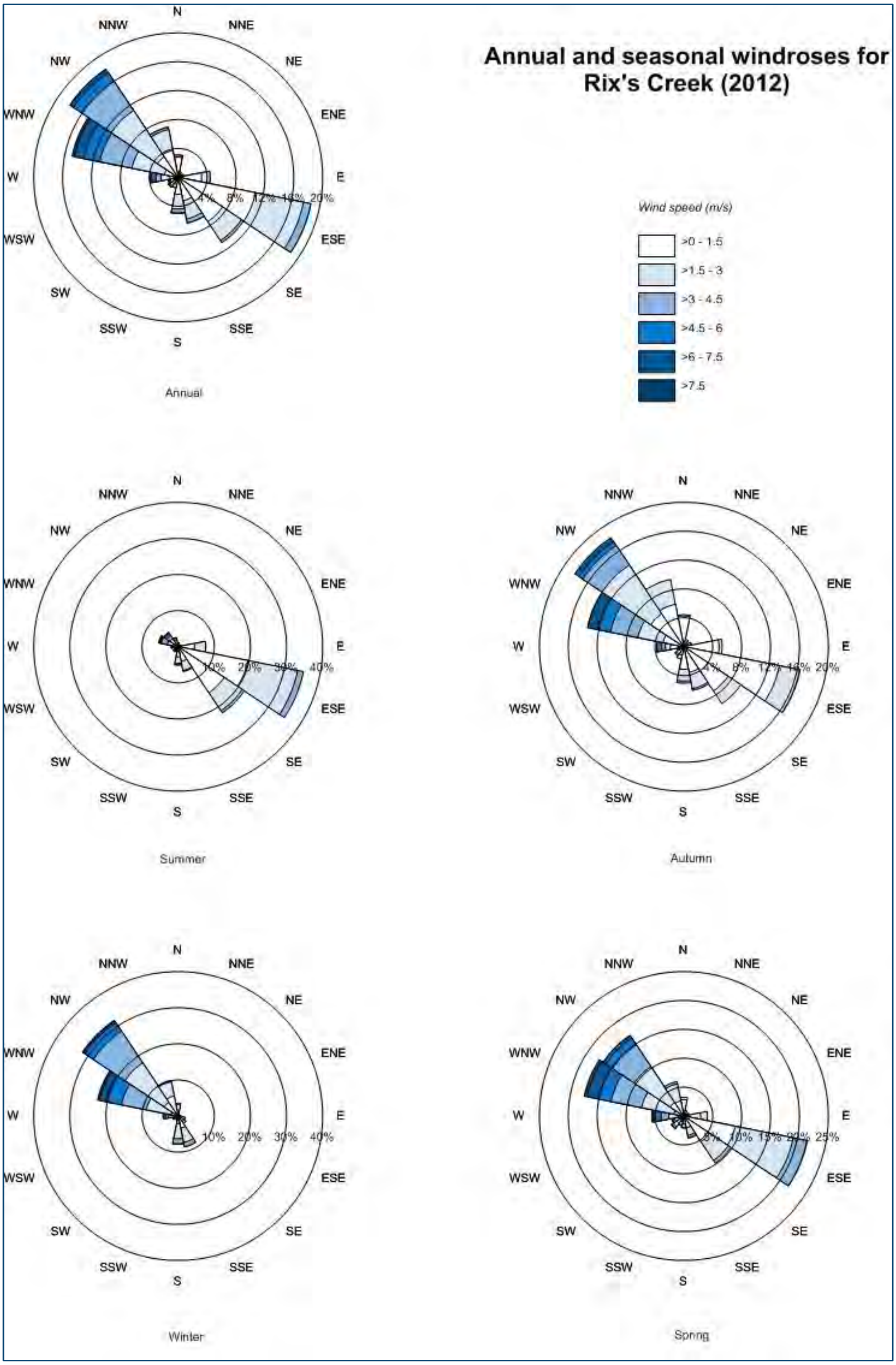

Figure 4-3: Annual and seasonal windroses for Rix's Creek (2012)

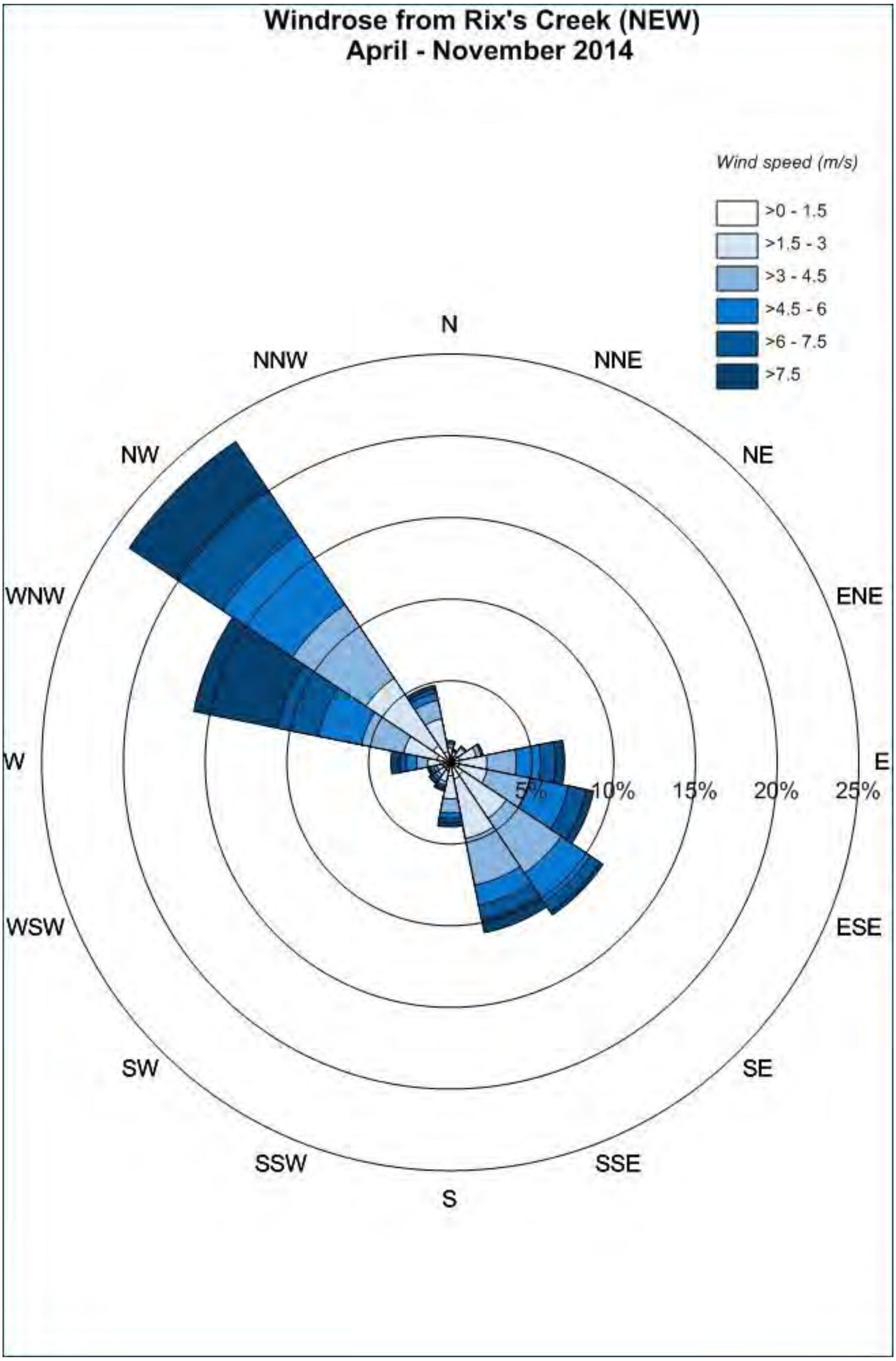

Figure 4-4: Windrose for Rix's Creek new weather station (April – November 2014)

4.3 Ambient air quality

The main sources of particulate matter in the wider area include active mining, agricultural activities, emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters, urban activity and various other commercial and industrial activities. Other pollutant emissions considered in the study include NO_2 and CO, which can potentially arise from mining operations such as the diesel powered equipment used on-site and methane flaring operations, and power generation, including the Liddell, Bayswater and Redbank power stations. This section reviews the ambient monitoring data collected from a number of ambient monitoring locations in the vicinity of the Project.

The air quality monitors reviewed in this assessment include five Tapered Element Oscillating Microbalances (TEOMs), two Beta Attenuation Mass (BAM) monitors measuring $PM_{2.5}$, 15 High Volume Air Samplers (HVAS) measuring either TSP or PM_{10}, 30 dust deposition gauges and three NO_2 monitors.

Table 4-2 lists the monitoring stations reviewed in this section which includes data from surrounding mining operations and NSW EPA monitoring stations. **Figure 4-5** and **Figure 4-6** shows the approximate location of each of the monitoring stations. **Appendix C** provides a summary of the monitoring data collected at Rix's Creek HVAS stations reviewed in this assessment.

Table 4-2: Summary of ambient monitoring stations

Monitoring site ID	Type	Monitoring data review period
Singleton	TEOM	December 2010 – December 2014
Maison Dieu	TEOM	April 2011 – December 2014
Camberwell	TEOM	July 2011 – December 2014
Singleton NW	TEOM	July 2011 – December 2014
Singleton South	TEOM	December 2011 – December 2014
Singleton	BAM – $PM_{2.5}$	December 2010 – December 2014
Camberwell	BAM – $PM_{2.5}$	July 2011 – December 2014
Rix's Creek	HVAS – PM_{10}	March 2010 – December 2013
Mines Rescue	HVAS – PM_{10}	January 2010 – December 2013
Retreat	HVAS – PM_{10}	January 2010 – December 2013
HV1 – (INTEGRA)	HVAS – PM_{10}	January 2012 – December 2013
HV3 – (INTEGRA)	HVAS – PM_{10}	January 2012 – December 2013
HVAS19 – (RAVOPS)	HVAS – PM_{10}	January 2012 – December 2012
Rix's Creek	HVAS – TSP	January 2010 – December 2013
Mines Rescue	HVAS – TSP	January 2010 – December 2013
Retreat	HVAS – TSP	January 2010 – December 2013
HV1 – (INTEGRA)	HVAS – TSP	January 2012 – December 2013
HV3 – (INTEGRA)	HVAS – TSP	January 2012 – December 2013
HVAS2 – (RAVOPS)	HVAS – TSP	January 2012 – December 2012
Site 2 – (ASHTON)	HVAS – TSP	January 2011 – December 2013
Site 3 – (ASHTON)	HVAS – TSP	January 2011 – December 2013
Site 8 – (ASHTON)	HVAS – TSP	January 2011 – December 2013
DDG1	Dust gauge	January 2010 – December 2013
DDG2	Dust gauge	January 2010 – December 2013
DDG3	Dust gauge	January 2010 – December 2013
DDG5	Dust gauge	January 2010 – December 2013
DDG6	Dust gauge	January 2010 – December 2013
DDG7	Dust gauge	January 2010 – December 2013
DDG8	Dust gauge	January 2010 – December 2013

Monitoring site ID	Type	Monitoring data review period
DDG9	Dust gauge	January 2010 – December 2013
DDG10	Dust gauge	January 2010 – December 2013
DDG11	Dust gauge	January 2010 – December 2013
DDG13	Dust gauge	January 2010 – December 2013
DDG14	Dust gauge	January 2010 – December 2013
DDG15	Dust gauge	January 2010 – December 2013
DDG16	Dust gauge	January 2010 – December 2013
DDG17	Dust gauge	January 2010 – December 2013
DDG18	Dust gauge	January 2010 – December 2013
DDG19	Dust gauge	January 2010 – December 2013
DDG20	Dust gauge	January 2010 – December 2013
DDG21	Dust gauge	January 2010 – December 2013
DDG22	Dust gauge	January 2010 – December 2013
DDG23	Dust gauge	January 2010 – December 2013
DDG25	Dust gauge	January 2010 – December 2013
DDG26	Dust gauge	January 2010 – December 2013
DDG27	Dust gauge	January 2010 – December 2013
DDG28	Dust gauge	January 2010 – December 2013
DDG29	Dust gauge	January 2010 – December 2013
DDG30	Dust gauge	January 2010 – December 2013
DDG31	Dust gauge	January 2010 – December 2013
DDG32	Dust gauge	January 2010 – December 2013
DDG33	Dust gauge	January 2010 – December 2013
Singleton	NO_2 monitor	November 2011 – December 2014
Muswellbrook	NO_2 monitor	November 2011 – December 2014
Beresfield	NO_2 monitor	January 2010 – December 2014

Figure 4-5: Monitoring locations

Figure 4-6: Dust deposition monitoring locations

4.3.1 PM_{10} monitoring

Ambient PM_{10} monitoring using TEOM and HVAS monitors is conducted by the NSW EPA (OEH), Rix's Creek and other neighbouring mining operations at locations in the wider area surrounding the Project location. The location of each of these monitors is shown in **Figure 4-5**. The monitoring records all ambient data, including all existing emission sources in the vicinity of the Project location that contributed to the measurements.

4.3.1.1 TEOM monitoring

A summary of the available data from the NSW EPA monitoring stations is presented in **Table 4-3**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-7**.

A review of **Table 4-3** indicates that the annual average PM_{10} concentrations for each monitoring station were below the relevant criterion of 30µg/m^3. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m^3 at times during the review period.

Figure 4-7 shows the trend of the recorded PM_{10} concentrations for the NSW EPA TEOM monitoring stations. Variation between the monitoring data sites are largely attributed to the proximity of these monitors to various dust sources located in the surrounding area.

It can be seen from **Figure 4-7** that PM_{10} concentrations are nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and pollen levels.

Table 4-3: Summary of PM_{10} levels from NSW EPA TEOM monitoring (µg/m³)

	2010	2011	2012	2013	2014(1)
	Annual average				
Singleton(2)	20.0	19.8	22.3	23.3	21.4
Maison Dieu(3)	-	22.1	25.8	25.8	22.7
Camberwell(4)	-	24.4	26.4	27.8	24.8
Singleton NW(4)	-	24.8	25.9	25.9	22.8
Singleton South(5)	-	13.4	19.0	20.2	18.2
	Maximum 24-hour average				
Singleton(2)	32.8	60.5	63.6	62.7	78.9
Maison Dieu(3)	-	78.3	87.7	84.2	63.7
Camberwell(4)	-	85.3	81.6	104.8	79.7
Singleton NW(4)	-	72.2	85.2	91.7	64.7
Singleton South(5)	-	18.1	52.3	60.3	44.8

(1)Data available till December 2014
(2)Data available from December 2010
(3)Data available from April 2011
(4)Data available from July 2011
(5)Data available from December 2011

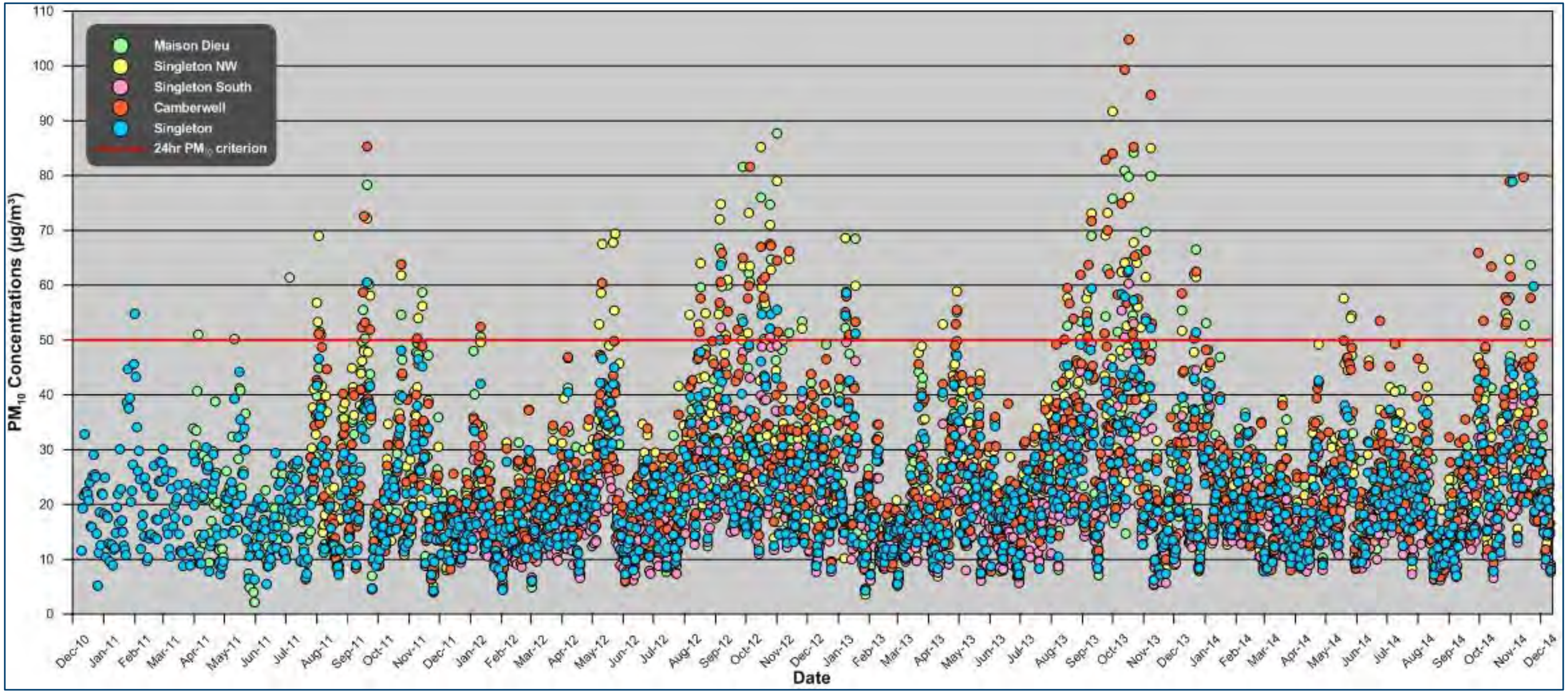

Figure 4-7: TEOM 24-hour average PM_{10} concentrations at NSW EPA monitors

4.3.1.2 HVAS monitoring

A summary of the PM_{10} readings from the six HVAS PM_{10} monitoring stations is presented in **Table 4-4**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-8**. The data in **Table 4-4** indicate that the annual average PM_{10} concentrations for each of the monitoring stations were below the relevant criterion of 30µg/m³ for the years reviewed.

The maximum 24-hour average concentrations at times exceeded the relevant criterion of 50µg/m³ at these monitors and can be identified as regional events indicated by monitors showing elevated levels over the same period. This is seen in **Figure 4-8** during late 2012 with elevated levels occurring due to widespread bushfire activity.

Table 4-4: Summary of PM_{10} levels from HVAS monitoring (µg/m³)

	2010	2011	2012	2013
	Annual average			
Rix's Creek(1)	20.3	24.4	25.2	29.5
Mines Rescue	22.7	19.3	19.6	20.5
Retreat	24.7	23.5	22.8	25.5
HV1(2)	-	-	19.7	21.2
HV3 (2)	-	-	24.0	20.6
HVAS19 (3)	-	-	21.8	-
	Maximum 24-hour average			
Rix's Creek(1)	43.0	107.0	94.0	129.0
Mines Rescue	58.0	51.5	61.0	53.0
Retreat	100.0	122.0	68.0	84.0
HV1(2)	-	-	61.0	73.0
HV3 (2)	-	-	81.0	56.0
HVAS19 (3)	-	-	82.1	-

(1) Data available from March 2010 (2) Data available from January 2012 (3) Data available from January 2012 till December 2012

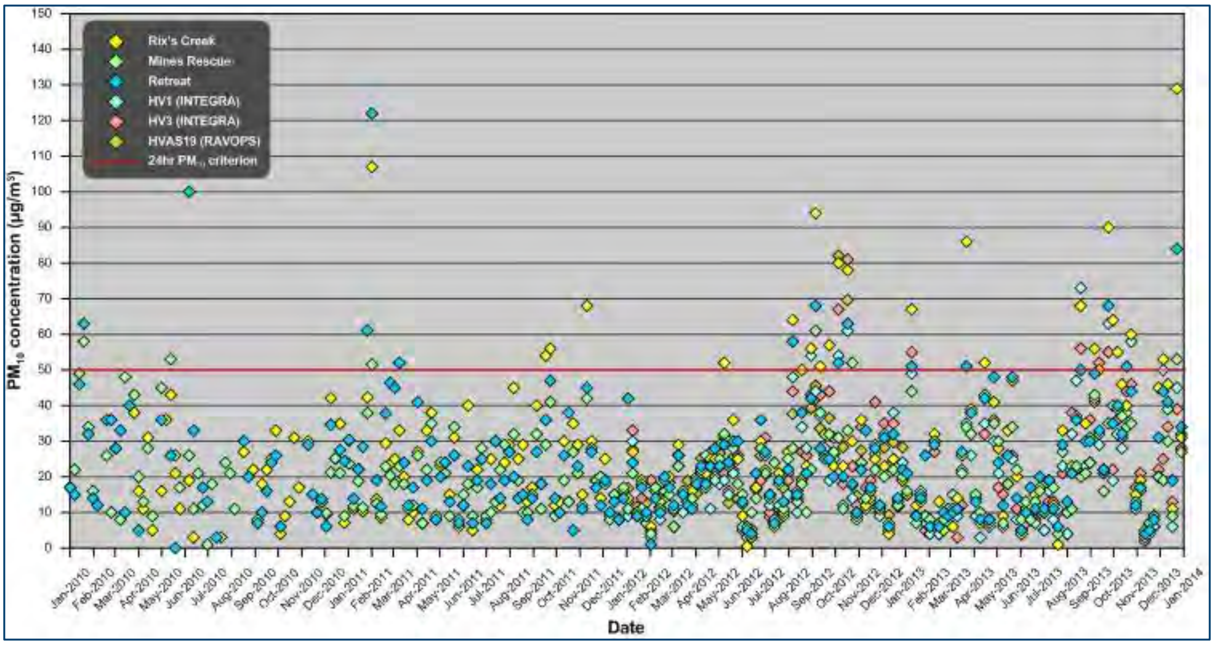

Figure 4-8: HVAS 24-hour average PM_{10} concentrations

4.3.2 TSP monitoring

TSP monitoring data are available from nine HVAS monitors surrounding the Rix's Creek Mine (see **Figure 4-5**). A summary of the results collected between 2010 and 2013 at these stations is shown in **Table 4-5**. Recorded 24-hour average TSP concentrations are presented in **Figure 4-9**.

The monitoring data presented in **Table 4-5** indicate that the annual average TSP concentrations for each monitoring station reviewed were below the annual average criterion of 90µg/m^3. **Figure 4-9** shows that the recorded 24-hour average TSP concentrations at each monitor follow a generally similar trend with levels nominally highest during warmer months.

Table 4-5: Summary of annual average TSP levels from HVAS monitoring (µg/m³)

	2010	2011	2012	2013
Rix's Creek	65.8	70.4	65.2	76.7
Mines Rescue	50.6	49.5	50.1	56.4
Retreat	63.0	61.6	65.8	86.0
HV1 - Lambkin	-	-	43.4	49.9
HV3 - Hardy	-	-	66.4	66.4
HVAS2 – Camberwell	-	-	65.3	-
Station 2	-	57.4	70.7	66.7
Station 3	-	63.7	75.3	70.8
Station 8	-	58.8	72.7	72.7

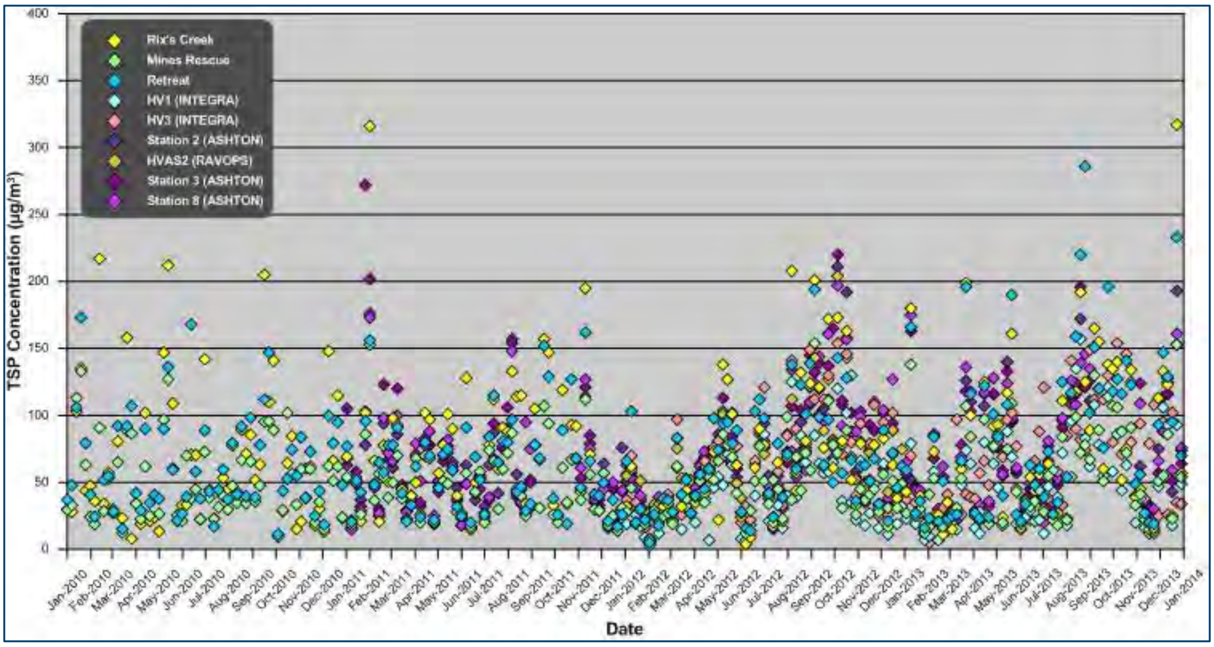

Figure 4-9: HVAS 24-hour average TSP concentrations

4.3.3 $PM_{2.5}$ monitoring

A summary of the ambient $PM_{2.5}$ readings from the NSW EPA monitoring stations are presented in **Table 4-6**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-10**.

Table 4-6 indicates that the annual average $PM_{2.5}$ concentrations for the Singleton monitor did not exceed the NEPM advisory reporting standard of 8µg/m³. In contrast the annual average $PM_{2.5}$ concentrations for the Camberwell monitor were above the advisory reporting standard in 2011 and 2013.

The maximum 24-hour average $PM_{2.5}$ concentrations recorded at these stations were found to exceed the advisory reporting standard of 25µg/m³ at times during the review period and can be generally attributed to bushfire events occurring during these periods.

The seasonal trends in $PM_{2.5}$ concentrations can be seen in **Figure 4-10**. It is unlikely that the trends in the $PM_{2.5}$ levels observed in the data are due to mining activity as mining produces a relatively steady level of $PM_{2.5}$ particulate emissions over the entire year. It can be reasonably inferred that the seasonal variation in ambient $PM_{2.5}$ levels are likely to be governed by many non-mining background sources such as wood heaters and motor vehicles and that these sources appear to govern the population exposure to $PM_{2.5}$ in this area.

This is reflected in the recent CSIRO study (**CSIRO, 2013**) that characterises fine particulate matter in the Hunter Valley region which found that wood burning activities in winter make up an average of 38 per cent of the $PM_{2.5}$ in Singleton.

Table 4-6: Summary of $PM_{2.5}$ levels from NSW EPA BAMs monitoring (µg/m³)

	2010	2011	2012	2013	2014[(1)]
	Annual average				
Singleton[(2)]	6.5	7.6	8.0	7.9	7.8
Camberwell[(3)]	-	8.5	7.5	8.2	7.9
	Maximum 24-hour average				
Singleton[(2)]	10.8	21.5	19.5	22.6	28.5
Camberwell[(3)]	-	22.8	19.6	29.5	31.6

[(1)]Data available till December 2014

[(2)]Data available from December 2010

[(3)]Data available from July 2011

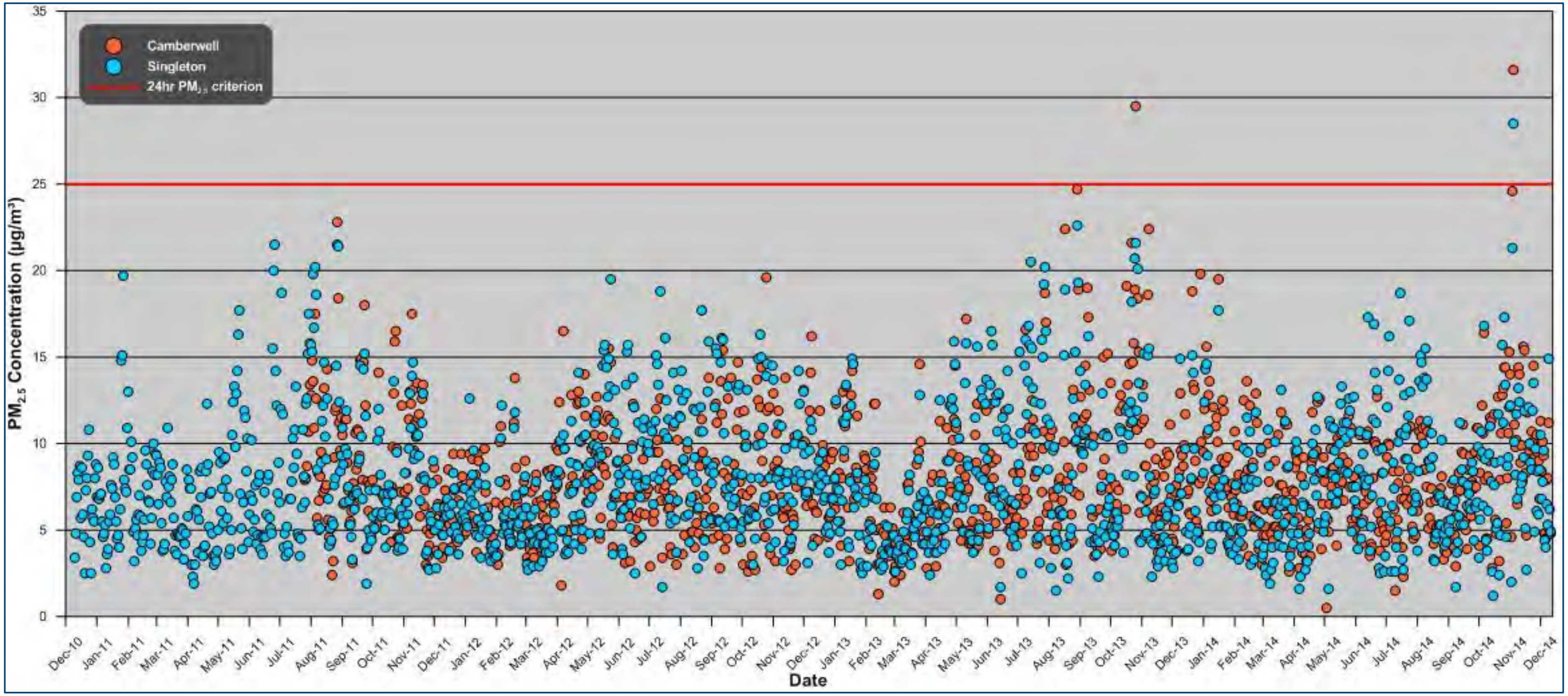

Figure 4-10: 24-hour average $PM_{2.5}$ concentrations at NSW EPA monitors

4.3.4 Dust deposition monitoring

The location of the dust deposition monitoring sites reviewed in this assessment are shown in **Figure 4-6**. **Table 4-7** summarises the annual average deposition levels at each gauge from 2010 to 2013.

Field notes accompanying the monitoring indicate that some of the samples were contaminated with materials such as bird droppings, insects or plant matter. This is a relatively common occurrence for this type of monitoring, and accordingly, contaminated samples have been excluded from the reported annual average results.

All gauges recorded an annual average insoluble deposition level below the criterion of 4g/m^2/month, with the exception of DDG6 and DDG7 in 2012 and 2013. The elevated levels at DDG6 appear to be influenced by a local source when comparing with the measured levels at the nearby DDG28 monitor which is lower. The DDG7 is likely to be influenced by activities occurring on the mine site and is not representative of sensitive locations in the wider area. In general, the air quality surrounding the site in terms of dust deposition is considered good.

Table 4-7: Annual average dust deposition (g/m²/month)

	2010	2011	2012	2013
DDG1	2.4	2.1	4.0	1.8
DDG2	1.5	2.9	2.1	1.8
DDG3	1.4	1.9	1.3	1.4
DDG5	1.8	1.9	2.4	2.6
DDG6	3.8	3.7	**5.4**	**5.0**
DDG7	2.0	3.0	**6.4**	**4.6**
DDG8	0.9	2.3	1.1	1.3
DDG9	1.0	1.1	1.2	1.1
DDG10	1.1	1.0	1.4	1.0
DDG11	1.1	1.7	2.3	1.6
DDG13	1.5	1.2	1.7	1.3
DDG14	1.5	2.4	2.1	1.8
DDG15	1.7	2.0	1.9	1.4
DDG16	1.5	2.2	2.0	2.0
DDG17	1.3	1.8	1.4	1.2
DDG18	1.3	2.3	1.4	1.3
DDG19	1.6	2.3	3.6	2.5
DDG20	1.8	2.0	2.4	2.3
DDG21	1.5	1.6	1.7	1.6
DDG22	1.6	1.6	1.5	1.5
DDG23	2.6	3.3	2.9	2.6
DDG25	3.4	3.4	3.7	3.4
DDG26	1.6	1.6	2.1	2.4
DDG27	1.8	2.7	1.7	2.5
DDG28	2.0	3.2	2.6	2.3
DDG29	1.1	1.4	2.3	1.7
DDG30	1.4	1.1	2.3	1.4
DDG31	1.5	2.2	1.8	1.7
DDG32	1.9	2.3	2.0	2.2
DDG33	1.4	1.6	1.5	1.5

4.3.5 Nitrogen dioxide

Figure 4-11 presents the maximum daily 1-hour average NO_2 concentrations from the Beresfield, Muswellbrook and Singleton NSW EPA monitoring sites from 2010 to December 2014. As shown in **Figure 4-11**, the Muswellbrook and Singleton monitoring sites were commissioned in November 2011 and data are only available after this date for these locations.

Ambient air quality monitoring data collected at these locations would include emissions from sources such as the Liddell, Bayswater and Redbank power stations, methane gas flaring operations at mining operations as well as other various combustion sources.

The monitoring data recorded are well below the NSW EPA 1-hour average goal of 246µg/m³ during this period at all of the monitors. The data in **Figure 4-11** indicate that levels of NO_2 are relatively low compared to the criterion level and show a seasonal fluctuation.

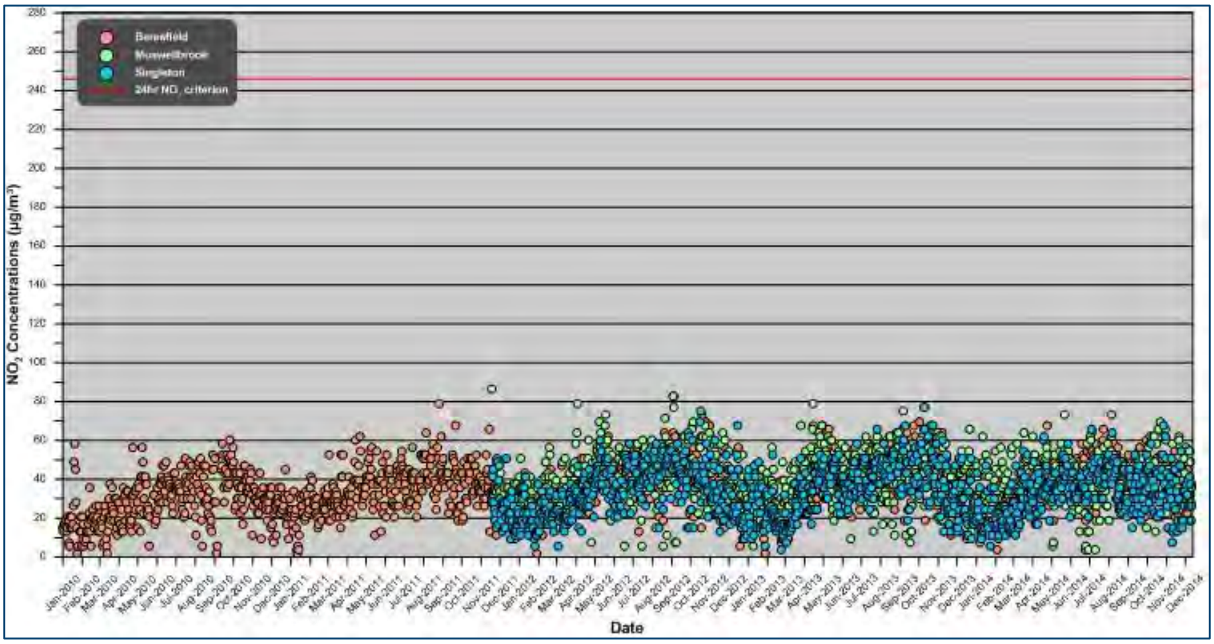

Figure 4-11: Daily 1-hour maximum NO_2 concentrations – Beresfield, Muswellbrook and Singleton

4.3.6 Carbon monoxide

The NSW EPA monitoring sites at Beresfield, Muswellbrook and Singleton do not record ambient concentrations of CO. Combustion activities are the cause of CO emissions and spatially there is very little such activity in the area apart from power generation, motor vehicles and wood heaters. Therefore, ambient concentrations of CO are expected to be low.

Ambient air quality goals for CO are set at higher concentration levels than NO_2 goals. Based on the NO_2 monitoring data which are low compared to the goals, and consideration of the typical mix of ambient pollutant levels, the indication is that ambient levels of CO would similarly also be well below the air quality goals.

5 MODELLING SCENARIOS

The assessment considers four mine plan years. These were selected to represent a range of potential impacts over the life of the Project and were the years with the likely highest dust effects, determined by reference to the location of the operations and quantity of dust generated in each year. The four mine plan years nominally represent years 2017, 2020, 2023 and 2026.

Indicative mine plans for each of the respective years are presented in **Figure 5-1**.

The indicative mine plan years show that active extraction predominately occurs in the West Pit and gradually progresses in a northerly direction away from Singleton (the remaining open cut resource, in the North Pit, will be mined at very reduced rates at the end of the project). Overburden emplacement in the early years occurs in areas to the east of the New England Hwy to fill the exposed voids before being emplaced behind the progression of the West Pit in the later years.

In Year 2017, mining occurs in the western portion of the West Pit with overburden material transported to emplacement areas to the south with the majority of the overburden material transported to the eastern areas across the New England Hwy.

In Year 2020, active mining occurs in two areas of the West Pit with all overburden material emplaced in areas to the east across the New England Hwy. As for 2017, ROM coal is transported via the existing haul route to the CHPP.

During 2023, production levels at the Project may increase significantly with activity concentrated in the West Pit. All overburden emplacement occurs behind the progression of the active mining and additional overburden emplacement areas to the west are utilised. ROM coal is transported across the New England Hwy via a new crossing to the north of the pit.

In Year 2026, mining is focused in areas to the east of the West Pit close to the New England Hwy with overburden emplacement to the south of the pit. The additional overburden emplacement areas to the west are completed and two haulage routes are utilised to transport ROM material to the CHPP for processing.

Active rehabilitation of areas occurs in all years following the general progression of the overburden emplacement areas as the landform is completed.

Beyond the Year 2026, production levels at the Project would decrease compared to the assessed years. Dust emissions generated at the site would be lower and hence the potential for impacts during these years is expected to be lower.

The modelling scenarios have considered the operation of the existing rail loop with product haulage to the product stockpile to the north of the site. Rix's Creek have proposed the construction and operation of a new rail loop and product stockpile located immediately to the north of the existing infrastructure area. This operation has been assessed in a previous air quality assessment which determined that air quality impacts would be negligible (**PAEHolmes, 2011**). For the purposes of this assessment, a worst-case operating scenario was considered where the operation of this infrastructure does not occur and has assumed product material would continue to be transported off-site via the existing rail loop.

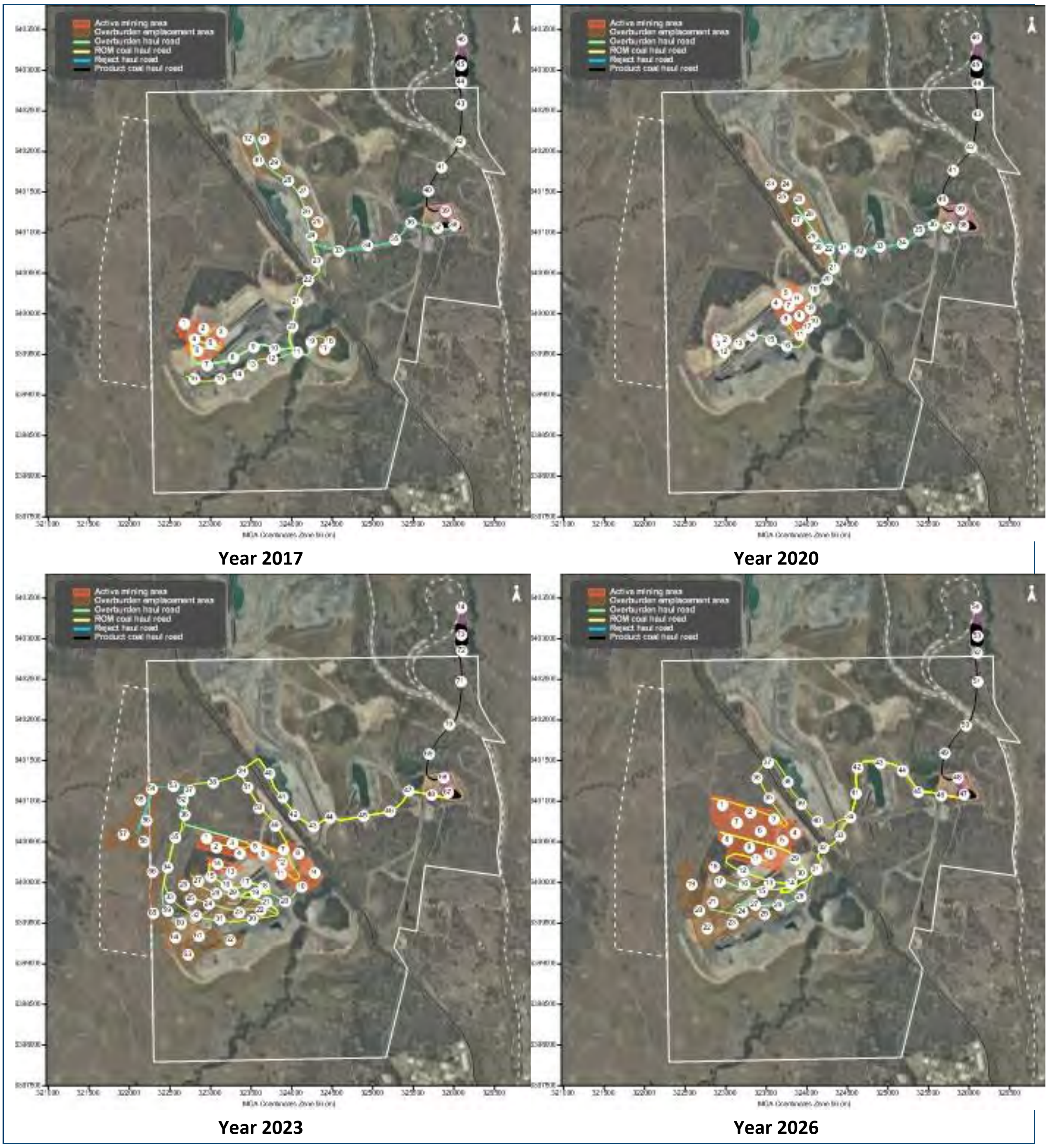

Figure 5-1: Indicative mine plans for the Project

5.1 Emission estimation

5.1.1 The Project

For each of the four indicative years selected to represent the key stages over the life of the Project, the rate of dust emission has been calculated by analysing the various types of dust generating activities taking place in each year and applying suitable emission factors.

The emission factors applied are considered the most applicable and representative factors available for calculating the dust generation rates for the proposed activities. The emission factors were sourced mainly from studies supported by the US EPA and from Australian studies and site specific data where possible. Total dust emissions from all significant dust generating activities for the Project are presented in **Table 5-1**. Detailed emission inventories and calculations are presented in **Appendix D**.

Table 5-1: Estimated emissions for the Project (kg of TSP)

ACTIVITY	2012	2017	2020	2023	2026
OB - Dozers stripping topsoil	16,270	21,967	21,425	40,775	19,121
OB - Drilling	8,806	11,890	11,596	22,069	10,349
OB - Blasting	20,229	42,852	40,254	110,407	30,290
OB - Dragline	36,609	-	-	-	-
OB - Loading OB to haul truck	32,363	52,804	51,500	98,013	45,962
OB - Hauling to emplacement area – 1	7,181	110,575	172,550	140,740	148,497
OB - Hauling to emplacement area – 2	29,323	48,653	220,310	263,594	115,497
OB - Hauling to emplacement area – 3	150,108	393,963	-	145,431	103,123
OB - Hauling to emplacement area – 4	41,492	-	-	140,740	-
OB - Hauling to emplacement area – 5	5,785	-	-	-	-
OB - Hauling to emplacement area – 6	28,525	-	-	-	-
OB - Emplacing at area – 1	1,942	14,785	18,025	19,603	13,789
OB - Emplacing at area – 2	4,531	7,393	33,475	28,424	18,385
OB - Emplacing at area – 3	13,916	30,626	-	30,384	13,789
OB - Emplacing at area – 4	4,207	-	-	19,603	-
OB - Emplacing at area – 5	647	-	-	-	-
OB - Emplacing at area – 6	7,120	-	-	-	-
OB - Dozers in pit	53,029	71,599	69,830	132,899	62,322
OB - Dozers on dump and rehab	159,086	214,797	209,491	398,697	186,965
CL - Dozers ripping/pushing/clean-up	157,717	140,154	147,370	242,602	122,824
CL - Loading ROM coal to haul truck	138,696	123,251	129,596	213,343	108,011
CL - Hauling ROM to hopper – 1	10,537	33,339	16,782	55,191	19,219
CL - Hauling ROM to hopper – 2	5,428	26,482	30,456	58,015	14,422
CL - Hauling ROM to hopper – 3	13,783	-	-	30,860	19,395
CL - Hauling ROM to hopper – 4	17,122	-	-	-	-
CHPP - Unloading ROM to hopper	69,348	61,625	64,798	106,672	54,006
CHPP - Rehandle ROM at hopper	6,935	6,163	6,480	10,667	5,401
CHPP - Dozer pushing ROM coal	25,944	25,944	25,944	25,944	25,944
CHPP - Dozer pushing Product coal	5,501	5,501	5,501	5,501	5,501
CHPP - Loading Product to Truck	219	220	228	373	189
CHPP - Hauling Product to hopper	24,886	24,328	25,204	41,240	20,920
CHPP - Unloading Product to hopper	219	220	228	373	189
CHPP - Loading Product coal to stockpile	164	165	171	280	142
CHPP - Conveying product to train loadout	185	185	185	185	185
CHPP - Loading Product coal to train	66	66	68	112	57
CHPP - Loading rejects	176	141	151	251	127
CHPP - Hauling rejects	23,108	15,671	11,900	52,715	18,295
CHPP - Unloading rejects	176	141	151	251	127
WE - Overburden emplacement areas	154,176	157,330	113,179	330,778	204,634
WE - Open pit	119,136	72,533	88,651	133,502	216,898
WE - ROM stockpiles	2,763	2,763	2,763	2,763	2,763
WE - Product stockpiles	5,798	6,469	6,469	6,469	6,469
Grading roads	47,445	47,445	47,445	47,445	47,445
Total TSP emissions (kg/yr)	**1,450,694**	**1,772,038**	**1,572,177**	**2,956,910**	**1,661,249**

OB – overburden, CL – coal, CPP – coal preparation plant, WE – wind erosion

The estimated dust emissions presented in **Table 5-1** reflect the application of best practice dust mitigation currently being implemented at the site in accordance with its Air Quality Management Plan (AQMP) and Pollution Reduction Program (PRP) (refer to **Section 6**). The dust control measures are described in the following section.

5.1.2 Other mining operations

In addition to the estimated dust emissions from the Project, emissions from all nearby approved mining operations were also modelled, per their current consent (or current proposed project), to assess potential cumulative dust effects.

Emissions estimates from these sources were derived from information provided in the air quality assessments available in the public domain at the time of modelling. These estimates are likely to be conservative, as in many cases, mines do not continually operate at the maximum extraction rates assessed in their respective environmental assessments. **Table 5-2** summarises the emissions adopted in this assessment for each of the nearby mining operations.

Table 5-2: Estimated emissions from the Project and nearby mining operations (kg of TSP)

Mining operation	2012	2017	2020	2023	2026
Integra Coal Mine(1)	3,582,117	2,955,240	2,989,345	2,989,345	2,989,345
Ravensworth Coal Mine(2)	7,901,683	9,541,213	11,629,545	11,558,269	11,172,839
Hunter Valley Operations(3)	10,902,098	9,029,790	7,568,834	7,568,834	7,568,834
Ashton South East Open Cut(4)	-	2,258,744	1,044,064	1,044,064	1,044,064
Glendell Coal Mine(5)	3,312,292	3,400,741	3,060,737	3,060,737	3,060,737
Mt Owen Coal Mine(6)	4,159,443	4,255,808	4,691,813	4,691,813	4,691,813
Ravensworth East Coal Mine(5)	5,110,750	4,967,410	4,967,410	4,967,410	4,967,410
Rix's Creek Coal mine	1,450,694	1,772,038	1,572,177	2,956,910	1,661,249
Total emissions	**36,419,077**	**38,180,984**	**37,523,925**	**38,837,382**	**37,156,291**

(1)Holmes Air Sciences (2009), (2)PAEHolmes (2010), (3)Holmes Air Sciences (2008), (4) PAEHolmes (2009), (5) Holmes Air Sciences (2007), (6) Holmes Air Sciences (2003)

It is noted that the consents for some mining operations expire at various stages of the Project life. However to assess potential worst case cumulative dust effects, it has been assumed that these operations would continue until the end of the Project. This assumption adds considerable conservatism to the model predictions.

Emissions from nearby mining operations were assumed to continue to contribute to the background level of dust in the area surrounding the Project, and these emissions were explicitly included in the modelling assessment. Additionally, there would be numerous smaller or very distant sources that contribute to the total background dust level. Modelling these sources is impractical; however, the residual level of dust due to all other such non-modelled sources has been included in the cumulative results, and the method for doing this is discussed further in **Section 8**.

5.2 Potential coal dust emissions from train wagons

As product coal produced at the Project will be transported off-site via rail to the Port of Newcastle for export to customers, there is potential to generate coal dust emissions from train wagons during transportation. The scale of the potential emissions would depend on various factors including the material properties of the product coal, meteorological factors and train/wagon specific factors.

Coal dust emissions from train wagons have the potential to originate from the coal surface of loaded wagons, leakage from wagon doors, re-suspension and wind erosion of coal spilled in the rail corridor, residual coal in unloaded wagons, and parasitic load on sills, shear plates and bogies of wagons.

The surface of loaded wagons provides a significant exposed area which is subject to wind erosion and air movement during transport. The amount of dust potentially generated during transport is related to the inherent dustiness of the coal material and the interactions of the air with the exposed coal surface (**Connell Hatch, 2008**).

Coal dust can potentially leak from the bottom doors of train wagons and fall into the ballast of the train line. This occurs when the doors of the wagon are not completely sealed. The amount of material released will depend on the material properties of the coal, and the vibrational forces experienced by the coal in the wagons that potentially break down the coal material. Dust impacts from this source are considered to be low as the ballast would provide a shielding effect to reduce particle lift-off (**Connell Hatch, 2008**).

During the loading process and in transit, there is potential for coal material to be spilled into the train corridor and cause parasitic loading on the sills, shear plates and bogies. These sources of emissions are easily prevented by careful loading of the material and profiling the shape of the load (**Connell Hatch, 2008**).

Residual coal remaining in an unloaded wagon can dry and become airborne during travel back to the site. This source is dependent on meteorological conditions, the train travel speed and the extent of any turbulent air generated in the unloaded wagon space causing the residual coal particles to become airborne.

5.2.1 Train wagon emission estimation

To determine the potential for dust-lift off during the transportation, dust emissions have been estimated from measurements conducted in other studies.

The study conducted by Katestone Environmental on behalf of Connell Hatch for Queensland Rail Limited (**Connell Hatch, 2008**) completed a review of a study by **Ferreira et al. (2003)** which focused on the release of coal dust from train wagons. The **Ferreira et al. (2003)** study conducted full-scale measurements of coal dust emissions from coal wagons over a 350km journey with an average train speed of between 55 and 60km/hr. The findings of this study determined that the total emission for an uncovered rail wagon was determined to be 9.6 grams of TSP per kilometre.

The Katestone Environmental study applied this emission factor with dispersion modelling and found that the resulting predicted concentration compared well with actual air quality monitoring conducted. This suggests that the findings of the **Ferreria et al. (2003)** study are sensible and therefore have been applied to estimate emissions for this Project.

When considering the maximum product coal yield of 2.7Mtpa it is estimated a peak of five train movements per day may occur. Each train would have a capacity of approximately 8,702 tonnes of product coal and consist of 91 wagons per train. This would result in an estimated emission rate of approximately 870g of TSP per km per train.

6 DUST MITIGATION AND MANAGEMENT

6.1 Dust management

The possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of mine operation consistent with current best practice for the control of dust emissions from coal mines in NSW has been carefully considered in the implementation of such measures at the Project. The measures applied to the Project reflect those outlined in the NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone, 2011**), and also imposed on mines in the current NSW EPA PRP's that relate to haul road emissions, and dust mitigation in response to adverse weather conditions.

Dust management practices are in place at the Project that respond to government and community concerns regarding the impacts of mining on regional air quality in the Hunter Valley.

These measures include implementation of best practice management techniques to reduce dust. Operational measures such as enforcing a cessation of particular operations during dry, windy conditions, and managing blast emissions via a site specific forecasting system provide additional assistance in reducing the potential dust impacts.

The NSW EPA has also placed a PRP on the Rix's Creek Mine Environment Protection Licence which requires identification and assessment of the practicality of implementing further best practice measures. The best practice controls currently implemented were considered in this assessment. Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix D**. A summary of key dust controls applied to current operations at the Project are shown in **Table 6-1**.

Table 6-1: Summary of best practice dust mitigation measures

Activity	Dust mitigation measure
Drilling	✦ Dust suppression system. ✦ Prevent disturbance of drill cuttings. ✦ Application of water on dusty areas prior to drilling. ✦ Ceasing operations when visible dust generated.
Blasting	✦ Watering blast areas to suppress dispersion of drill cuttings. ✦ Review meteorological and blast forecast prior to blasting.
Hauling on unsealed roads	✦ Watering of haul road surfaces. ✦ Prevent material being deposited / spilled on haul roads. ✦ Restrict general vehicle speed. ✦ Trafficable areas clearly marked, vehicle movements restricted to these areas. ✦ Trafficable areas and vehicle manoeuvring areas maintained. ✦ Fleet optimisation to reduce vehicle kilometres travelled.
Material extraction/unloading	✦ Application of water on dusty areas prior to extraction. ✦ Sheltered dumping during periods of adverse weather. ✦ Minimise the fall distance of materials during loading and unloading. ✦ Ceasing operation during high dust periods.
Unloading ROM to hopper	✦ Water sprays to minimise dust; ✦ Slower tipping during adverse weather conditions. ✦ Drop heights reduced as far as practicable. ✦ Visual triggers for dust mitigation.
Conveyors and transfers	✦ Enclosed conveyors.

Activity	Dust mitigation measure
	✦ Belt cleaning. ✦ Enclosed chutes.
Dozer operation	✦ Avoid use during unfavourable conditions. ✦ Minimise travel speed in dusty conditions. ✦ Travel on water watered routes between work areas.
Graders	✦ Travel on watered routes. ✦ Water haul roads immediately after grading, where possible.
Exposed areas	✦ Minimise area of disturbance, rehabilitate areas as soon as feasible. ✦ Apply interim stabilisation on areas inactive for long periods.
Coal processing	✦ Enclosed facility with internal water sprays.
Rehabilitation	✦ Rehabilitation expedited to achieve maximum coverage rate. ✦ Vegetation is actively managed.
ROM and product stockpiles	✦ Automated water sprays during high winds. ✦ Minimise drop heights when stacking. ✦ Manual implementation of water sprays and/or water cart during dusty periods. ✦ Visual surveillance of dust plumes during activity. ✦ Stockpiling and recovery on ROM coal is minimised as practical.
Rail operations	✦ Ensure streamlined and consistent profiled coal surface within rail wagons. ✦ Minimise spillage and parasitic loading. ✦ Clean and collect any spillage on regular basis.

The operation of dust mitigation and management measures commensurate with best practice is a key aspect of Rix's Creek Mine operations. Such measures can be seen in Rix's Creek recent Pollution Reduction Programs.

It should be noted that attainment of best practice requires ongoing improvement and thus the current best practice mitigation and dust management measures are likely to improve over time, as they are regularly reviewed and updated through the management plan framework.

6.2 Reactive and Predictive management

Rix's Creek was the first coal mine in the Hunter Valley to adopt predictive management systems to manage its potential blast overpressure, dust and fume impacts, and its potential operational noise impacts.

The predictive tools in place at the mine are used to provide operators with forecasts, several days in advance at ½ hourly to 2 hourly intervals, of the likely future impacts that may arise from activities on the mine. This allows the operations team to plan ahead for periods of potential impact, and allows the mine to react quickly where conditions or performance deteriorates due to the changing weather conditions.

The mine is committed to putting in place equivalent systems for operational dust controls prior to commencement of the Project, and thereby also limiting the potential for maximum short term impacts to occur due to the Project.

6.3 Monitoring network

The Rix's Creek Mine air quality monitoring network, is illustrated in **Figure 4-5** and **Figure 4-6**. The network of monitors surround the mine operation and are positioned in areas representative of the surrounding sensitive receptor locations. This network is augmented by ambient air quality monitoring stations operated by the NSW EPA and provide an extensive network of stations from which to measure ambient air quality.

Rix's Creek Mine also operates several portable Intermediate Monitoring Units (IMUs) to provide notification of dust levels at locations near to the operations and between the operations and receivers. As the units are generally positioned close to mine activity, the recorded dust levels are more significantly influenced by the mine's activities, and provide a good indication of the dust levels emanating from the operations. When certain thresholds are reached, indicating excessive emissions, the mine is able to take action to minimise the emissions before there is any significant effect at receptors.

7 DISPERSION MODELLING APPROACH

7.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach.

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The CALPUFF model is an advanced "puff" model that can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three dimensional, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC, 2011**).

7.2 Modelling methodology

Modelling was undertaken using a combination of TAPM and the CALPUFF Modelling System. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for three dimensional simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the three dimensional meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

7.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 32deg31min south and 151deg7min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the three dimensional wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domains. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative three dimensional wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality. The coarse scale wind flow fields also give a better set of starting conditions with which to operate the finer grid run.

The CALMET initial domain was run on a 150 x 150km area with a 3km grid resolution, refined for a second domain on a 50 x 50km grid with a 1km grid resolution and third domain on a 30 x 30km with 0.6km grid resolution then further refined for a final domain on a 22 x 22km grid with a 0.22km grid resolution.

The available meteorological data for January 2012 to December 2012 from eight nearby meteorological monitoring sites were included in the simulation. **Table 7-1** outlines the parameters used from each station. Three dimensional upper air data was sourced from TAPM output.

Table 7-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Rix's Creek Weather Station		✓			✓		
Cessnock Airport Automatic Weather Station (BoM) (Station No. 061260)	✓	✓			✓	✓	✓
Merriwa (Roscommon) Weather Station (BoM) (Station No, 061287)	✓	✓	✓	✓	✓	✓	✓
Murrurundi Gap Automatic Weather Station (BoM) (Station No. 061392)	✓	✓	✓	✓	✓	✓	✓
Camberwell Automatic Weather Station	✓	✓			✓		
Paterson (Tocal) Automatic Weather Station (BoM) (Station No. 061250)	✓	✓			✓	✓	
Scone Airport Automatic Weather Station (BoM) (Station No. 061363)	✓	✓			✓	✓	✓
Williamtown RAAF (BoM) (Station No. 061078)	✓	✓	✓	✓	✓	✓	✓
Nullo Mountain Automatic Weather Station (BoM) (Station No. 062100)	✓	✓			✓	✓	

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = sea level pressure

Local land use and detailed topographical information including local mine topography was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 7-1**.

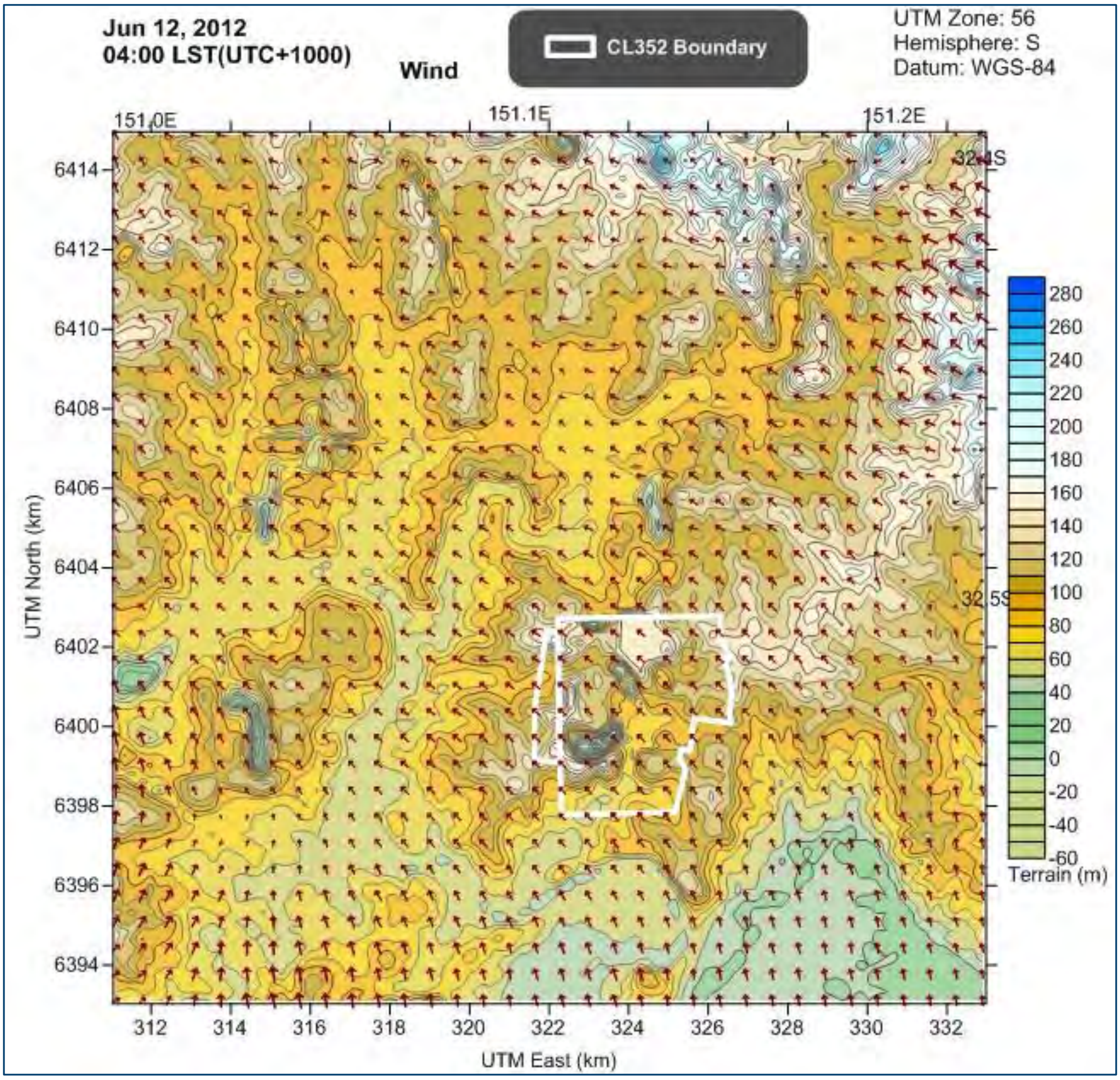

Figure 7-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data was extracted from a central point within the CALMET domain and is graphically represented in **Figure 7-2** and **Figure 7-3**.

Figure 7-2 presents the annual and seasonal windroses from the CALMET data. The CALMET modelling results reflect the expected wind distribution patterns of the area based on consideration of the measured data and the expected terrain effects on the prevailing winds. This is evident as the data are similar to those measured at the Rix's Creek weather station as shown in **Figure 4-3**.

On an annual basis, winds from the west-northwest, northwest and east-southeast are most frequent. During summer, winds from the east-southeast dominate the distribution with fewer winds from the southeast. The autumn and spring wind distributions are similar to the annual distributions with the majority of winds originating from the west-northwest, northwest and east-southeast. In winter, winds from the west-northwest and northwest are most predominant.

Overall the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. This is evident as the windroses based on the CALMET data also compare well with the windroses generated with the measured data, as presented in **Figure 4-3**.

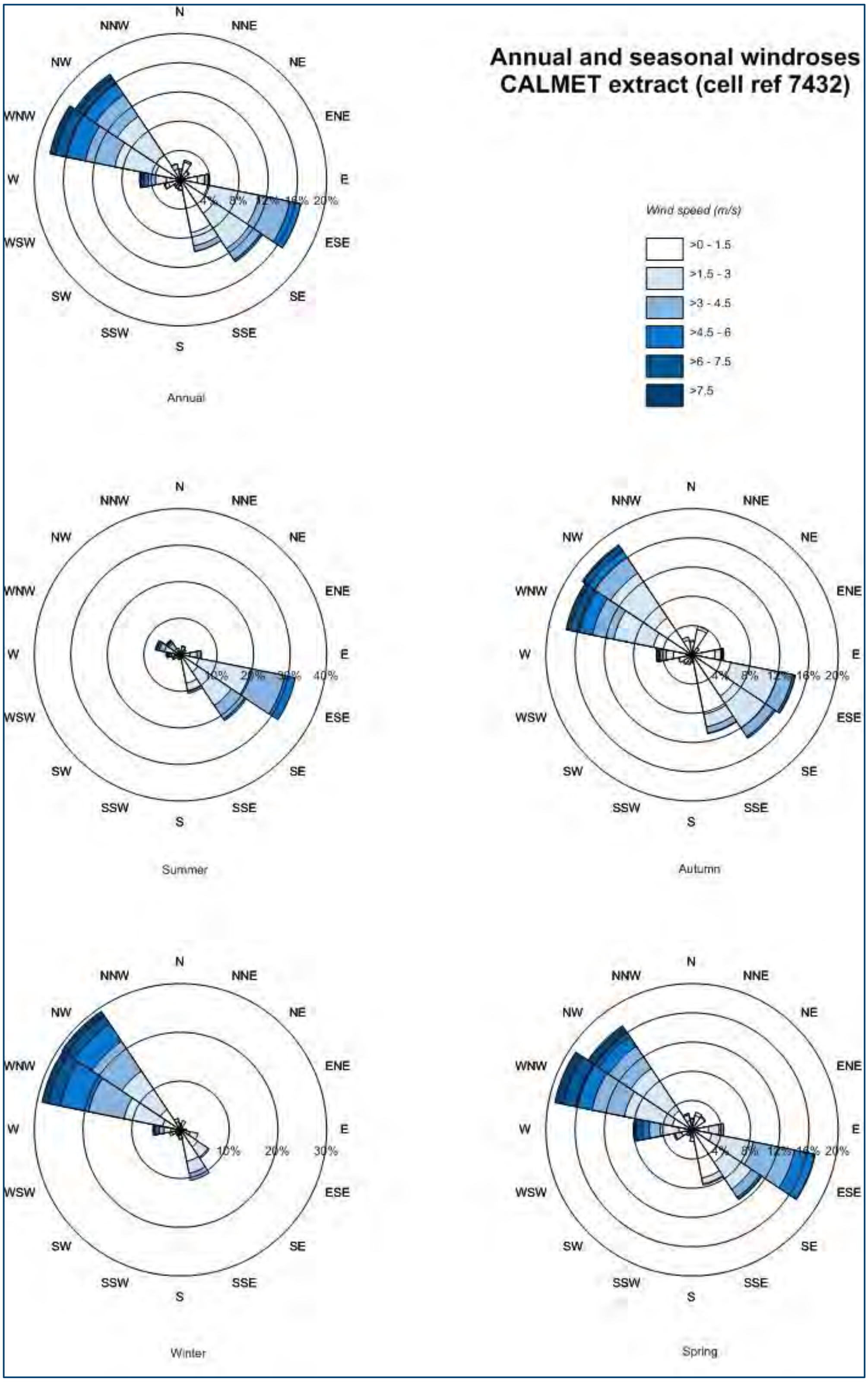

Figure 7-2: Windroses from CALMET extract (Cell ref 7432)

Figure 7-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

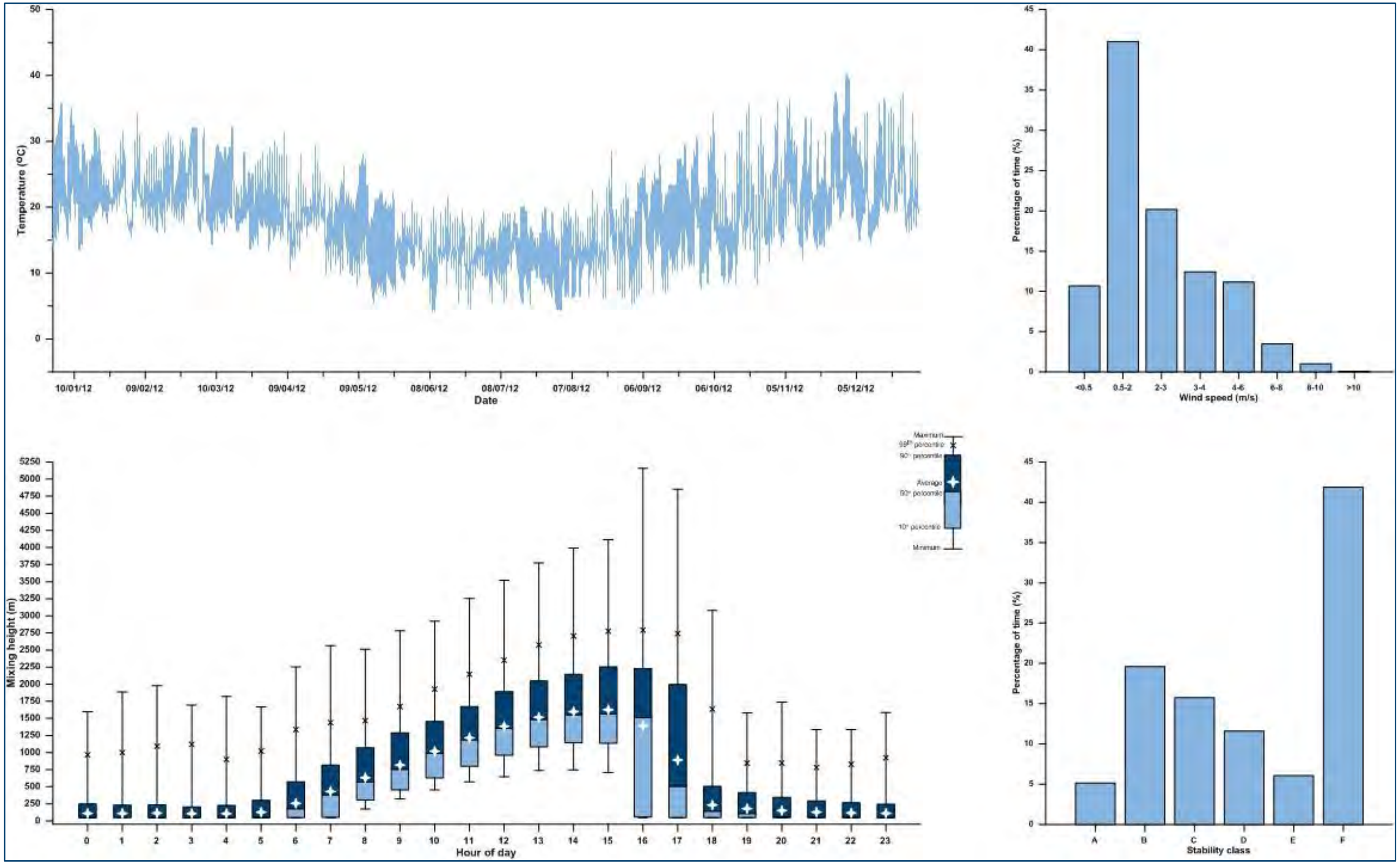

Figure 7-3: Meteorological analysis of CALMET extract (Cell ref 7432)

7.2.2 Dispersion modelling

CALPUFF modelling is based on the application of three particle size categories; fine particulate, coarse matter and rest. The distribution of particles for each particle size category was derived from measurements in the **SPCC (1986)** study and is presented in **Table 7-2**.

Table 7-2: Distribution of particles

Particle category	Size range	Distribution[(1)]
Fine particulate	0 to 2.5µm	4.68% of TSP
Coarse matter	2.5 to 10µm	34.4% of TSP
Rest	10 to 30µm	60.92% of TSP

[(1)]Particle distribution sources from **SPCC (1986)**

Each particle-size category is modelled separately and later combined to predict short-term and long-term average concentrations for $PM_{2.5}$, PM_{10}, and TSP. Dust deposition was predicted using the proven dry deposition algorithm within the CALPUFF model. Particle deposition is expressed in terms of atmospheric resistance through the surface layer, deposition layer resistance and gravitational settling (**Slinn and Slinn, 1980** and **Pleim *et al.*, 1984**). Gravitational settling is a function of the particle size and density, simulated for spheres by the Stokes equation (**Gregory, 1973**).

CALPUFF is capable of tracking the mass balance of particles emitted into the modelling domain. For each hour CALPUFF tracks the mass emitted, the amount deposited, the amounts remaining in the surface mixed layer or the air above the mixed layer and the amount advected out of the modelling domain. The versatility to address both dispersion and deposition algorithms in CALPUFF, combined with the three dimensional meteorological and land use field, generally results in a more accurate model prediction compared to other Gaussian plume models (**Pfender *et al.*, 2006**).

Emissions from each activity occurring at the Project were represented by a series of volume sources and a point source and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source. It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

8 ACCOUNTING FOR BACKGROUND DUST LEVELS

Other significant dust generating sources surrounding the Project were explicitly included in the model, including Integra, Ravensworth, Hunter Valley Operations, Ashton SEOC, Mount Owen, Glendell and Ravensworth East coal mines. These mining operations are the nearest significant operations and variously contribute to particulate matter concentrations near the Project. **Section 5** outlines how dust emissions from these sources have been accounted for in the modelling to assess cumulative effects.

Other dust generating activities in the surrounding area would also contribute to existing dust levels and an allowance for this contribution as well as contributions from other non-modelled dust sources is included in the assessment.

The contribution to the prevailing background dust levels of other non-modelled dust sources was estimated by modelling the past (known) mining activities (including Integra, Ravensworth, Hunter Valley Operations, Mount Owen, Glendell and Ravensworth East coal mines) for January 2012 to December 2012 and comparing the model predictions with the actual measured data from the corresponding monitoring stations. The average difference between the measured and predicted $PM_{2.5}$, PM_{10}, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources, and was added to the future predicted values to account for the background dust levels (not already in the model and due to the numerous non-modelled dust sources).

This approach is preferable to modelling the Project alone and adding a background level at all points across the modelling domain to estimate cumulative impacts. This is because the approach includes modelling of other major sources (i.e. mining operations) that more reliably represent the higher dust levels near such sources, and also accounts for the seasonal and time varying changes in the background levels that arise from these major dust sources. In addition, to account for any underestimation caused by not including every source (as it's not possible to do that reasonably), the relatively smaller contribution arising from the other non-modelled dust sources, as determined above, was added to the results to obtain the most accurate predictions of future cumulative impacts across the modelled domain.

Using the approach described above, the estimated annual average contribution from other non-modelled dust sources in the surrounding area was found to be:

- $PM_{2.5}$ – 5.2µg/m^3;
- PM_{10} – 11.5µg/m^3;
- TSP – 44.1µg/m^3; and,
- Deposited dust – 1.8g/m^2/month.

It is important that the above values are not confused with measured background levels, background levels excluding only the Project, or the change in existing levels as a result of the Project. The values above are not background levels in that sense, but are the residual amount of the background dust that is not accounted for directly in the air dispersion modelling.

To account for background levels when assessing total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts, the mine only incremental levels are added to the total measured ambient dust levels (per the

NSW EPA contemporaneous assessment guidance). Further details regarding the total cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts are provided in **Section 9.6**.

The predicted Project alone contribution and total (cumulative) levels for short and long term averaging periods are presented in tabular format as well as contour plots in the following section of this report.

9 DISPERSION MODELLING RESULTS

The dispersion model predictions for each of the indicative mine plan years are presented in this section. The results show the estimated maximum 24-hour average and annual average $PM_{2.5}$ concentrations, maximum 24-hour and annual average PM_{10} concentrations, annual average TSP concentrations and annual average dust (insoluble solids) deposition (DD) rates for the Project operating in isolation (the Project only impact) and with other sources (the total (cumulative) impact).

It is important to note that when assessing impacts for a maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations; the predictions show the highest modelled predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations that occur at each point within the modelling domain for the worst day (a 24-hour period) over the one year modelling period. When assessing the total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts based on model predictions, challenges arise as the predicted impacts are often overestimated by the model. Difficulties associated with identification and quantification of emissions from non-modelled sources over any particular 24-hour period also result in additional complications.

The potential 24-hour average $PM_{2.5}$ and PM_{10} impacts therefore need to be calculated differently to annual average impacts and consequently the predicted total (cumulative) impacts for maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations have been addressed specifically in **Section 9.6**.

Each of the potential sensitive receptor locations shown in **Figure 3-1** and listed in **Appendix B** were assessed individually as discrete receptors with the predicted results presented in tabular form for each of the indicative mine plan years.

For sources not explicitly included in the model, and to fully account for all cumulative dust levels, the unaccounted fractions of background dust levels (which arise from the other non-modelled sources) as described in **Section 8**, were added to the model predictions with the results presented in the following sections for each of the indicative mine plan years.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix E**.

9.1 Year 2017

Table 9-1 and **Table 9-2** present the model predictions at each of the privately-owned and mine-owned sensitive receptor locations respectively. The values presented in bold indicate predicted values above the relevant criteria.

The privately-owned receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations. These receptors are impacted at levels above the criteria regardless of the Project.

Figure E-1 to **Figure E-10** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in 2017.

Table 9-1: Modelling predictions for 2017 – privately-owned receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
1	6	1	47	10	17	0.4	7	29	71	2.4
2	1	0	9	1	2	0.0	6	20	56	2.2
3	1	0	7	1	1	0.0	6	18	54	2.1
4	1	0	8	1	1	0.0	6	18	55	2.1
5	1	0	8	1	1	0.0	6	18	55	2.1
6	1	0	6	1	1	0.0	6	18	53	2.1
7	1	0	10	1	1	0.0	6	18	54	2.1
8	1	0	9	1	1	0.0	6	18	54	2.1
9	1	0	8	1	1	0.0	6	18	54	2.1
10	1	0	6	0	1	0.0	6	18	54	2.1
11	1	0	6	0	1	0.0	6	18	53	2.0
12	0	0	3	0	0	0.0	6	17	53	2.0
13	1	0	8	0	1	0.0	6	17	53	2.1
14	1	0	8	1	1	0.0	6	17	53	2.1
15	2	1	19	4	7	0.2	6	21	59	2.2
16	3	1	21	4	7	0.2	6	21	59	2.2
17	3	1	23	4	7	0.2	7	22	60	2.3
18	3	0	25	4	6	0.2	6	21	59	2.2
19	3	0	26	4	6	0.2	7	22	59	2.2
20	3	0	22	3	5	0.1	6	21	58	2.2
21	3	0	21	3	5	0.1	6	21	58	2.2
22	3	0	20	3	4	0.1	6	21	58	2.2
23	2	0	18	3	4	0.1	6	20	58	2.2
24	1	0	10	2	2	0.1	6	20	57	2.2
25	2	0	12	2	4	0.2	6	19	55	2.2
26	2	0	12	3	4	0.2	6	19	55	2.2
27	2	0	17	2	4	0.1	6	19	56	2.1
28	2	0	13	2	4	0.1	6	19	55	2.1
29	2	0	12	2	3	0.1	6	19	55	2.1
30	2	0	11	2	3	0.1	6	18	54	2.1

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
31	2	0	16	3	4	0.1	6	19	56	2.1
32	2	0	17	3	5	0.2	6	20	57	2.2
33	2	0	18	3	5	0.2	6	20	57	2.2
34	2	0	18	3	4	0.1	6	20	56	2.2
35	2	0	14	3	4	0.1	6	19	56	2.1
36	2	0	15	2	4	0.1	6	19	55	2.1
37	2	0	16	3	4	0.1	6	19	56	2.2
38	2	0	14	2	3	0.1	6	19	55	2.1
39	2	0	15	2	3	0.1	6	19	55	2.1
40	3	1	27	4	7	0.3	6	19	56	2.2
41	4	1	30	5	8	0.3	6	20	57	2.3
42	4	1	32	5	8	0.3	6	20	58	2.3
43	4	1	29	4	7	0.2	6	20	56	2.2
44	4	1	35	6	9	0.3	6	21	59	2.3
45	3	0	23	4	5	0.2	6	18	54	2.1
46	3	1	26	4	6	0.2	6	19	55	2.1
47	4	1	31	6	10	0.4	7	22	60	2.4
48	4	1	28	6	10	0.4	6	21	59	2.4
49	3	1	26	6	9	0.4	6	21	58	2.4
50	3	1	26	5	8	0.3	6	20	57	2.3
51	3	0	20	3	5	0.2	6	18	54	2.2
52	3	1	21	4	6	0.3	6	19	55	2.2
53	3	1	21	5	8	0.4	6	20	57	2.4
54	4	1	28	6	10	0.5	7	22	60	2.4
55	4	1	30	7	11	0.5	7	22	61	2.5
56	1	0	10	3	4	0.3	6	18	53	2.3
57	2	1	16	4	7	0.5	6	20	56	2.5
58	2	1	17	4	7	0.5	6	20	57	2.5
59	2	1	17	4	6	0.3	6	20	57	2.3
60	2	0	13	3	5	0.3	6	18	54	2.3
61	3	1	27	6	10	0.3	7	23	61	2.3
62	2	1	16	4	7	0.3	6	21	58	2.3
63	2	0	12	3	5	0.4	6	18	54	2.4
64	2	0	11	3	4	0.3	6	18	54	2.3
65	3	1	24	5	9	0.5	7	21	59	2.5
66	2	0	14	4	6	0.4	6	18	54	2.4
67	2	1	16	4	7	0.5	6	19	56	2.4
68	2	0	14	4	6	0.4	6	18	55	2.4
69	2	0	13	3	5	0.4	6	18	54	2.4
70	1	0	12	3	5	0.3	6	18	53	2.3
71	2	0	15	4	6	0.4	6	19	56	2.4
72	2	0	17	4	6	0.4	6	20	56	2.4
73	2	0	15	4	6	0.4	6	19	55	2.3
74	2	0	13	3	5	0.4	6	19	55	2.4

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
75	1	0	11	3	5	0.3	6	18	54	2.3
76	3	1	20	5	8	0.3	7	22	60	2.3
77	2	0	15	3	5	0.3	6	19	56	2.3
78	2	1	19	4	7	0.4	6	20	57	2.4
79	3	1	22	5	8	0.4	6	21	59	2.4
80	3	1	20	4	7	0.4	6	20	57	2.4
81	2	0	13	3	5	0.3	6	18	53	2.2
82	2	0	15	3	5	0.3	6	18	54	2.3
83	2	0	14	2	3	0.1	6	17	51	2.1
84	2	0	14	3	4	0.2	6	17	52	2.1
85	1	0	9	3	4	0.3	6	18	53	2.3
86	1	0	10	2	4	0.2	6	18	53	2.2
87	1	0	9	2	4	0.2	6	17	53	2.2
88	1	0	10	2	4	0.2	6	18	53	2.2
89	2	0	12	3	4	0.3	6	18	54	2.3
90	1	0	10	3	4	0.3	6	18	53	2.3
91	2	0	12	3	4	0.3	6	18	54	2.3
92	2	0	11	3	4	0.2	6	18	54	2.2
93	1	0	8	2	3	0.2	6	17	52	2.1
94	2	0	13	3	5	0.2	6	19	55	2.3
95	2	0	12	3	4	0.2	6	18	54	2.2
96	2	0	18	2	3	0.0	6	17	52	2.0
97	3	0	22	3	5	0.1	6	18	54	2.1
98	3	0	19	3	5	0.1	6	18	54	2.0
99	2	0	18	3	4	0.1	6	18	53	2.0
100	2	0	19	3	4	0.1	6	17	53	2.0
101	2	0	17	2	3	0.1	6	17	52	2.0
102	2	0	18	2	4	0.1	6	17	52	2.0
103	2	0	16	2	3	0.0	6	17	51	2.0
104	3	0	23	4	6	0.1	6	19	55	2.1
105	3	0	20	3	5	0.1	6	18	54	2.0
106	3	0	20	3	4	0.1	6	18	53	2.0
107	3	0	19	3	4	0.1	6	18	53	2.0
108	3	0	19	3	4	0.1	6	17	53	2.0
109	2	0	18	2	3	0.1	6	17	52	2.0
110	2	0	19	2	3	0.1	6	17	52	2.0
111	2	0	17	2	3	0.0	6	17	52	2.0
112	2	0	17	2	3	0.0	6	17	51	1.9
113	2	0	18	2	3	0.0	6	17	52	1.9
114	2	0	17	2	3	0.0	6	17	51	1.9
115	2	0	18	2	3	0.0	6	17	52	1.9
116	2	0	18	2	3	0.0	6	17	52	1.9
117	3	0	20	2	3	0.0	6	17	52	2.0
118	3	0	21	2	4	0.0	6	17	53	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
119	3	0	20	2	3	0.0	6	17	52	1.9
120	3	0	22	2	3	0.0	6	17	53	1.9
121	3	0	24	3	4	0.0	6	18	53	2.0
122	3	0	24	3	4	0.0	6	18	53	2.0
123	1	0	6	1	1	0.0	6	18	53	2.1
124	1	0	5	0	1	0.0	6	17	53	2.1
125	1	0	7	1	1	0.0	6	17	53	2.1
126	1	0	6	1	1	0.0	6	17	52	2.0
127	1	0	6	1	1	0.0	6	17	51	2.0
128	1	0	7	1	1	0.0	6	17	51	2.0
129	1	0	7	1	1	0.0	6	16	51	2.0
130	1	0	8	1	1	0.0	6	16	51	1.9
131	2	0	13	1	2	0.0	6	16	51	1.9
132	2	0	12	1	2	0.0	6	16	50	1.9
133	1	0	8	1	1	0.0	6	15	49	1.9
134	1	0	6	0	1	0.0	6	18	53	2.1
135	1	0	6	0	1	0.0	6	18	54	2.1
136	4	1	30	4	6	0.1	6	20	56	2.0
137	4	1	34	5	7	0.1	6	20	57	2.0
138	5	1	35	5	8	0.1	6	21	58	2.0
139	4	1	30	4	6	0.1	6	20	56	2.0
140	6	1	45	7	12	0.2	7	23	62	2.1
141	2	0	14	2	3	0.0	6	17	52	1.9
142	1	0	10	1	1	0.0	6	17	52	2.0
143	2	0	13	1	2	0.0	6	17	52	2.0
144	2	0	13	1	2	0.0	6	17	52	2.0
145	1	0	9	1	1	0.0	6	17	52	2.0
146	2	0	15	1	2	0.0	6	17	53	2.0
147	2	0	12	1	1	0.0	6	18	53	2.1
148	2	0	17	1	1	0.0	6	19	55	2.1
149	3	0	20	2	3	0.0	6	20	56	2.1
150	2	0	15	1	2	0.0	6	20	57	2.2
151	2	0	15	1	1	0.0	6	20	57	2.2
152	4	1	30	4	6	0.1	6	20	56	2.0
153	4	0	28	4	5	0.1	6	19	55	2.0
154	4	0	29	3	5	0.1	6	19	55	2.0
155	4	1	32	4	6	0.1	6	20	56	2.0
156	4	0	29	3	5	0.1	6	19	55	2.0
157	4	1	32	4	6	0.1	6	19	55	2.0
158	4	0	28	3	5	0.0	6	19	54	2.0
159	4	0	32	4	5	0.1	6	19	55	2.0
160	4	0	29	3	5	0.0	6	19	55	2.0
161	3	0	26	3	4	0.0	6	19	54	2.0
162	3	0	22	3	4	0.0	6	18	54	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
163	3	0	23	2	3	0.0	6	18	53	2.0
164	3	0	22	3	3	0.0	6	20	56	2.1
165	2	0	13	1	2	0.0	6	20	57	2.2
166	3	0	25	3	4	0.0	6	18	53	1.9
167	2	0	17	2	3	0.0	6	19	56	2.0
168	2	0	15	2	3	0.0	6	20	56	2.1
169	2	0	15	2	2	0.0	6	20	57	2.1
170	4	1	31	7	10	0.1	**14**	**79**	**165**	3.7
171	6	1	44	9	13	0.2	8	29	70	2.1
172	3	1	27	5	8	0.1	**9**	**41**	**90**	2.6
173	6	1	44	8	12	0.1	**9**	**43**	**92**	2.6
174	3	1	24	4	6	0.1	**9**	**37**	83	2.5
175	2	0	17	2	3	0.0	8	**36**	84	2.6
176	2	0	19	3	5	0.1	**9**	**38**	85	2.5
177	2	0	12	2	2	0.0	**14**	**80**	**185**	**5.1**

*Advisory NEPM reporting standard applicable to the population as a whole

Table 9-2: Modelling predictions for 2017 – mine-owned receptors

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M1	2	0	12	2	3	0.0	8	**33**	79	2.4
M2	2	0	15	2	3	0.0	**10**	**47**	**107**	2.9
M3	2	0	18	3	4	0.0	**10**	**51**	**116**	3.4
M4	4	1	30	6	9	0.1	**9**	**38**	86	2.5
M5	4	1	31	6	8	0.1	**10**	**44**	**93**	2.6
M6	4	1	27	5	8	0.1	**15**	**89**	**181**	3.9
M7	3	1	26	5	8	0.1	**20**	**132**	**272**	**5.6**
M8	3	0	26	3	3	0.0	6	18	54	2.0
M9	3	0	22	2	3	0.0	6	18	53	2.0
M10	3	0	19	2	3	0.0	6	18	53	2.0
M11	3	0	23	3	4	0.0	6	18	54	2.0
M12	2	0	18	2	3	0.0	6	18	53	2.0
M13	3	0	20	2	3	0.0	6	18	53	2.0
M14	3	0	19	2	3	0.0	6	18	53	2.0
M15	2	0	17	2	3	0.0	6	17	52	1.9
M16	5	1	36	8	13	0.5	7	24	63	2.5
M17	8	2	**58**	13	22	0.5	8	30	74	2.5
M18	8	2	**60**	13	23	0.6	8	30	75	2.5
M19	10	2	**77**	17	29	0.8	8	**34**	82	2.7
M20	9	2	**70**	16	27	0.7	8	**33**	80	2.7

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M21	5	1	34	8	13	0.3	7	26	67	2.3
M22	6	1	48	11	18	0.4	7	29	72	2.4
M23	5	1	39	10	16	0.3	7	28	70	2.4
M24	1	0	10	1	1	0.0	6	18	55	2.1
M25	1	0	9	1	1	0.0	6	18	54	2.1
M26	1	0	9	1	1	0.0	6	18	54	2.1
M27	1	0	9	1	1	0.0	7	22	60	2.2
M28	0	0	3	0	0	0.0	7	26	67	2.2
M29	3	1	24	4	6	0.1	**9**	**41**	88	2.5
M30	4	1	26	4	6	0.1	**9**	**41**	88	2.5
M31	4	1	26	4	6	0.1	**9**	**39**	85	2.5
M32	1	0	7	1	1	0.0	7	28	71	2.5

*Advisory NEPM reporting standard applicable to the population as a whole

9.1.1 Predicted maximum 24-hour average $PM_{2.5}$ concentrations

Figure E-1 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in isolation.

The results in **Table 9-1** and **Table 9-2** indicate that all privately-owned and mine-owned receptors are predicted to experience maximum 24-hour average $PM_{2.5}$ concentrations below the advisory reporting standard of 25µg/m³.

Results for the total (cumulative) impact for maximum 24-hour average $PM_{2.5}$ concentrations are discussed in **Section 9.6**.

9.1.2 Predicted annual average $PM_{2.5}$ concentrations

Figure E-2 shows the predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in isolation and **Figure E-3** shows the predicted total impact from the Project and other sources.

The results in **Table 9-1** indicate that six privately-owned receptors; Receptors 170, 172, 173, 174, 176 and 177, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-1**.

Table 9-2 indicates that nine mine-owned receptors; Receptors M2, M3, M4, M5, M6, M7, M30, M31 and M32 are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due emissions from the Project and other sources.

9.1.3 Predicted maximum 24-hour average PM_{10} concentrations

Figure E-4 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in isolation.

The results in **Table 9-1** indicate that all privately-owned receptors are predicted to experience maximum 24-hour average PM_{10} concentrations below the relevant criterion of 50µg/m^3.

Table 9-2 indicates that four mine-owned receptors; M18, M19, M20 and M21, are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m^3.

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 9.6**.

9.1.4 Predicted annual average PM_{10} concentrations

Figure E-5 shows the predicted annual average PM_{10} concentrations due to emissions from the Project in isolation and **Figure E-6** shows the predicted total impact from the Project and other sources.

The results in **Table 9-1** indicate that seven privately-owned receptors; Receptors 170, 172, 173, 174, 175, 176 and 177, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-1**.

Table 9-2 indicates that 12 mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6, M7, M19, M20, M30, M31 and M32 are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources.

9.1.5 Predicted annual average TSP concentrations

Figure E-7 shows the predicted annual average TSP concentrations due to emissions from the Project in isolation. **Figure E-8** shows the predicted total impact from the Project and other sources.

The results in **Table 9-1** indicate that four privately-owned receptors; Receptors 170, 173 and 177, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-1**.

Table 9-2 indicates that five mine-owned receptors; Receptors M2, M3, M5, M6 and M7, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources.

9.1.6 Predicted annual average dust deposition levels

Figure E-9 shows the predicted annual average dust deposition levels due to emissions from the Project in isolation. **Figure E-10** shows the predicted total impact from the Project and other sources.

The results in **Table 9-1** and **Table 9-2** indicate that all privately-owned and mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month.

The results in **Table 9-1** indicate that one privately-owned receptor; Receptor 177, is predicted to experience annual average dust deposition levels above the relevant criterion of 4g/m^2/month due to emissions from the Project and other sources. This receptor is largely unaffected by activity from the Project due to its distance away from the Project. This location would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-1**.

Table 9-2 indicates that one mine-owned receptor; Receptor M7, is predicted to experience annual average dust deposition levels above the relevant criterion of 4g/m^2/month due to emissions from the Project and other sources.

9.2 Year 2020

Table 9-3 and **Table 9-4** present the model predictions at each of the privately-owned and mine-owned sensitive receptor locations respectively. The values presented in bold indicate predicted values above the relevant criteria.

The privately-owned receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations. These receptors are impacted at levels above the criteria regardless of the Project.

Figure E-11 to **Figure E-20** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in 2020.

Table 9-3: Modelling predictions for 2020 – privately-owned receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
1	10	2	**71**	16	27	0.7	8	**34**	80	2.7
2	1	0	9	1	2	0.0	6	19	56	2.1
3	1	0	7	1	1	0.0	6	18	54	2.1
4	1	0	8	1	1	0.0	6	18	54	2.1
5	1	0	8	1	1	0.0	6	18	54	2.1
6	1	0	7	1	1	0.0	6	17	52	2.0
7	1	0	8	1	1	0.0	6	18	54	2.1
8	1	0	8	1	1	0.0	6	18	53	2.1
9	1	0	7	0	1	0.0	6	17	53	2.0
10	1	0	5	0	1	0.0	6	17	52	2.0
11	1	0	5	0	0	0.0	6	17	52	2.0
12	0	0	3	0	0	0.0	6	17	52	1.9
13	1	0	7	0	1	0.0	6	17	52	2.0
14	1	0	6	0	1	0.0	6	17	52	2.0
15	3	1	21	4	7	0.2	6	21	58	2.2
16	3	1	23	4	7	0.2	6	21	59	2.2
17	3	1	25	4	7	0.2	7	22	59	2.2
18	4	0	26	4	6	0.2	6	21	58	2.2
19	4	1	27	4	6	0.2	6	21	59	2.2
20	3	0	23	3	5	0.1	6	20	57	2.2
21	3	0	22	3	4	0.1	6	20	57	2.2
22	3	0	20	3	4	0.1	6	20	57	2.2
23	2	0	18	2	4	0.1	6	20	57	2.1
24	1	0	10	1	2	0.0	6	19	56	2.1
25	2	0	14	3	4	0.2	6	18	55	2.2
26	2	0	15	3	4	0.2	6	19	55	2.2
27	2	0	17	2	4	0.1	6	19	55	2.1
28	2	0	14	2	4	0.1	6	19	55	2.1
29	2	0	13	2	3	0.1	6	18	54	2.1
30	2	0	14	2	3	0.1	6	18	54	2.1

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
31	2	0	17	3	4	0.1	6	19	55	2.1
32	2	0	18	3	5	0.2	6	20	56	2.2
33	3	0	20	3	5	0.2	6	20	56	2.2
34	2	0	19	3	4	0.1	6	19	56	2.1
35	2	0	15	3	4	0.1	6	19	55	2.1
36	2	0	16	2	3	0.1	6	19	55	2.1
37	2	0	17	3	4	0.1	6	19	56	2.1
38	2	0	15	2	3	0.1	6	19	55	2.1
39	2	0	16	2	3	0.1	6	19	55	2.1
40	2	0	18	3	4	0.1	6	18	54	2.1
41	3	0	20	3	5	0.1	6	19	55	2.1
42	3	0	21	4	5	0.1	6	19	55	2.1
43	3	0	19	3	5	0.1	6	18	54	2.1
44	3	1	23	4	6	0.1	6	19	55	2.1
45	2	0	17	3	4	0.1	6	18	53	2.0
46	3	0	19	3	4	0.1	6	18	53	2.0
47	3	1	23	4	6	0.2	6	20	56	2.2
48	3	1	22	4	6	0.2	6	20	56	2.2
49	3	1	20	4	6	0.2	6	19	55	2.1
50	3	0	19	3	5	0.1	6	19	54	2.1
51	2	0	14	2	3	0.1	6	17	52	2.0
52	2	0	16	3	4	0.1	6	18	53	2.1
53	3	0	18	3	5	0.2	6	19	55	2.2
54	3	1	23	4	6	0.2	6	20	56	2.2
55	3	1	25	5	7	0.2	6	20	57	2.2
56	2	0	12	3	4	0.3	6	18	53	2.2
57	2	1	17	4	6	0.4	6	19	55	2.4
58	3	1	20	4	7	0.4	6	20	57	2.5
59	3	1	20	5	8	0.4	6	21	58	2.4
60	2	0	14	4	5	0.4	6	19	55	2.4
61	4	1	32	7	12	0.4	7	24	63	2.5
62	3	1	19	5	8	0.3	6	21	59	2.4
63	2	0	13	3	4	0.3	6	18	53	2.2
64	2	0	13	3	5	0.4	6	19	54	2.4
65	3	1	25	6	9	0.5	7	22	60	2.5
66	2	0	14	3	4	0.2	6	18	53	2.2
67	2	0	16	3	5	0.2	6	18	54	2.2
68	2	0	14	3	4	0.2	6	18	53	2.2
69	2	0	13	3	4	0.2	6	18	53	2.2
70	2	0	12	2	3	0.2	6	17	52	2.2
71	2	1	16	4	6	0.4	6	20	56	2.5
72	2	1	17	4	7	0.4	6	20	57	2.5
73	2	0	15	3	4	0.2	6	18	53	2.2
74	2	0	16	3	5	0.4	6	19	55	2.4

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
75	2	0	13	3	5	0.3	6	18	54	2.3
76	3	1	27	6	10	0.4	7	23	62	2.4
77	2	1	17	4	7	0.4	6	20	57	2.4
78	3	1	20	5	7	0.5	6	21	58	2.5
79	3	1	25	6	9	0.5	7	22	60	2.5
80	3	1	21	5	8	0.5	6	21	59	2.5
81	2	0	12	2	3	0.1	6	17	52	2.1
82	2	0	13	2	4	0.1	6	17	52	2.1
83	1	0	10	2	2	0.1	6	16	51	2.0
84	1	0	11	2	3	0.1	6	17	51	2.0
85	1	0	11	3	4	0.3	6	18	53	2.3
86	1	0	12	3	4	0.3	6	18	54	2.3
87	1	0	11	3	4	0.3	6	18	53	2.3
88	1	0	11	3	4	0.2	6	18	54	2.2
89	2	0	13	3	5	0.3	6	19	55	2.3
90	2	0	12	3	4	0.3	6	18	54	2.3
91	2	0	13	3	5	0.3	6	19	54	2.4
92	2	0	12	3	4	0.2	6	18	54	2.2
93	1	0	10	2	4	0.2	6	17	53	2.2
94	2	0	13	3	5	0.3	6	19	55	2.3
95	2	0	12	3	5	0.3	6	18	54	2.3
96	2	0	15	2	2	0.0	6	17	51	1.9
97	2	0	18	2	4	0.1	6	18	53	2.0
98	2	0	18	2	3	0.0	6	17	52	2.0
99	2	0	16	2	3	0.0	6	17	52	2.0
100	2	0	16	2	3	0.0	6	17	52	2.0
101	2	0	14	2	2	0.0	6	17	51	1.9
102	2	0	15	2	3	0.0	6	17	52	2.0
103	2	0	13	2	2	0.0	6	16	51	1.9
104	3	0	19	3	4	0.1	6	18	53	2.0
105	2	0	18	2	3	0.0	6	17	52	2.0
106	2	0	17	2	3	0.0	6	17	52	2.0
107	2	0	17	2	3	0.0	6	17	52	2.0
108	2	0	17	2	3	0.0	6	17	52	2.0
109	2	0	16	2	3	0.0	6	17	52	2.0
110	2	0	15	2	2	0.0	6	17	52	1.9
111	2	0	14	2	2	0.0	6	17	51	1.9
112	2	0	14	1	2	0.0	6	16	51	1.9
113	2	0	14	2	2	0.0	6	16	51	1.9
114	2	0	13	1	2	0.0	6	16	51	1.9
115	2	0	14	2	2	0.0	6	17	51	1.9
116	2	0	14	2	2	0.0	6	16	51	1.9
117	2	0	15	2	2	0.0	6	17	52	1.9
118	2	0	16	2	3	0.0	6	17	52	1.9

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
119	2	0	14	2	2	0.0	6	17	51	1.9
120	2	0	15	2	2	0.0	6	17	52	1.9
121	2	0	17	2	3	0.0	6	17	52	1.9
122	2	0	17	2	3	0.0	6	17	52	1.9
123	1	0	5	0	1	0.0	6	17	52	2.0
124	1	0	4	0	0	0.0	6	17	52	2.0
125	1	0	6	0	1	0.0	6	17	52	2.0
126	1	0	5	1	1	0.0	6	16	51	2.0
127	1	0	5	1	1	0.0	6	16	51	2.0
128	1	0	6	1	1	0.0	6	16	51	2.0
129	1	0	5	1	1	0.0	6	16	51	1.9
130	1	0	7	1	1	0.0	6	16	50	1.9
131	1	0	10	1	2	0.0	6	16	51	1.9
132	1	0	9	1	1	0.0	6	16	50	1.9
133	1	0	6	1	1	0.0	6	15	49	1.9
134	1	0	4	0	0	0.0	6	17	52	2.0
135	1	0	5	0	0	0.0	6	17	52	2.0
136	3	0	24	3	4	0.0	6	19	54	2.0
137	4	0	27	3	5	0.0	6	19	55	2.0
138	4	1	29	4	5	0.1	6	20	56	2.0
139	3	0	24	3	4	0.0	6	19	54	2.0
140	5	1	35	5	8	0.1	6	21	58	2.0
141	2	0	11	1	2	0.0	6	17	52	1.9
142	1	0	8	1	1	0.0	6	17	51	2.0
143	1	0	10	1	1	0.0	6	17	51	1.9
144	1	0	9	1	1	0.0	6	17	51	2.0
145	1	0	8	1	1	0.0	6	17	52	2.0
146	2	0	12	1	1	0.0	6	17	52	2.0
147	1	0	9	1	1	0.0	6	17	52	2.0
148	2	0	11	1	1	0.0	6	18	53	2.0
149	2	0	14	2	2	0.0	6	19	55	2.0
150	2	0	11	1	1	0.0	6	19	55	2.1
151	1	0	11	1	1	0.0	6	19	56	2.1
152	3	0	24	3	4	0.0	6	19	54	2.0
153	3	0	22	3	4	0.0	6	18	54	2.0
154	3	0	21	3	4	0.0	6	18	54	2.0
155	3	0	24	3	4	0.0	6	19	54	2.0
156	3	0	21	3	3	0.0	6	18	53	2.0
157	3	0	23	3	4	0.0	6	19	54	2.0
158	3	0	20	2	3	0.0	6	18	53	1.9
159	3	0	23	3	4	0.0	6	19	54	2.0
160	3	0	18	2	3	0.0	6	18	53	1.9
161	2	0	17	2	3	0.0	6	18	53	1.9
162	2	0	16	2	3	0.0	6	18	53	1.9

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
163	2	0	16	2	2	0.0	6	17	52	1.9
164	2	0	16	2	2	0.0	6	19	55	2.0
165	1	0	10	1	1	0.0	6	19	56	2.1
166	2	0	17	2	3	0.0	6	17	52	1.9
167	2	0	13	2	2	0.0	6	19	55	2.0
168	2	0	12	2	2	0.0	6	19	55	2.0
169	2	0	11	1	2	0.0	6	19	55	2.1
170	5	1	39	8	11	0.2	**16**	**100**	**218**	**5.3**
171	4	1	28	7	10	0.2	8	29	70	2.2
172	5	1	32	7	10	0.1	**10**	**47**	**101**	2.7
173	7	1	49	9	13	0.1	**9**	**39**	85	2.4
174	4	1	33	6	9	0.1	**9**	**37**	83	2.4
175	2	0	18	2	3	0.0	8	**36**	83	2.6
176	3	1	22	4	6	0.1	**9**	**39**	87	2.5
177	2	0	13	2	2	0.0	**9**	**43**	**99**	2.8

*Advisory NEPM reporting standard applicable to the population as a whole

Table 9-4: Modelling predictions for 2020 – mine-owned receptors

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M1	2	0	18	2	3	0.0	**9**	**38**	89	2.7
M2	3	0	25	3	4	0.0	**11**	**54**	**121**	3.2
M3	4	0	29	4	5	0.0	**11**	**56**	**126**	3.6
M4	6	1	41	8	11	0.1	**10**	**49**	**104**	2.7
M5	5	1	37	7	10	0.1	**9**	**37**	82	2.4
M6	4	1	32	7	10	0.1	**9**	**40**	87	2.5
M7	4	1	33	7	10	0.1	**9**	**43**	**95**	2.7
M8	2	0	18	2	2	0.0	6	18	53	2.0
M9	2	0	17	2	2	0.0	6	17	53	1.9
M10	2	0	14	2	2	0.0	6	17	52	1.9
M11	2	0	17	2	3	0.0	6	18	53	1.9
M12	2	0	14	2	2	0.0	6	17	52	1.9
M13	2	0	15	2	2	0.0	6	17	52	1.9
M14	2	0	15	2	2	0.0	6	17	52	1.9
M15	2	0	12	2	2	0.0	6	17	52	1.9
M16	5	1	37	7	12	0.4	7	24	63	2.5
M17	7	1	**53**	11	18	0.4	7	28	70	2.4
M18	7	2	**56**	12	19	0.5	7	29	72	2.5
M19	10	2	**76**	16	27	0.7	8	**34**	80	2.7
M20	11	2	**80**	17	28	0.8	8	**35**	82	2.8

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	**-**	**50**	**-**	**-**	**2**	**8***	**30**	**90**	**4**
M21	6	1	43	10	17	0.5	7	28	69	2.5
M22	10	2	**73**	15	25	0.6	8	**33**	79	2.6
M23	8	2	**58**	13	22	0.6	8	**31**	75	2.6
M24	1	0	9	1	1	0.0	6	18	54	2.1
M25	1	0	8	1	1	0.0	6	18	53	2.1
M26	1	0	8	1	1	0.0	6	17	53	2.0
M27	1	0	9	1	1	0.0	6	21	59	2.2
M28	0	0	3	0	0	0.0	7	27	68	2.2
M29	4	1	27	5	7	0.1	8	**34**	77	2.4
M30	4	1	29	5	7	0.1	8	**35**	79	2.4
M31	4	1	30	6	8	0.1	8	**36**	81	2.4
M32	1	0	8	1	1	0.0	7	24	64	2.3

*Advisory NEPM reporting standard applicable to the population as a whole

9.2.1 Predicted maximum 24-hour average $PM_{2.5}$ concentrations

Figure E-11 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in isolation.

The results in **Table 9-3** and **Table 9-4** indicate that all privately-owned and mine-owned receptors are predicted to experience maximum 24-hour average $PM_{2.5}$ concentrations below the advisory reporting standard of 25µg/m³.

Results for the total (cumulative) impact for maximum 24-hour average $PM_{2.5}$ concentrations are discussed in **Section 9.6**.

9.2.2 Predicted annual average $PM_{2.5}$ concentrations

Figure E-12 shows the predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in isolation and **Figure E-13** shows the predicted total impact from the Project and other sources.

The results in **Table 9-3** indicate that six privately-owned receptors; Receptors 170, 172, 173, 174, 176 and 177, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-3**.

Table 9-4 indicates that seven mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6 and M7, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources.

9.2.3 Predicted maximum 24-hour average PM_{10} concentrations

Figure E-14 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in isolation.

The results in **Table 9-3** indicate that all privately-owned receptors with the exception of Receptor 1 are predicted to experience maximum 24-hour average concentrations below the relevant criterion of 50µg/m^3.

Further analysis of the number of days that this receptor experiences levels above 50µg/m^3 is presented in **Table 9-5**. The analysis indicates that Receptor 1 is predicted to experience six days above the relevant criterion of 50µg/m^3.

Table 9-5: Analysis of Year 2020 – maximum 24-hour average PM_{10} concentrations

Receptor ID	Number of days over 50µg/m^3
1	6

Table 9-4 indicates that six mine-owned receptors; M18, M19, M20, M21, M23 and M24, are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m^3.

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 9.6**.

9.2.4 Predicted annual average PM_{10} concentrations

Figure E-15 shows the predicted annual average PM_{10} concentrations due to emissions from the Project in isolation and **Figure E-16** shows the predicted total impact from the Project and other sources.

The results in **Table 9-3** indicate that eight privately-owned receptors; Receptors 1, 170, 172, 173, 174, 175, 176 and 177, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project, with receptor 1 having a written agreement. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-3**.

Table 9-4 indicates that 16 mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6, M7, M19, M20, M22, M23, M30, M31 and M32, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources.

9.2.5 Predicted annual average TSP concentrations

Figure E-17 shows the predicted annual average TSP concentrations due to emissions from the Project in isolation. **Figure E-18** shows the predicted total impact from the Project and other sources.

The results in **Table 9-3** indicate that three privately-owned receptors; Receptors 170, 172 and 177, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-3**.

Table 9-4 indicates that four mine-owned receptors; Receptors M2, M3, M4, and M7, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources.

9.2.6 Predicted annual average dust deposition levels

Figure E-19 shows the predicted annual average dust deposition levels due to emissions from the Project in isolation. **Figure E-20** shows the predicted total impact from the Project and other sources.

The results in **Table 9-3** and **Table 9-4** indicate that all privately-owned and mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month.

The results in **Table 9-3** indicate that one privately-owned receptor; Receptor 170, is predicted to experience annual average dust deposition levels above the relevant criterion of 4g/m^2/month due to emissions from the Project and other sources. This receptor is largely unaffected by activity from the Project due to its distance away from the Project. This location would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-3**.

Table 9-4 indicates that all mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 4g/m^2/month due emissions from the Project and other sources.

9.3 Year 2023

Table 9-6 and **Table 9-7** present the model predictions at each of the privately-owned and mine-owned sensitive receptor locations respectively. The values presented in bold indicate predicted values above the relevant criteria.

The privately-owned receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations. These receptors are impacted at levels above the criteria regardless of the Project.

Figure E-21 to **Figure E-30** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in 2023.

Table 9-6: Modelling predictions for 2023 – privately-owned receptors

Receptor ID	$PM_{2.5}$ (μg/m³)		PM_{10} (μg/m³)		TSP (μg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (μg/m³)	PM_{10} (μg/m³)	TSP (μg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
1	10	2	**77**	17	31	1.0	8	**36**	84	3.0
2	2	0	15	2	3	0.1	6	20	57	2.1
3	2	0	12	1	2	0.0	6	18	54	2.1
4	2	0	12	1	2	0.0	6	18	54	2.1
5	2	0	12	1	2	0.0	6	18	54	2.1
6	1	0	10	1	1	0.0	6	17	53	2.0
7	2	0	13	1	2	0.0	6	18	54	2.1
8	2	0	14	1	1	0.0	6	18	54	2.1
9	2	0	12	1	1	0.0	6	17	53	2.0
10	1	0	10	1	1	0.0	6	17	53	2.0
11	1	0	10	1	1	0.0	6	17	52	2.0
12	1	0	6	0	1	0.0	6	17	52	1.9
13	1	0	11	1	1	0.0	6	17	52	2.0
14	1	0	10	1	1	0.0	6	17	52	2.0
15	3	1	26	5	8	0.3	7	22	60	2.3
16	4	1	31	5	8	0.3	7	22	60	2.3
17	5	1	34	5	9	0.3	7	22	61	2.3
18	5	1	39	5	8	0.2	7	22	60	2.2
19	5	1	41	5	8	0.2	7	22	60	2.2
20	5	1	35	4	6	0.2	6	21	59	2.2
21	4	0	34	4	6	0.1	6	21	58	2.2
22	4	0	32	3	5	0.1	6	21	58	2.2
23	4	0	29	3	5	0.1	6	21	58	2.1
24	2	0	16	2	3	0.1	6	20	57	2.1
25	2	0	18	3	6	0.2	6	19	56	2.2
26	2	0	19	4	6	0.2	6	20	56	2.2
27	3	0	25	3	5	0.1	6	20	56	2.1
28	2	0	18	3	5	0.2	6	19	56	2.2
29	2	0	16	3	5	0.2	6	19	55	2.2
30	2	0	17	3	5	0.2	6	19	55	2.2

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
31	3	0	23	3	6	0.2	6	20	57	2.2
32	3	1	24	4	7	0.2	6	20	58	2.2
33	4	1	27	4	6	0.2	6	20	58	2.2
34	3	0	26	4	6	0.2	6	20	57	2.2
35	3	0	19	3	6	0.2	6	20	56	2.2
36	3	0	22	3	5	0.1	6	19	56	2.1
37	3	0	22	4	6	0.2	6	20	57	2.2
38	3	0	22	3	4	0.1	6	19	55	2.1
39	3	0	23	3	5	0.1	6	19	56	2.1
40	3	1	26	5	8	0.3	6	20	58	2.3
41	4	1	29	6	9	0.4	6	21	59	2.4
42	4	1	30	6	10	0.4	7	21	59	2.4
43	4	1	28	5	8	0.3	6	20	58	2.3
44	4	1	32	6	10	0.4	7	22	60	2.4
45	3	1	23	4	6	0.2	6	19	56	2.2
46	3	1	25	4	7	0.2	6	20	57	2.2
47	4	1	33	7	12	0.5	7	23	62	2.5
48	4	1	31	7	12	0.5	7	23	62	2.5
49	4	1	29	7	11	0.5	7	22	61	2.5
50	4	1	27	6	9	0.4	6	21	59	2.4
51	3	1	21	4	6	0.3	6	19	55	2.3
52	3	1	23	5	7	0.4	6	20	57	2.4
53	4	1	27	6	10	0.6	7	22	60	2.6
54	4	1	32	7	13	0.6	7	23	63	2.6
55	4	1	34	8	14	0.6	7	24	64	2.6
56	2	1	18	5	8	0.6	6	20	56	2.7
57	3	1	25	7	11	1.0	7	22	61	3.0
58	4	1	28	7	12	1.1	7	23	63	3.1
59	3	1	25	6	10	0.6	7	22	61	2.7
60	3	1	22	5	8	0.7	6	21	58	2.8
61	6	1	45	10	17	0.8	7	27	68	2.8
62	3	1	26	6	10	0.5	7	22	61	2.5
63	3	1	20	5	8	0.7	6	20	57	2.7
64	3	1	21	5	8	0.7	6	20	58	2.8
65	5	1	40	9	16	1.1	7	25	67	3.2
66	3	1	21	5	8	0.6	6	20	57	2.6
67	3	1	23	5	9	0.7	6	21	58	2.7
68	3	1	21	5	9	0.7	6	20	58	2.7
69	3	1	20	5	8	0.6	6	20	57	2.7
70	2	1	18	4	7	0.5	6	19	56	2.5
71	3	1	26	6	10	0.9	7	22	60	3.0
72	4	1	28	6	11	0.9	7	22	61	3.0
73	3	1	22	5	8	0.5	6	20	57	2.5
74	3	1	22	6	10	0.9	6	21	59	3.0

Receptor ID	PM$_{2.5}$ (µg/m³)		PM$_{10}$ (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM$_{2.5}$ (µg/m³)	PM$_{10}$ (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
75	3	1	20	5	8	0.8	6	20	58	2.8
76	4	1	32	8	13	0.6	7	24	64	2.7
77	3	1	22	5	9	0.6	6	21	59	2.7
78	4	1	32	8	13	1.0	7	23	63	3.1
79	4	1	35	8	13	0.9	7	24	64	2.9
80	4	1	32	7	12	0.9	7	23	63	3.0
81	2	1	19	4	6	0.4	6	19	55	2.4
82	3	1	20	4	7	0.4	6	19	56	2.4
83	2	0	17	3	4	0.2	6	17	53	2.1
84	2	0	18	3	5	0.3	6	18	54	2.3
85	2	1	18	4	7	0.6	6	19	56	2.6
86	2	1	18	4	6	0.4	6	19	56	2.5
87	2	1	17	4	6	0.5	6	19	56	2.5
88	2	0	16	3	5	0.3	6	19	55	2.3
89	2	1	19	4	7	0.5	6	20	56	2.5
90	2	1	19	4	7	0.6	6	20	56	2.6
91	3	1	20	5	7	0.6	6	20	57	2.7
92	2	0	18	3	6	0.3	6	19	55	2.3
93	2	0	16	3	5	0.3	6	18	54	2.3
94	2	1	19	4	7	0.4	6	20	56	2.4
95	2	1	17	4	6	0.4	6	19	56	2.5
96	3	0	20	3	4	0.1	6	18	53	2.0
97	3	1	23	4	6	0.2	6	19	56	2.1
98	3	0	22	4	5	0.1	6	19	55	2.1
99	3	0	21	3	5	0.1	6	18	54	2.1
100	3	0	21	3	5	0.1	6	18	54	2.0
101	3	0	19	3	4	0.1	6	18	53	2.0
102	3	0	20	3	4	0.1	6	18	54	2.0
103	2	0	18	2	4	0.1	6	17	53	2.0
104	3	1	25	4	6	0.2	6	20	56	2.1
105	3	0	23	4	6	0.1	6	19	55	2.1
106	3	0	22	3	5	0.1	6	18	54	2.0
107	3	0	22	3	5	0.1	6	18	54	2.0
108	3	0	22	3	5	0.1	6	18	54	2.0
109	3	0	21	3	4	0.1	6	18	54	2.0
110	3	0	21	3	4	0.1	6	18	54	2.0
111	3	0	19	3	4	0.1	6	18	53	2.0
112	2	0	18	2	4	0.1	6	17	53	2.0
113	3	0	19	3	4	0.1	6	18	53	2.0
114	2	0	18	2	4	0.0	6	17	53	2.0
115	3	0	19	3	4	0.1	6	18	53	2.0
116	2	0	18	2	4	0.0	6	18	53	2.0
117	3	0	20	3	4	0.1	6	18	53	2.0
118	3	0	21	3	4	0.1	6	18	54	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
119	2	0	18	2	4	0.0	6	18	53	2.0
120	3	0	19	3	4	0.1	6	18	53	2.0
121	3	0	22	3	4	0.1	6	18	54	2.0
122	3	0	22	3	4	0.1	6	18	54	2.0
123	1	0	9	1	1	0.0	6	17	53	2.0
124	1	0	7	1	1	0.0	6	17	52	2.0
125	1	0	9	1	1	0.0	6	17	52	2.0
126	1	0	8	1	1	0.0	6	17	52	2.0
127	1	0	8	1	1	0.0	6	16	51	2.0
128	1	0	8	1	1	0.0	6	16	51	2.0
129	1	0	7	1	1	0.0	6	16	51	2.0
130	1	0	11	1	2	0.0	6	16	51	1.9
131	2	0	15	2	2	0.0	6	17	52	1.9
132	2	0	12	1	2	0.0	6	16	51	1.9
133	1	0	8	1	1	0.0	6	15	50	1.9
134	1	0	8	1	1	0.0	6	17	53	2.0
135	1	0	9	1	1	0.0	6	17	53	2.0
136	4	1	29	4	7	0.1	6	20	57	2.1
137	4	1	33	5	8	0.1	6	21	58	2.1
138	5	1	35	5	8	0.1	7	21	59	2.1
139	4	1	29	4	7	0.1	6	20	57	2.1
140	5	1	41	7	11	0.2	7	23	62	2.2
141	2	0	14	2	3	0.0	6	17	53	1.9
142	2	0	12	1	2	0.0	6	17	52	2.0
143	2	0	15	1	2	0.0	6	17	52	2.0
144	2	0	14	1	2	0.0	6	17	52	2.0
145	2	0	12	1	1	0.0	6	17	52	2.0
146	2	0	15	1	2	0.0	6	17	53	2.0
147	2	0	13	1	2	0.0	6	17	53	2.0
148	2	0	14	1	2	0.0	6	18	54	2.1
149	3	0	25	2	3	0.0	6	20	56	2.1
150	2	0	18	1	2	0.0	6	20	56	2.1
151	2	0	16	1	2	0.0	6	20	56	2.2
152	4	1	29	4	7	0.1	6	20	57	2.0
153	4	1	27	4	6	0.1	6	20	56	2.0
154	4	1	27	4	6	0.1	6	20	56	2.0
155	4	1	30	4	7	0.1	6	20	57	2.0
156	3	0	26	4	5	0.1	6	19	56	2.0
157	4	1	29	4	6	0.1	6	20	57	2.0
158	3	0	25	3	5	0.1	6	19	55	2.0
159	4	1	29	4	6	0.1	6	20	56	2.0
160	3	0	23	3	4	0.0	6	19	55	2.0
161	3	0	22	3	4	0.0	6	19	55	2.0
162	3	0	20	3	4	0.0	6	18	54	2.0

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
163	3	0	25	2	3	0.0	6	18	53	2.0
164	4	0	28	3	4	0.0	6	20	57	2.1
165	3	0	19	2	2	0.0	6	20	57	2.1
166	3	0	23	3	4	0.0	6	18	54	2.0
167	3	0	21	3	4	0.1	6	20	56	2.0
168	3	0	21	2	3	0.0	6	20	56	2.1
169	3	0	20	2	3	0.0	6	20	57	2.1
170	6	2	44	11	17	0.2	**17**	**103**	**222**	**5.4**
171	6	2	45	13	20	0.4	8	**36**	81	2.5
172	4	1	33	7	10	0.1	**10**	**46**	**99**	2.6
173	6	1	48	10	14	0.2	**9**	**39**	84	2.4
174	5	1	34	7	9	0.1	8	**36**	82	2.4
175	2	0	17	3	4	0.0	8	**36**	83	2.6
176	3	1	25	5	7	0.1	**9**	**38**	86	2.5
177	2	0	18	2	3	0.0	**9**	**43**	**99**	2.8

*Advisory NEPM reporting standard applicable to the population as a whole

Table 9-7: Modelling predictions for 2023 – mine-owned receptors

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M1	3	0	20	2	3	0.0	**9**	**38**	89	2.7
M2	3	0	24	3	5	0.0	**11**	**53**	**121**	3.2
M3	3	0	26	4	5	0.1	**11**	**55**	**125**	3.5
M4	5	1	37	7	11	0.1	**10**	**47**	**101**	2.7
M5	6	1	44	8	12	0.1	**9**	**37**	82	2.4
M6	6	1	45	9	13	0.1	**9**	**40**	87	2.5
M7	6	1	44	9	13	0.2	**9**	**44**	**95**	2.6
M8	4	0	26	2	3	0.0	6	18	54	2.0
M9	3	0	25	2	3	0.0	6	18	54	2.0
M10	3	0	21	2	3	0.0	6	18	53	2.0
M11	3	0	23	2	3	0.0	6	18	54	2.0
M12	3	0	20	2	3	0.0	6	18	53	2.0
M13	3	0	19	2	3	0.0	6	18	53	2.0
M14	3	0	19	2	3	0.0	6	18	53	2.0
M15	2	0	16	2	3	0.0	6	18	53	2.0
M16	8	2	**60**	12	21	1.0	7	29	72	3.1
M17	10	2	**77**	18	33	1.0	8	**36**	85	3.0
M18	10	2	**79**	19	35	1.1	8	**37**	88	3.1
M19	12	3	**96**	26	47	1.5	**9**	**44**	**100**	3.5
M20	13	3	**101**	27	49	1.6	**9**	**44**	**102**	3.7

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M21	7	2	**54**	12	21	0.6	8	30	73	2.7
M22	11	3	**86**	20	36	1.2	**9**	**38**	90	3.3
M23	9	2	**68**	15	26	0.8	8	**33**	80	2.9
M24	2	0	14	1	2	0.0	6	18	54	2.1
M25	2	0	14	1	1	0.0	6	18	54	2.1
M26	2	0	14	1	1	0.0	6	18	53	2.0
M27	2	0	13	1	2	0.0	7	21	59	2.2
M28	1	0	5	1	1	0.0	7	27	68	2.2
M29	5	1	35	6	9	0.1	8	**33**	76	2.3
M30	5	1	36	7	9	0.1	8	**35**	78	2.3
M31	5	1	34	6	9	0.1	8	**36**	80	2.4
M32	1	0	11	1	2	0.0	7	25	64	2.3

*Advisory NEPM reporting standard applicable to the population as a whole

9.3.1 Predicted maximum 24-hour average $PM_{2.5}$ concentrations

Figure E-21 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in isolation.

The results in **Table 9-6** and **Table 9-7** indicate that all privately-owned and mine-owned receptors are predicted to experience maximum 24-hour average concentrations below the advisory reporting standard of 25µg/m³.

Results for the total (cumulative) impact for maximum 24-hour average $PM_{2.5}$ concentrations are discussed in **Section 9.6**.

9.3.2 Predicted annual average $PM_{2.5}$ concentrations

Figure E-22 shows the predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in isolation and **Figure E-23** shows the predicted total impact from the Project and other sources.

The results in **Table 9-6** indicate that five privately-owned receptors; Receptors 170, 172, 173, 176 and 177, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-6**.

Table 9-7 indicates that 10 mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6, M7, M19, M20 and M22, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources.

9.3.3 Predicted maximum 24-hour average PM_{10} concentrations

Figure E-24 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in isolation.

The results in **Table 9-6** indicate that all privately-owned receptors with the exception of Receptor 1 are predicted to experience maximum 24-hour average concentrations below the relevant criterion of 50µg/m^3.

Further analysis of the number of days that this receptor experiences levels above 50µg/m^3 is presented in **Table 9-8**. The analysis indicates that Receptor 1 is predicted to experience 19 days above the relevant criterion of 50µg/m^3.

Table 9-8: Analysis of Year 2023 – maximum 24-hour average PM_{10} concentrations

Receptor ID	Number of days over 50µg/m^3
1	19

Table 9-7 indicates that eight mine-owned receptors; M16, M17, M18, M19, M20, M21, M22 and M23, are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m^3.

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 9.6**.

9.3.4 Predicted annual average PM_{10} concentrations

Figure E-25 shows the predicted annual average PM_{10} concentrations due to emissions from the Project in isolation and **Figure E-26** shows the predicted total impact from the Project and other sources.

The results in **Table 9-6** indicate that nine privately-owned receptors; Receptors 1, 170, 171, 172, 173, 174, 175, 176 and 177, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project, with receptor 1 having written agreement. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-6**.

Table 9-7 indicates that 16 mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6, M7, M17, M18, M19, M20, M22, M23, M30, M31 and M32, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources.

9.3.5 Predicted annual average TSP concentrations

Figure E-27 shows the predicted annual average TSP concentrations due to emissions from the Project in isolation. **Figure E-28** shows the predicted total impact from the Project and other sources.

The results in **Table 9-6** indicate that three privately-owned receptors; Receptors 170, 172 and 177, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-6**.

Table 9-7 indicates that six mine-owned receptors; Receptors M2, M3, M4, M7, M19 and M20, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources.

9.3.6 Predicted annual average dust deposition levels

Figure E-29 shows the predicted annual average dust deposition levels due to emissions from the Project in isolation. **Figure E-30** shows the predicted total impact from the Project and other sources.

The results in **Table 9-6** and **Table 9-7** indicate that all privately-owned and mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month.

The results in **Table 9-6** indicate that one privately-owned receptor; Receptor 170, is predicted to experience annual average dust deposition levels above the relevant criterion of 4g/m^2/month due to emissions from the Project and other sources. This receptor is largely unaffected by activity from the Project due to its distance away from the Project. This location would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-6**.

Table 9-7 indicates that all mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 4g/m^2/month due to emissions from the Project and other sources.

9.4 Year 2026

Table 9-9 and **Table 9-10** present the model predictions at each of the privately-owned and mine-owned sensitive receptor locations respectively. The values presented in bold indicate predicted values above the relevant criteria. The privately-owned receptor locations highlighted in orange are identified as already in the acquisition zone for other mine operations.

Figure E-31 to **Figure E-40** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in 2026.

Table 9-9: Modelling predictions for 2026 – privately-owned receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
1	5	1	42	10	17	0.6	7	28	71	2.7
2	1	0	8	1	2	0.0	6	19	55	2.1
3	1	0	7	1	1	0.0	6	17	53	2.1
4	1	0	7	1	1	0.0	6	18	54	2.1
5	1	0	7	1	1	0.0	6	18	53	2.1
6	1	0	6	0	1	0.0	6	17	52	2.0
7	1	0	7	1	1	0.0	6	18	53	2.1
8	1	0	8	0	1	0.0	6	17	53	2.0
9	1	0	7	0	1	0.0	6	17	52	2.0
10	1	0	6	0	1	0.0	6	17	52	2.0
11	1	0	6	0	0	0.0	6	17	52	2.0
12	0	0	3	0	0	0.0	6	16	52	1.9
13	1	0	6	0	1	0.0	6	17	52	2.0
14	1	0	6	0	1	0.0	6	17	52	2.0
15	2	0	14	3	5	0.2	6	20	57	2.2
16	2	0	17	3	5	0.2	6	20	57	2.2
17	2	0	19	3	6	0.2	6	20	57	2.2
18	3	0	21	3	5	0.1	6	20	57	2.2
19	3	0	22	3	5	0.1	6	20	57	2.2
20	2	0	19	2	4	0.1	6	19	56	2.1
21	2	0	18	2	3	0.1	6	19	56	2.1
22	2	0	17	2	3	0.1	6	19	56	2.1
23	2	0	16	2	3	0.1	6	19	56	2.1
24	1	0	9	1	2	0.0	6	19	55	2.1
25	2	0	12	2	3	0.1	6	18	54	2.1
26	2	0	11	2	4	0.1	6	18	54	2.1
27	2	0	14	2	3	0.1	6	18	54	2.1
28	1	0	11	2	3	0.1	6	18	54	2.1
29	1	0	10	2	3	0.1	6	18	53	2.1
30	1	0	10	2	3	0.1	6	18	53	2.1
31	2	0	13	2	3	0.1	6	18	54	2.1
32	2	0	13	2	4	0.1	6	19	55	2.1
33	2	0	15	2	4	0.1	6	19	55	2.1

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
34	2	0	14	2	3	0.1	6	19	55	2.1
35	1	0	11	2	3	0.1	6	18	54	2.1
36	2	0	12	2	3	0.1	6	18	54	2.1
37	2	0	12	2	4	0.1	6	18	54	2.1
38	2	0	12	2	3	0.1	6	18	54	2.1
39	2	0	12	2	3	0.1	6	18	54	2.1
40	2	0	19	3	5	0.2	6	18	55	2.2
41	3	0	22	4	6	0.2	6	19	56	2.2
42	3	0	22	4	6	0.2	6	19	56	2.2
43	2	0	18	3	5	0.2	6	19	55	2.1
44	3	1	24	4	7	0.2	6	20	57	2.2
45	2	0	15	2	4	0.1	6	18	53	2.1
46	2	0	17	3	4	0.1	6	18	54	2.1
47	3	1	27	5	8	0.3	6	20	58	2.3
48	3	1	26	5	8	0.3	6	20	58	2.3
49	3	1	25	4	7	0.3	6	20	57	2.3
50	3	0	22	4	6	0.3	6	19	56	2.2
51	2	0	15	2	4	0.2	6	17	53	2.1
52	2	0	18	3	5	0.2	6	18	54	2.2
53	3	1	23	4	7	0.3	6	19	56	2.3
54	3	1	27	5	8	0.4	6	20	58	2.4
55	4	1	29	5	9	0.4	6	21	59	2.4
56	1	0	11	3	5	0.4	6	18	53	2.4
57	2	1	18	4	7	0.6	6	20	57	2.7
58	2	1	19	5	8	0.7	6	20	58	2.7
59	2	0	19	4	6	0.4	6	20	57	2.5
60	2	0	12	3	5	0.5	6	19	55	2.5
61	3	1	27	6	10	0.5	7	23	62	2.6
62	3	0	20	4	6	0.3	6	20	57	2.4
63	2	0	14	3	5	0.4	6	18	54	2.5
64	1	0	12	3	5	0.5	6	18	54	2.5
65	3	1	24	6	10	0.7	7	22	60	2.8
66	2	0	17	3	5	0.4	6	18	54	2.4
67	2	0	19	3	6	0.4	6	19	55	2.4
68	2	0	16	3	5	0.4	6	18	54	2.5
69	2	0	15	3	5	0.4	6	18	54	2.4
70	2	0	14	3	4	0.3	6	17	53	2.3
71	2	0	15	4	6	0.6	6	19	56	2.7
72	2	1	14	4	7	0.6	6	20	57	2.7
73	2	0	18	3	5	0.3	6	18	54	2.3
74	2	0	15	4	6	0.6	6	19	55	2.6
75	2	0	12	3	5	0.5	6	18	54	2.5
76	3	1	24	5	8	0.4	6	21	59	2.5
77	2	0	15	3	6	0.4	6	19	56	2.5

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
78	2	1	18	5	8	0.7	6	20	58	2.8
79	3	1	20	5	8	0.6	6	21	59	2.6
80	2	1	17	4	7	0.6	6	20	58	2.7
81	2	0	16	3	4	0.3	6	17	53	2.2
82	2	0	17	3	4	0.3	6	17	53	2.2
83	2	0	12	2	3	0.1	6	16	51	2.1
84	2	0	14	2	3	0.2	6	17	52	2.1
85	1	0	11	3	4	0.4	6	18	53	2.4
86	1	0	9	2	4	0.3	6	18	53	2.3
87	1	0	9	2	4	0.3	6	18	53	2.3
88	1	0	11	2	3	0.2	6	17	53	2.2
89	1	0	11	3	4	0.3	6	18	54	2.4
90	1	0	10	3	4	0.4	6	18	54	2.4
91	1	0	10	3	5	0.4	6	18	54	2.5
92	2	0	13	2	4	0.2	6	18	53	2.2
93	1	0	8	2	3	0.2	6	17	52	2.2
94	2	0	14	2	4	0.3	6	18	54	2.3
95	1	0	11	2	4	0.3	6	18	54	2.3
96	2	0	13	2	2	0.0	6	17	52	2.0
97	2	0	16	2	4	0.1	6	18	53	2.1
98	2	0	15	2	3	0.1	6	17	53	2.0
99	2	0	14	2	3	0.1	6	17	52	2.0
100	2	0	14	2	3	0.1	6	17	52	2.0
101	2	0	12	2	2	0.0	6	16	51	2.0
102	2	0	13	2	3	0.1	6	17	52	2.0
103	1	0	11	1	2	0.0	6	16	51	2.0
104	2	0	17	2	4	0.1	6	18	54	2.0
105	2	0	16	2	3	0.1	6	17	53	2.0
106	2	0	15	2	3	0.0	6	17	52	2.0
107	2	0	15	2	3	0.1	6	17	52	2.0
108	2	0	15	2	3	0.0	6	17	52	2.0
109	2	0	14	2	3	0.0	6	17	52	2.0
110	2	0	14	2	3	0.0	6	17	52	2.0
111	2	0	13	2	2	0.0	6	17	51	2.0
112	2	0	12	1	2	0.0	6	16	51	1.9
113	2	0	12	1	2	0.0	6	16	51	2.0
114	2	0	12	1	2	0.0	6	16	51	1.9
115	2	0	13	1	2	0.0	6	17	51	2.0
116	2	0	12	1	2	0.0	6	16	51	1.9
117	2	0	13	2	2	0.0	6	17	52	2.0
118	2	0	13	2	2	0.0	6	17	52	2.0
119	1	0	11	1	2	0.0	6	16	51	1.9
120	2	0	12	1	2	0.0	6	17	52	1.9
121	2	0	13	2	2	0.0	6	17	52	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
122	2	0	12	2	2	0.0	6	17	52	2.0
123	1	0	5	0	0	0.0	6	17	52	2.0
124	0	0	4	0	0	0.0	6	16	52	2.0
125	1	0	5	0	1	0.0	6	17	52	2.0
126	1	0	4	0	1	0.0	6	16	51	2.0
127	1	0	4	0	1	0.0	6	16	51	2.0
128	1	0	5	0	1	0.0	6	16	51	2.0
129	1	0	4	0	1	0.0	6	16	50	1.9
130	1	0	6	1	1	0.0	6	16	50	1.9
131	1	0	7	1	1	0.0	6	16	50	1.9
132	1	0	7	1	1	0.0	6	16	50	1.9
133	1	0	5	1	1	0.0	6	15	49	1.9
134	1	0	4	0	0	0.0	6	17	52	2.0
135	1	0	5	0	0	0.0	6	17	52	2.0
136	3	0	20	3	4	0.1	6	18	54	2.0
137	3	0	21	3	4	0.1	6	19	55	2.0
138	3	0	23	3	5	0.1	6	19	55	2.0
139	3	0	20	3	4	0.1	6	18	54	2.0
140	4	1	27	4	6	0.1	6	20	57	2.1
141	1	0	8	1	1	0.0	6	16	51	1.9
142	1	0	6	1	1	0.0	6	16	51	2.0
143	1	0	8	1	1	0.0	6	16	51	2.0
144	1	0	8	1	1	0.0	6	16	51	2.0
145	1	0	7	1	1	0.0	6	17	52	2.0
146	1	0	8	1	1	0.0	6	17	52	2.0
147	1	0	7	1	1	0.0	6	17	52	2.0
148	1	0	8	1	1	0.0	6	18	53	2.0
149	2	0	13	1	2	0.0	6	19	55	2.0
150	1	0	8	1	1	0.0	6	19	55	2.1
151	1	0	8	1	1	0.0	6	19	56	2.2
152	3	0	19	2	4	0.1	6	18	54	2.0
153	2	0	18	2	3	0.0	6	18	54	2.0
154	2	0	17	2	3	0.0	6	18	53	2.0
155	3	0	19	2	4	0.0	6	18	54	2.0
156	2	0	15	2	3	0.0	6	18	53	2.0
157	2	0	18	2	3	0.0	6	18	54	2.0
158	2	0	14	2	3	0.0	6	17	53	2.0
159	2	0	16	2	3	0.0	6	18	53	2.0
160	2	0	11	2	2	0.0	6	17	53	1.9
161	2	0	11	1	2	0.0	6	17	53	1.9
162	2	0	11	1	2	0.0	6	17	52	1.9
163	2	0	13	1	1	0.0	6	17	52	2.0
164	2	0	14	1	2	0.0	6	19	55	2.0
165	1	0	10	1	1	0.0	6	19	56	2.1

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
166	2	0	12	1	2	0.0	6	17	52	1.9
167	1	0	11	1	2	0.0	6	19	54	2.0
168	2	0	11	1	2	0.0	6	19	55	2.1
169	1	0	11	1	1	0.0	6	19	55	2.1
170	5	1	36	7	10	0.1	**16**	**99**	**215**	**5.3**
171	4	1	31	7	10	0.2	8	30	71	2.3
172	3	1	25	4	6	0.1	**9**	**43**	**95**	**2.6**
173	4	1	31	6	8	0.1	8	**34**	78	2.3
174	3	1	23	4	6	0.1	8	**33**	78	2.3
175	2	0	12	2	2	0.0	8	**35**	81	2.5
176	2	0	18	3	4	0.0	8	**36**	83	2.4
177	2	0	12	1	2	0.0	**9**	**42**	**98**	2.8

*Advisory NEPM reporting standard applicable to the population as a whole

Table 9-10: Modelling predictions for 2026 – mine-owned receptors

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M1	2	0	14	1	2	0.0	**9**	**37**	87	2.7
M2	2	0	17	2	3	0.0	**10**	**52**	**119**	3.2
M3	2	0	17	2	3	0.0	**11**	**53**	**123**	3.5
M4	4	1	29	4	6	0.1	**9**	**44**	**97**	2.6
M5	4	1	28	5	7	0.1	8	**33**	76	2.3
M6	4	1	27	5	8	0.1	8	**36**	82	2.4
M7	4	1	28	5	8	0.1	**9**	**40**	90	2.6
M8	2	0	14	1	2	0.0	6	17	52	2.0
M9	2	0	13	1	2	0.0	6	17	52	2.0
M10	1	0	11	1	1	0.0	6	17	52	1.9
M11	2	0	12	1	2	0.0	6	17	52	1.9
M12	1	0	10	1	1	0.0	6	17	52	1.9
M13	1	0	10	1	2	0.0	6	17	52	1.9
M14	1	0	10	1	2	0.0	6	17	52	1.9
M15	1	0	8	1	2	0.0	6	17	51	1.9
M16	4	1	33	8	13	0.7	7	24	64	2.7
M17	6	1	**51**	12	21	0.6	7	29	73	2.6
M18	7	2	**52**	12	22	0.7	8	29	75	2.7
M19	8	2	**61**	16	29	1.0	8	**33**	82	3.0
M20	8	2	**61**	16	29	1.0	8	**33**	82	3.0
M21	4	1	35	7	12	0.4	7	25	65	2.5
M22	7	1	**52**	11	21	0.8	8	29	74	2.8
M23	5	1	40	9	15	0.5	7	27	68	2.6

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard									
	25*	-	50	-	-	2	8*	30	90	4
M24	1	0	8	1	1	0.0	6	18	54	2.1
M25	1	0	8	1	1	0.0	6	17	53	2.0
M26	1	0	8	0	1	0.0	6	17	53	2.0
M27	1	0	7	1	1	0.0	6	21	58	2.2
M28	0	0	3	0	0	0.0	7	27	68	2.2
M29	3	1	22	4	5	0.1	8	**31**	73	2.3
M30	3	1	23	4	5	0.1	8	**32**	74	2.3
M31	3	1	22	4	5	0.1	8	**33**	76	2.3
M32	1	0	7	1	1	0.0	7	24	63	2.3

*Advisory NEPM reporting standard applicable to the population as a whole

9.4.1 Predicted maximum 24-hour average $PM_{2.5}$ concentrations

Figure E-31 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in isolation.

The results in **Table 9-9** and **Table 9-10** indicate that all privately-owned and mine-owned receptors are predicted to experience maximum 24-hour average concentrations below the advisory reporting standard of 25µg/m³.

Results for the total (cumulative) impact for maximum 24-hour average $PM_{2.5}$ concentrations are discussed in **Section 9.6**.

9.4.2 Predicted annual average $PM_{2.5}$ concentrations

Figure E-32 shows the predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in isolation and **Figure E-33** shows the predicted total impact from the Project and other sources.

The results in **Table 9-9** indicate that three privately-owned receptors; Receptors 170, 172, and 177, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-9**.

Table 9-10 indicates that five mine-owned receptors; Receptors M1, M2, M3, M4 and M7, are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard of 8µg/m³ due to emissions from the Project and other sources.

9.4.3 Predicted maximum 24-hour average PM_{10} concentrations

Figure E-34 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in isolation.

The results in **Table 9-9** indicate that all privately-owned receptors are predicted to experience maximum 24-hour average concentrations below the relevant criterion of 50µg/m^3.

Table 9-10 indicates that five mine-owned receptors; M17, M18, M19, M20, and M22, are predicted to experience maximum 24-hour average concentrations above the relevant criterion of 50µg/m^3.

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 9.6**.

9.4.4 Predicted annual average PM_{10} concentrations

Figure E-35 shows the predicted annual average PM_{10} concentrations due to emissions from the Project in isolation and **Figure E-36** shows the predicted total impact from the Project and other sources.

The results in **Table 9-9** indicate that seven privately-owned receptors; ; Receptors 170, 172, 173, 174, 175, 176 and 177, are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-9**.

Table 9-10 indicates that 12 mine-owned receptors; Receptors M1, M2, M3, M4, M5, M6, M7, M19, M20, M30, M31 and M32 are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 due emissions from the Project and other sources.

9.4.5 Predicted annual average TSP concentrations

Figure E-37 shows the predicted annual average TSP concentrations due to emissions from the Project. **Figure E-38** shows the predicted total impact from the Project and other sources.

The results in **Table 9-9** indicate that three privately-owned receptors; Receptors 170, 172 and 177, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources. These receptors are largely unaffected by activity from the Project due to their distance away from the Project. These locations would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-9**.

Table 9-10 indicates that three mine-owned receptors; Receptors M2, M3 and M4, are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 due to emissions from the Project and other sources.

9.4.6 Predicted annual average dust deposition levels

Figure E-39 shows the predicted annual average dust deposition levels due to emissions from the Project. **Figure E-40** shows the predicted total impact from the Project and other sources.

The results in **Table 9-9** and **Table 9-10** indicate that all privately-owned and mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month.

The results in **Table 9-9** indicate that one privately-owned receptor; Receptor 170, is predicted to experience annual average dust deposition levels above the relevant criterion of 4g/m²/month due to emissions from the Project and other sources. This receptor is largely unaffected by activity from the Project due to its distance away from the Project. This location would be influenced by other modelled dust sources in the area as indicated by the low incremental predictions due to the Project in **Table 9-9**.

Table 9-10 indicates that all mine-owned receptors are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 4g/m²/month due to emissions from the Project and other sources.

9.5 Summary of results

Table 9-11 summarises the privately-owned receptor locations where impacts are predicted to exceed relevant assessment criteria. The privately-owned receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations and are impacted regardless of the Project.

Only one of the nine impacted receptors (Receptor 1) is directly associated with impacts due to the Project. It is understood that there is an agreement in place between the Project and this receptor.

The remaining eight privately-owned receptors shown in orange highlighting are predicted to experience levels above the relevant criteria due to other mines.

Please note that due to the conservative nature of the modelling assumptions applied for other mines, the levels predicted at the receptors near other mines are likely to be significantly higher than the levels for the same receptors shown in the more refined site-specific assessments made for the other mines and in reality the actual levels are expected to be lower.

Table 9-11: Summary of modelled predictions where predicted impacts exceed assessment criteria – Privately-owned receptors

Receptor ID	$PM_{2.5}$	PM_{10}			TSP	DD	
	Total ann. ave	Project only 24-hour ave		Total ann. ave	Total ann. ave	Project only ann. ave	Total ann. ave
	Criterion 8µg/m^3	Criterion 50µg/m^3		Criterion 30µg/m^3	Criterion 90µg/m^3	Criterion 2g/m^2/mth	Criterion 4g/m^2/mth
	Year of impact (level of impact - µg/m^3)		No. of days > 50µg/m^3	Year of impact (level of impact - µg/m^3)		Year of impact (level of impact – g/m^2/mth)	
1	-	2020 (71) 2023 (77)	6 19	2020 (34) 2023 (36)	-	-	-
170	2017 (14) 2020 (16) 2023 (17) 2026 (16)	-	-	2017 (79) 2020 (100) 2023 (103) 2026 (99)	2017 (165) 2020 (218) 2023 (222) 2026 (215)	-	2020 (5.3) 2023 (5.4) 2026 (5.3)
171	-	-	-	2023 (36)	-	-	-
172	2017 (9) 2020 (10) 2023 (10) 2026 (9)	-	-	2017 (41) 2020 (47) 2023 (46) 2026 (43)	2020 (101) 2023 (99) 2026 (95)	-	-
173	2017 (9) 2020 (9) 2023 (9)	-	-	2017 (43) 2020 (39) 2023 (39) 2026 (34)	2017 (92)	-	-
174	2017 (9) 2020 (9)	-	-	2017 (37) 2020 (37) 2023 (36) 2026 (33)	-	-	-
175	-	-	-	2017 (36) 2020 (36) 2023 (36) 2026 (35)	-	-	-
176	2017 (9) 2020 (9)	-	-	2017 (38) 2020 (39)	-	-	-

Receptor ID	$PM_{2.5}$	PM_{10}			TSP	DD	
	Total ann. ave	Project only 24-hour ave		Total ann. ave	Total ann. ave	Project only ann. ave	Total ann. ave
	Criterion 8µg/m³	Criterion 50µg/m³		Criterion 30µg/m³	Criterion 90µg/m³	Criterion 2g/m²/mth	Criterion 4g/m²/mth
	Year of impact (level of impact - µg/m³)		No. of days > 50µg/m³	Year of impact (level of impact - µg/m³)		Year of impact (level of impact – g/m²/mth)	
	2023 (9)			2023 (38) 2026 (36)			
177	2017 (14) 2020 (9) 2023 (9) 2026 (9)	-	-	2017 (80) 2020 (43) 2023 (43) 2026 (42)	2017 (185) 2020 (99) 2023 (99) 2026 (98)	-	2017 (5.1)

9.6 Assessment of total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} concentrations

9.6.1 Introduction

The NSW EPA contemporaneous assessment method was applied to examine the potential maximum (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts for the Project.

The analysis described in this section focusses on the nearest likely impacted receptor locations with reference to locations surrounding the Project where the data required to conduct this assessment are available. There are three surrounding monitoring stations where suitable ambient monitoring data are available. The monitoring data collected at these sites cover the contemporaneous modelling period. The assessment of cumulative impacts uses the monitoring data from the closest monitor.

Figure 9-1 shows the location of each of these monitors in relation to the Project and surrounding locations for the assessment.

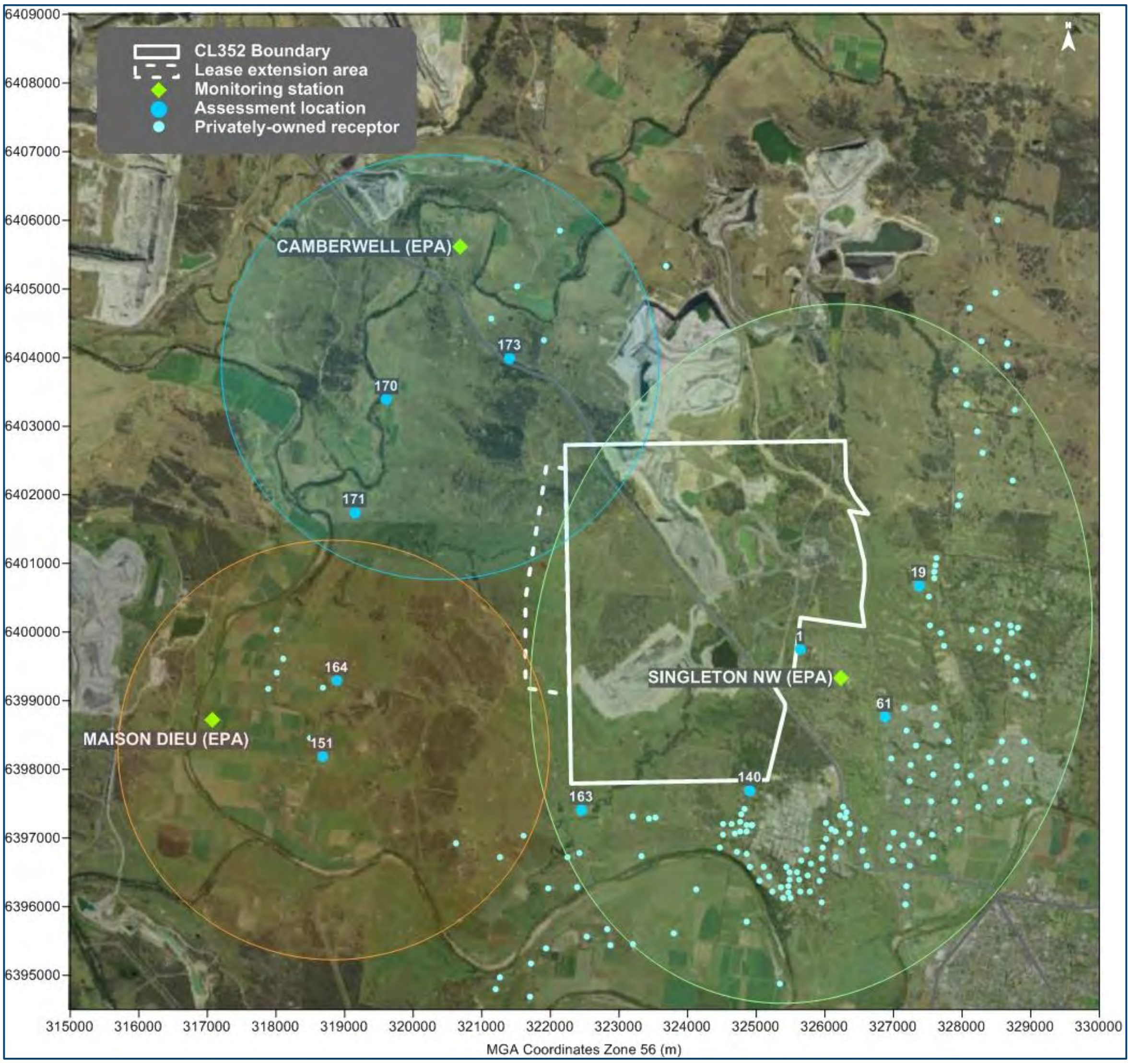

Figure 9-1: Locations for contemporaneous cumulative impact assessment

9.6.2 Contemporaneous assessment per NSW EPA Approved Methods

An assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with the methods outlined in Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC**, **2005**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts.

As shown in **Section 4.3**, maximum background levels have on occasion recorded levels over the 24-hour average PM_{10} criterion level and the $PM_{2.5}$ advisory reporting standard. Due to these elevated levels in the monitoring data, the screening Level 1 NSW EPA approach of adding maximum background levels to maximum predicted Project only levels would not be appropriate for assessing the potential 24-hour average impacts on these elevated days.

In such situations, the NSW EPA approach applies a more thorough Level 2 assessment whereby the measured background level on a given day is added contemporaneously with the corresponding Project only level predicted using the same day's weather data. This method factors into the assessment the spatial and temporal variation in background levels affected by the weather and existing sources of dust in the area on a given day. However, even with a detailed Level 2 approach, any air dispersion modelling has limitations in predicting short term impacts which may arise many years into the future, and these limitations need to be understood when interpreting the results.

Ambient (background) dust concentration data for January 2012 to December 2012 from the surrounding NSW EPA TEOM monitoring stations have been applied in the Level 2 contemporaneous 24-hour average $PM_{2.5}$ and PM_{10} assessment and represent the prevailing measured background levels in the vicinity of the Project and the closest surrounding sensitive receptor locations.

Table 9-12 provides a summary of the findings of the contemporaneous assessment at each relevant receptor. The receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations and are impacted regardless of the Project.

Detailed tables of the full assessment results are provided in **Appendix F**.

Table 9-12: NSW EPA contemporaneous assessment – maximum number of additional days above criteria

Receptor ID	$PM_{2.5}$ analysis				PM_{10} analysis			
	2017	2020	2023	2026	2017	2020	2023	2026
1	0	0	0	0	2	**21**	**32**	4
19	0	0	0	0	1	1	3	1
61	0	0	0	0	2	5	5	4
140	0	0	0	0	3	2	4	1
151	0	0	0	0	1	1	2	1
163	0	0	0	0	3	3	1	0
164	0	0	0	0	1	1	1	1
170	0	0	0	0	0	0	1	0
171	0	0	0	0	3	0	5	1
173	0	0	0	0	0	0	2	0

The results in **Table 9-12** indicate that there is no likely potential for cumulative 24-hour average $PM_{2.5}$ impacts to occur however there is potential for cumulative 24-hour average PM_{10} impacts.

Potential cumulative PM_{10} impacts could arise at a number of the assessed sensitive receptor locations. For the majority of these receptors, it is predicted that between 1 to 5 additional days for PM_{10} is likely to occur.

Analysis of the assessment results provided in **Appendix F** indicates that the Project generally has low incremental effects during these days, except at Receptor 1.

For Receptor 1 located immediately southeast of the Project, impacts above the criterion are predicted to occur in 2020 and 2023 with 21 and 31 additional days of predicted potential impact respectively.

Further analysis of the predicted cumulative $PM_{2.5}$ and PM_{10} impacts are presented in **Figure 9-2** to **Figure 9-9** showing time series plots of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations predicted to be experienced as a result of the Project at three representative receptors, Receptor 61, 140, and 19.

These three receptors are the most affected receptors due to the Project. Receptor 19 is the most affected of the receptors in the more populated rural residential areas to the northwest of Singleton, Receptor 19 is the most affected receptor in the Singleton urban area and Receptor 140 is the most affected receptor in the cluster of rural receptors west of Singleton. All other privately owned receptors would experience less effects (except Receptor 1, which has an agreement in place with the Project).

The yellow bars in the figures show the predicted additional levels due to the Project above background levels (i.e. the yellow sections of the bars indicate the amount of increased dust). The blue bars show the existing background levels, however the orange sections overlap the blue bars and these orange coloured bars indicate the reduction relative to existing background levels that are predicted to occur. The top of yellow (or bottom of the orange) bar indicates the predicted future cumulative level associated with the Project and background combined.

The results indicate that $PM_{2.5}$ levels remain relatively similar as a result of the Project.

Figure 9-2: Predicted 24-hour average $PM_{2.5}$ concentrations for Receptors 61, 140 and 19 in Year 2017

Figure 9-3: Predicted 24-hour average $PM_{2.5}$ concentrations for Receptors 61, 140 and 19 in Year 2020

Figure 9-4: Predicted 24-hour average $PM_{2.5}$ concentrations for Receptors 61, 140 and 19 in Year 2023

Figure 9-5: Predicted 24-hour average $PM_{2.5}$ concentrations for Receptors 61, 140 and 19 in Year 2026

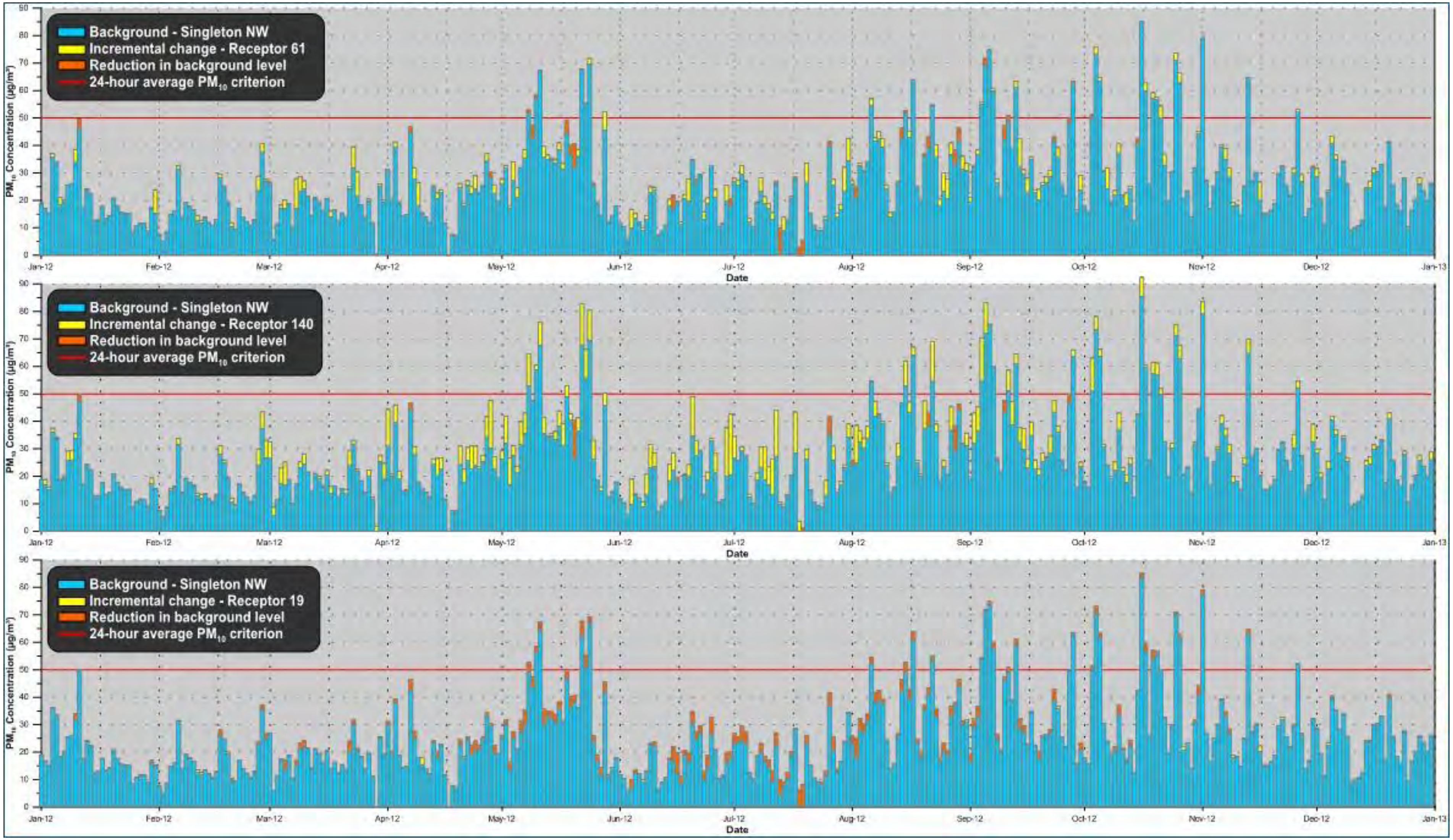

Figure 9-6: Predicted 24-hour average PM_{10} concentrations for Receptors 61, 140 and 19 in Year 2017

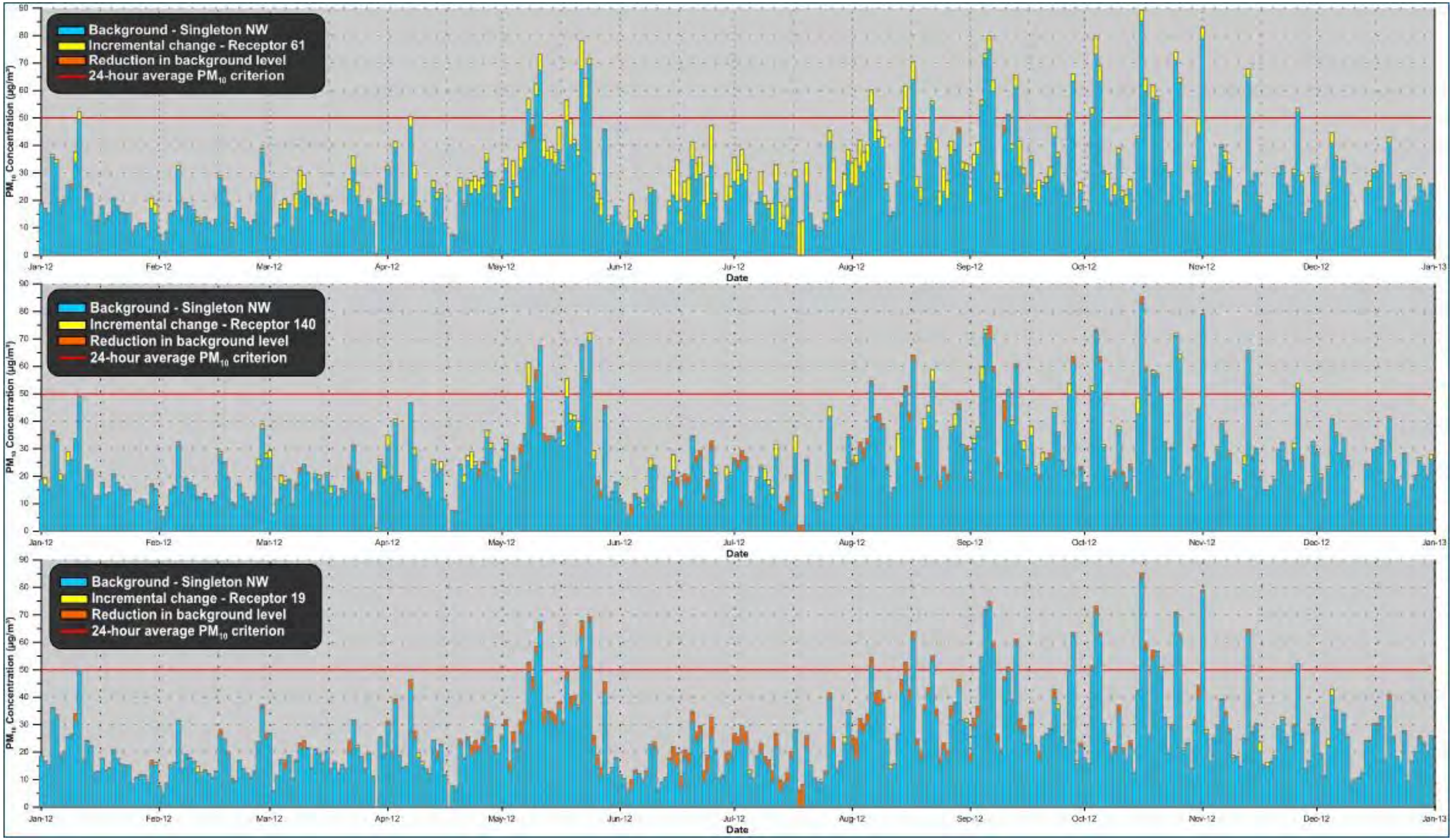

Figure 9-7: Predicted 24-hour average PM_{10} concentrations for Receptors 61, 140 and 19 in Year 2020

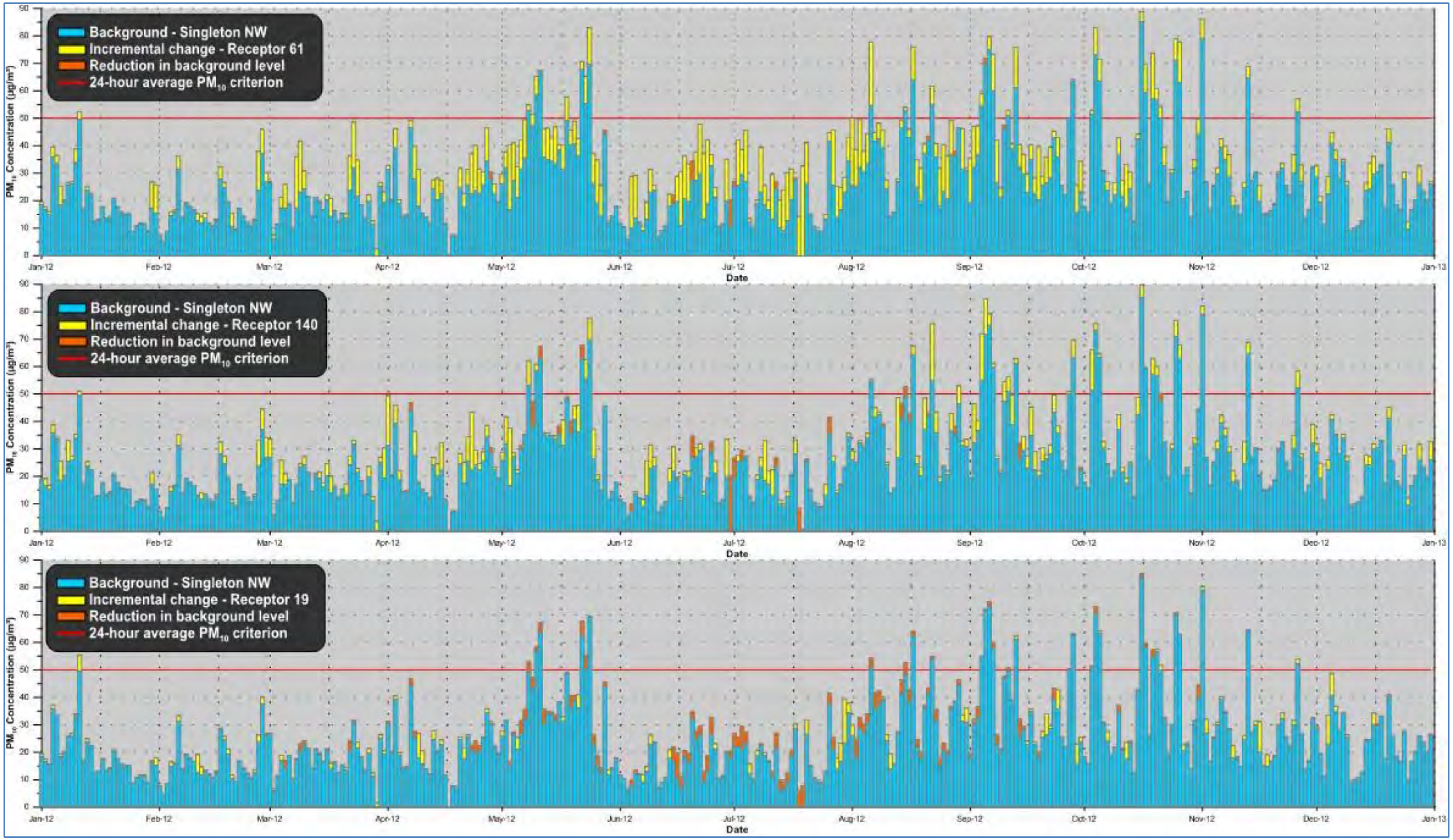

Figure 9-8: Predicted 24-hour average PM_{10} concentrations for Receptors 61, 140 and 19 in Year 2023

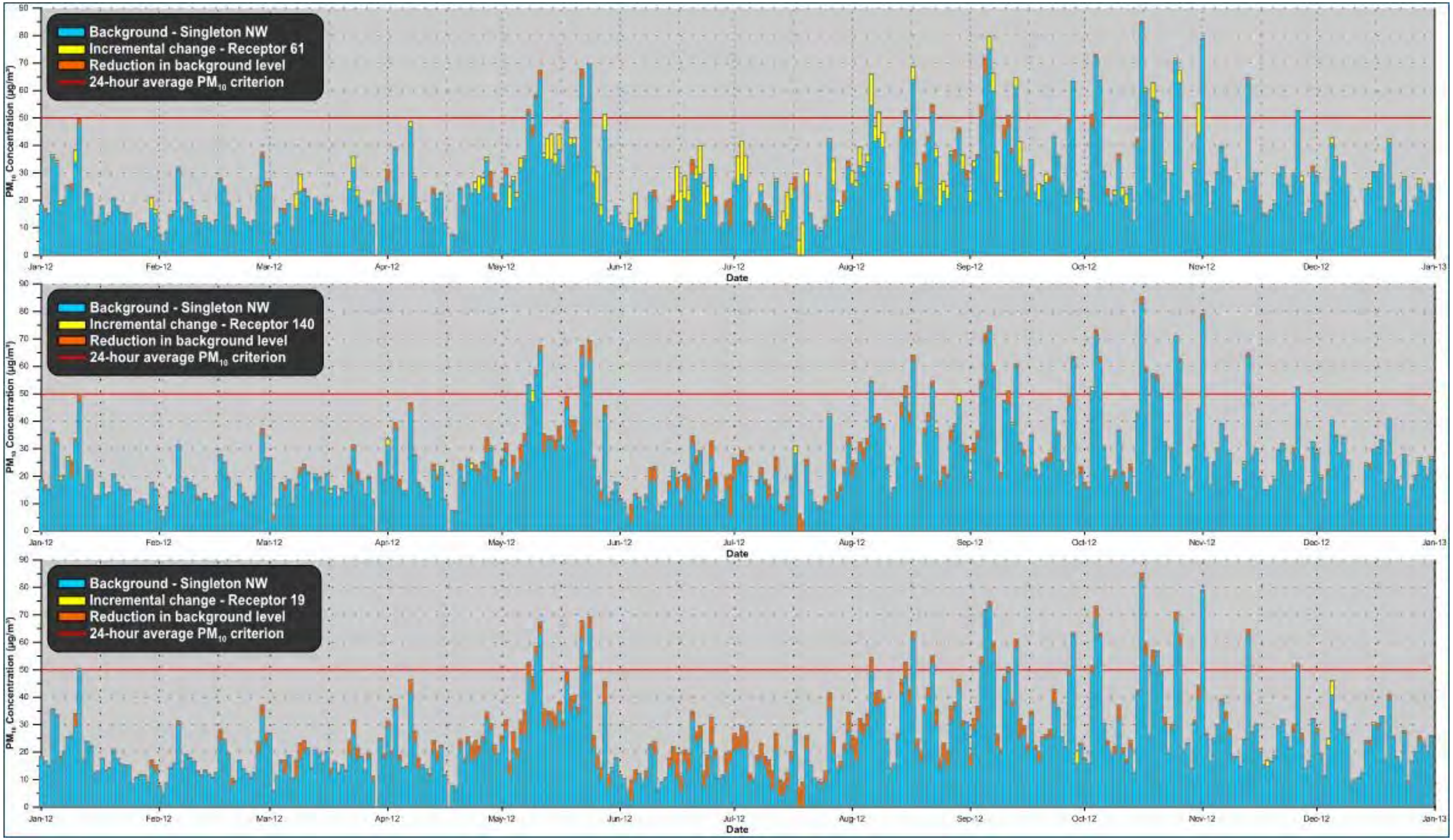

Figure 9-9: Predicted 24-hour average PM_{10} concentrations for Receptors 61, 140 and 19 in Year 2026

9.7 Dust impacts on more than 25 per cent of privately-owned land

An assessment was made to ascertain where the potential impacts due to the Project may extend over more than 25 per cent of any privately-owned land. Such an assessment can only be conducted approximately, based on the predicted pollutant dispersion contours.

For this Project, the maximum extent of the 6^{th} highest 24-hour average PM_{10} impact due to the Project in isolation was greater than the extent of any of the other assessed dust metrics and hence represents the most impacting parameter in every case.

The contour presented in **Figure 9-10** defines the maximum extent of the 6^{th} highest 24-hour average PM_{10} level for all years assessed over the full life of the Project. The effects are summarised **Table 9-13** for all land on which there is a home, or an entitlement to build a home.

Of the nine lots listed in **Table 9-13**, five lots are afforded acquisition rights by other approved mines. These lots are shown in orange shading in the table and in **Figure 9-10**. Of the remaining four lots, Lot 2 DP 804005 is the remainder of a consolidation from which Rix's Creek acquired Lot 1 DP 804005 as part of the 1995 consent process. Rix's Creek has engaged with this land owner to explain their potential acquisition rights. The remaining three lots are held by two landowners, in a combination of joint ownership and individual ownership, as part of a large rural holding (which adjoins both Rix's Creek Mine and Ashton South East Open Cut). Accordingly, Rix's Creek will discuss potential acquisition rights resulting from the Rix's Creek Continuation Project with these neighbouring two landholders.

Table 9-13: Privately-owned land with dust impacts on more than 25% of the land

DP	Lot
804005	
252692	52
252692	53
252692	54
121623	
1124347	
1111313	
1111313	
1136411	

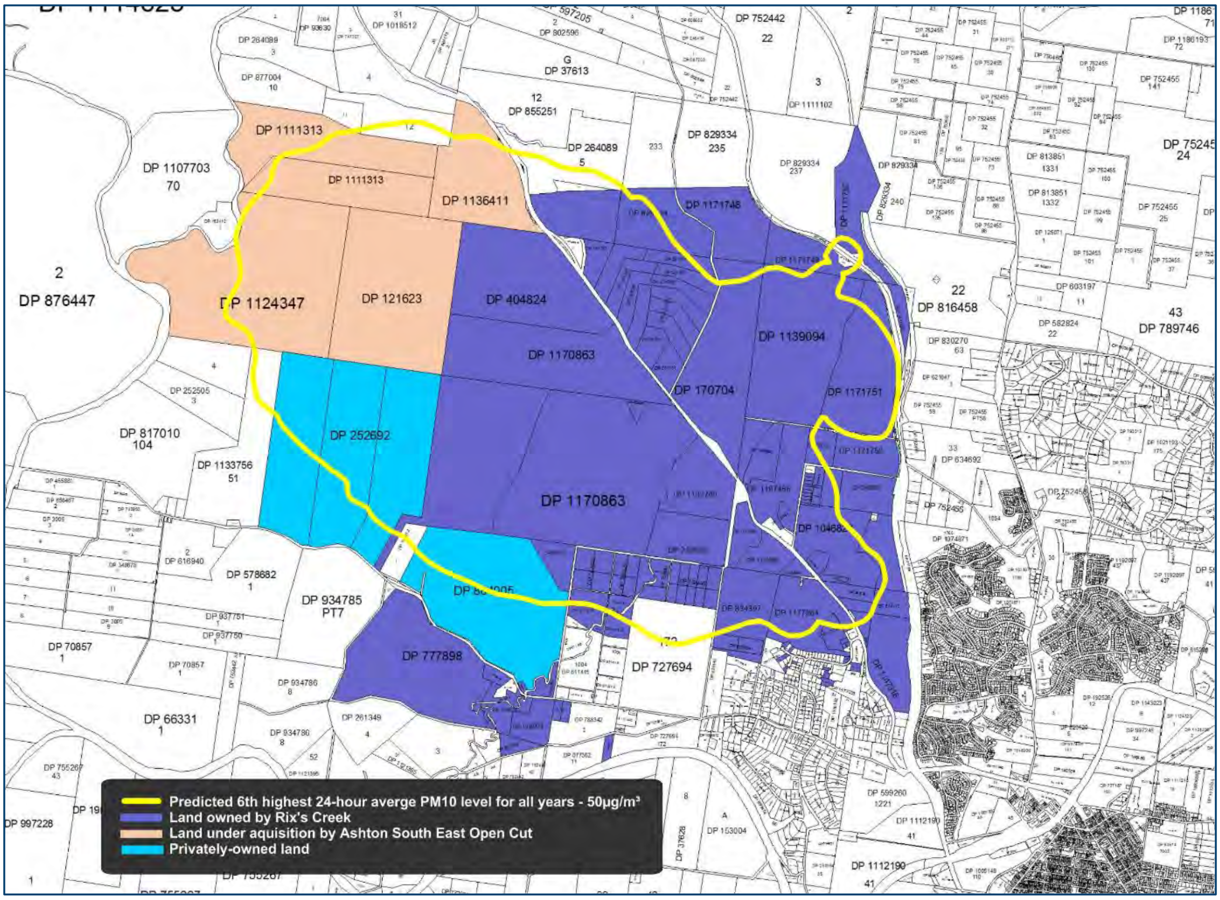

Figure 9-10: Predicted 6th highest 24-hour average PM_{10} level for all years assessed

10 ASSESSMENT OF DIESEL EMISSIONS

It is generally considered that the quantity of emissions generated from diesel powered equipment used for mining activity is too low to generate any significant off-site concentrations. This is due to consideration of the relatively small individual sources, the generally large distance between the sources and sensitive receptor locations, and the generally widely spread distribution of sources across the mine site.

A large amount of diesel fuel is used in mining and, consequently, there may be potential for impacts to arise due to the emissions from diesel powered equipment used during operations.

It is noted that the available monitoring data do not indicate any likely issues in this regard. For example, NO_2 is a significant pollutant emitted from the combustion of diesel, yet NO_2 levels at the monitoring stations in the Hunter Valley are low relative to the criteria.

Fine particulate (i.e. $PM_{2.5}$) is also a significant pollutant emitted from diesel combustion. A recent CSIRO study (**CSIRO, 2013**) on the composition of fine particulates in the Hunter Valley found that wood burning in winter made up an average of 62 per cent of the $PM_{2.5}$ in Muswellbrook and 38 per cent of the $PM_{2.5}$ in Singleton. Secondary sulphate and industry aged sea salt made the highest contribution during summer months, sulphate levels were found to be comparable to other Australian locations. Vehicle and industry sources comprised approximately 8 per cent and 17 per cent in Muswellbrook and Singleton, respectively.

Whilst these data may not indicate any issue related to diesel combustion, it is recognised that the locations at which these data were collected are some distance away from coal mines. Thus an assessment of potential impacts from diesel combustion was conducted for the Project to determine whether any risk may arise. It should be noted that emissions of fine particulate from diesel combustion in mining equipment is generally already included within the assessment of mine dust presented in **Section 8**.

10.1 Approach to assessment

10.1.1 Emission estimation

Emissions from diesel powered equipment were estimated on the basis of manufacturer's data. It is noted that manufacturer's equipment performance specifications were typically categorised on the basis of the US EPA federal tier standards of emissions for diesel equipment (**Dieselnet**, **2012**).

Emissions for certain plant included non-methane-hydrocarbon (NMHC) and NO_x emissions as a single value. For the purpose of this assessment it has been conservatively assumed that the total emission (NHMC and NO_x) comprises NO_2.

The various types of diesel powered mining equipment to be used under the Project were identified (see **Table 10-1**). Plant hours of operation were based on assumed plant availability and utilisation rates for the specific equipment type, conservatively assuming that all operational plant operates at full power for 50 per cent of the time.

The emission rates used in the modelling are considered conservative and likely to overestimate actual emissions from mining equipment.

Table 10-1: Summary of diesel powered equipment and associated emissions

Equipment type	Number of equipment			
	2017	2020	2023	2026
5600 Excavator	1	1	2	1
9800 Excavator	1	1	1	1
992K Loader	2	2	2	2
994F Loader	2	2	2	2
Dozer	8	8	11	11
Drill	2	2	4	3
Grader	3	2	3	3
Watercart	3	4	4	3
789 Truck	4	4	5	5
793 Truck	14	18	18	18

10.1.2 Dispersion modelling

Dispersion modelling of the diesel powered equipment was conducted for each indicative mine plan year. Modelled sources were described as point sources and impacts due to the Project were added to the ambient background level to assess potential impacts.

The NO_2 monitoring data presented in **Section 4** shows that the maximum measured 1-hour average NO_2 background level at the Singleton monitor during 2012 was 75.2µg/m^3. In lieu of any data for the site, per the Victorian EPA approach[2], the 70th percentile level of 41.4µg/m^3 obtained from the Singleton data was used as a constant background level contributing to the total cumulative impact predictions. The annual average NO_2 background level at the Singleton monitor during 2012 was 16.9µg/m^3.

It is noted that the background levels measured in Singleton are likely to be higher than the levels for the majority of sensitive receptor locations because there are many densely positioned sources of NO_X in Singleton, such as motor vehicles. The measured levels would also include some contribution of emissions arising from the existing operations and thus are considered to be even more conservative and likely to overestimate actual levels.

The conversion of NO_X to NO_2 was estimated using an empirical equation for estimating the oxidation rate of NO in power plant plumes developed by **Janssen et al. (1988)**. This method is outlined in the Approved Methods **(DEC, 2005)** and is used to calculate the ratio of NO_2 to NO_X as determined by the atmospheric conditions and distance from the maximum recorded level to the source.

The separation distance from the sources to the maximum predicted 1-hour and annual average ground-level concentrations was taken to be the nominal distance from the centroid of all NO_X sources to the nearest maximum affected sensitive receptor locations. Applying conservative "A" and "α" constant values, the ratio of NO_2 to NO_X at receptors due to the diesel powered equipment was calculated to be approximately 13%.

[2]The Victorian Government's State Environment Protection Policy (Air Quality Management), **SEPP (2001)** states at Part B, 3(b) *"Proponents required to include background data where no appropriate hourly background data exists must add the 70th percentile of one year's observed hourly concentrations as a constant value to the predicted maximum concentration from the model simulation. In cases where a 24-hour averaging time is used in the model, the background data must be based on 24-hour averages. "*.

10.2 Modelling predictions

Figure G-1 to **Figure G-6** in **Appendix G** present isopleth diagrams of the predicted modelling results for the assessed 1-hour average and annual average NO_2 concentrations.

The privately-owned receptor locations highlighted in orange are already identified in the acquisition zone for other mine operations due to particulate impacts.

Table 10-2 and **Table 10-3** presents the model predictions at each of the privately owned and mine owned sensitive receptor locations respectively. The results presented in the tables include the contribution from background levels.

Table 10-2: Predicted cumulative NO_2 concentrations (µg/m^3) for each indicative mine plan year – privately-owned sensitive receptors

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
1	145	19	230	22	231	21	212	21
2	99	18	130	18	129	18	129	18
3	88	17	118	17	118	17	119	17
4	89	17	128	18	114	17	111	17
5	78	17	101	17	97	17	111	17
6	78	17	96	17	93	17	106	17
7	79	17	104	17	89	17	94	17
8	81	17	102	17	89	17	93	17
9	84	17	106	17	94	17	98	17
10	80	17	99	17	91	17	99	17
11	76	17	100	17	92	17	97	17
12	71	17	96	17	82	17	88	17
13	86	17	105	17	88	17	90	17
14	81	17	94	17	84	17	88	17
15	79	18	112	18	115	18	124	18
16	83	18	106	18	111	18	118	18
17	90	18	108	18	108	18	116	18
18	86	18	106	18	119	18	106	18
19	86	18	107	18	108	18	117	18
20	89	18	106	18	103	18	117	18
21	96	18	107	18	104	18	116	18
22	102	18	106	18	104	18	112	18
23	106	18	117	18	111	18	105	18
24	103	18	134	18	133	18	129	18
25	73	18	96	18	104	18	113	18
26	76	18	109	18	103	18	113	18
27	95	18	97	18	94	18	97	18
28	72	18	112	18	105	18	103	18
29	69	17	102	18	98	18	100	18
30	66	17	96	18	98	18	97	18
31	87	18	113	18	103	18	107	18
32	81	18	114	18	105	18	115	18
33	85	18	98	18	99	18	104	18
34	90	18	104	18	99	18	103	18
35	79	18	116	18	104	18	108	18
36	88	18	100	18	93	18	96	18
37	84	18	117	18	104	18	111	18
38	91	18	92	18	89	18	92	18
39	94	18	94	18	92	18	94	18
40	89	19	121	19	113	19	110	19

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
41	104	19	140	19	124	19	121	19
42	111	19	146	19	128	19	125	19
43	98	19	136	19	124	19	126	19
44	121	19	153	20	135	20	132	19
45	81	18	110	19	119	18	118	18
46	90	19	133	19	131	19	133	19
47	128	20	156	20	140	20	133	20
48	125	19	154	20	139	20	131	20
49	115	19	150	20	132	20	125	20
50	96	19	136	19	118	19	114	19
51	72	18	97	18	94	18	92	18
52	78	18	113	19	104	19	101	19
53	94	19	142	19	128	20	123	19
54	126	19	158	20	146	20	138	20
55	129	20	162	20	151	20	144	20
56	60	18	80	18	83	18	81	18
57	76	18	95	19	105	19	104	19
58	79	18	95	19	109	19	113	19
59	73	18	108	19	102	18	99	18
60	62	18	81	18	84	18	80	18
61	96	18	121	20	130	20	128	20
62	74	18	112	18	115	18	120	18
63	62	18	84	18	92	19	89	18
64	62	18	75	18	77	18	79	18
65	94	18	102	20	115	20	119	20
66	64	18	91	18	102	19	98	19
67	66	18	99	19	110	19	105	19
68	63	18	87	18	100	19	92	19
69	62	18	87	18	96	19	91	18
70	60	18	83	18	88	18	86	18
71	71	18	85	19	97	19	103	19
72	70	18	92	19	91	19	92	19
73	67	18	99	19	103	19	100	19
74	68	18	84	18	98	19	97	19
75	62	18	75	18	87	18	86	18
76	87	18	120	19	116	19	113	19
77	67	18	90	18	91	18	94	18
78	80	18	92	19	104	19	111	19
79	82	18	107	19	115	19	112	19
80	74	18	98	19	103	19	99	19
81	63	18	87	18	93	18	89	18
82	65	18	93	18	94	18	92	18
83	64	18	81	18	79	18	78	18
84	64	18	86	18	84	18	85	18
85	59	18	73	18	81	18	80	18
86	60	18	77	18	81	18	78	18
87	59	18	76	18	81	18	81	18
88	64	17	93	18	86	18	88	18
89	63	18	84	18	85	18	85	18
90	60	18	77	18	76	18	78	18
91	60	18	77	18	77	18	74	18
92	64	18	104	18	102	18	103	18
93	56	17	72	18	72	18	72	18
94	68	18	107	18	101	18	102	18
95	65	18	90	18	82	18	84	18
96	111	18	116	18	119	18	124	18

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
97	87	18	134	19	133	18	136	18
98	91	18	143	18	138	18	144	18
99	82	18	129	18	131	18	133	18
100	94	18	137	18	134	18	140	18
101	95	18	130	18	126	18	131	18
102	81	18	129	18	129	18	133	18
103	85	18	129	18	123	18	128	18
104	101	19	147	19	143	19	149	18
105	100	18	143	18	142	18	150	18
106	107	18	125	18	130	18	136	18
107	105	18	133	18	135	18	142	18
108	107	18	126	18	130	18	136	18
109	105	18	131	18	132	18	138	18
110	109	18	120	18	124	18	128	18
111	108	18	125	18	126	18	130	18
112	112	18	111	18	113	18	117	18
113	112	18	111	18	115	18	119	18
114	112	18	113	18	111	18	117	18
115	112	18	115	18	111	18	119	18
116	112	18	120	18	109	18	116	18
117	108	18	121	18	110	18	118	18
118	103	18	123	18	109	18	118	18
119	95	18	120	18	110	18	114	18
120	92	18	120	18	113	18	118	18
121	96	18	124	18	115	18	121	18
122	90	18	119	18	118	18	125	18
123	70	17	84	17	80	17	80	17
124	67	17	80	17	75	17	75	17
125	69	17	87	17	80	17	81	17
126	72	17	82	17	84	17	87	17
127	68	17	90	17	93	17	98	17
128	71	17	91	17	95	17	101	17
129	67	17	91	17	91	17	94	17
130	67	17	79	17	84	17	96	17
131	67	17	89	17	91	17	94	17
132	64	17	83	17	90	17	92	17
133	62	17	80	17	80	17	86	17
134	69	17	92	17	89	17	92	17
135	65	17	86	17	85	17	85	17
136	114	18	137	18	128	18	137	18
137	124	18	144	19	129	18	141	18
138	125	19	148	19	135	18	145	18
139	114	18	137	18	128	18	137	18
140	113	19	154	19	137	19	147	19
141	76	17	117	17	108	17	117	17
142	80	17	109	17	97	17	100	17
143	81	17	105	17	96	17	100	17
144	77	17	97	17	90	17	94	17
145	74	17	91	17	88	17	88	17
146	80	17	111	17	106	17	111	17
147	74	17	97	17	92	17	108	17
148	92	17	121	17	113	17	114	17
149	88	17	109	18	106	18	118	17
150	78	17	109	17	98	17	96	17
151	87	17	116	17	94	17	95	17
152	116	18	136	18	125	18	135	18

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
153	111	18	134	18	119	18	128	18
154	108	18	133	18	119	18	126	18
155	119	18	139	18	123	18	132	18
156	104	18	129	18	122	18	129	18
157	114	18	138	18	125	18	134	18
158	94	18	121	18	124	18	134	18
159	109	18	138	18	129	18	139	18
160	101	17	141	18	120	18	133	18
161	98	17	134	18	124	18	134	18
162	81	17	114	18	117	17	135	17
163	89	17	116	17	96	17	107	17
164	95	17	115	18	110	18	127	18
165	77	17	97	17	92	17	90	17
166	85	18	113	18	121	18	131	18
167	75	17	91	18	91	18	96	18
168	80	17	95	18	95	17	98	17
169	79	17	99	17	95	17	95	17
170	71	18	96	19	109	19	117	20
171	84	18	106	19	109	19	111	19
172	85	18	126	20	117	19	133	19
173	102	19	132	21	125	20	145	20
174	78	18	102	19	106	19	114	19
175	72	18	108	18	91	18	101	18
176	75	18	109	19	99	18	116	19
177	73	17	115	18	89	18	108	18

Table 10-3: Predicted NO_2 concentrations (µg/m^3) for each indicative mine plan year – mine-owned sensitive receptors

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
M1	67	17	93	18	92	18	104	18
M2	71	17	102	18	96	18	115	18
M3	71	17	100	18	96	18	105	18
M4	80	18	132	20	121	19	141	19
M5	80	18	116	20	116	19	127	19
M6	71	18	101	19	106	19	113	19
M7	67	18	91	19	101	19	109	19
M8	90	17	116	17	100	17	103	17
M9	92	17	116	17	101	17	109	17
M10	89	17	112	17	103	17	108	17
M11	87	17	116	17	110	17	114	17
M12	86	17	112	17	104	17	108	17
M13	90	17	113	17	107	17	117	17
M14	88	17	113	17	111	17	125	17
M15	84	17	125	18	102	17	118	17
M16	123	19	132	21	129	21	135	21
M17	145	21	205	23	191	23	184	23
M18	145	21	211	23	193	24	193	23
M19	165	22	221	24	217	25	207	25
M20	190	21	198	24	199	25	199	24
M21	146	19	173	21	167	20	152	20
M22	163	19	215	22	207	22	169	22
M23	163	19	213	22	209	21	188	21
M24	81	17	105	17	87	17	93	17

Receptor ID	2017		2020		2023		2026	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
M25	81	17	103	17	88	17	91	17
M26	81	17	103	17	90	17	94	17
M27	88	17	133	18	117	17	124	17
M28	75	17	98	17	84	17	90	17
M29	69	18	98	19	105	19	113	19
M30	73	18	105	19	110	19	119	19
M31	80	18	107	19	105	19	114	19
M32	59	17	94	18	84	17	101	17

10.3 Summary

10.3.1 Analysis of NO_2 modelling

The modelling predictions in **Table 10-2** and **Table 10-3** indicate that in all the assessed years, all privately-owned and mine-owned sensitive receptor locations are predicted to experience maximum 1-hour average and annual average NO_2 concentrations below the relevant criteria of 246µg/m^3 and 63µg/m^3, respectively.

10.3.2 Other diesel powered plant impacts

The ambient air quality goals for CO are set at higher concentration levels than the NO_2 goals. Based on the NO_2 monitoring data which are low compared to the goals, and consideration of the typical mix of ambient pollutant levels and associated emissions of CO, the indication is that predictions of CO would be well below the air quality goals and do not require further consideration.

10.3.3 Mitigation measures

The Project would ensure diesel emissions from the site are minimised where possible by ensuring engines of all on-site vehicles are switched off when not in use, where practical fitting plant and equipment with pollution reduction devices and maintaining and servicing vehicles according to manufacturer's specifications.

11 ASSESSMENT OF COAL DUST EMISSIONS FROM TRAIN WAGONS

11.1 Dispersion modelling

The transportation model CAL3QHCR, developed by the US EPA, has been used to assess potential impacts from this source. CAL3QHCR was designed for use in dispersion modelling of road transport emissions, however given the similar linear nature of the potential train wagon emissions compared to road transport emissions it is considered to be a suitable model for this situation also.

To consider the range of varying land use between the Project site and the Port of Newcastle, and the varying orientation of the rail line relative to the prevailing winds, the dispersion model has been set up to assess theoretical sections of the rail line over a distance of 3km with two varying alignments (north/south and east/west) and two different land use categories. Dust level calculation points were applied at a 10m spacing, perpendicular from the centre of the rail line source alignment out to a distance to 200m either side of the rail line.

11.2 Modelling predictions

Figure 11-1 presents the model predictions for each scenario. The modelling predictions indicate that at distances of 50m and beyond from the rail track centreline, the maximum 24-hour average TSP concentration for all assessed scenarios would be approximately 1.6µg/m^3 for the Project. For urban areas, the predicted the maximum 24-hour average TSP level at 50m from the rail line centre would be approximately 1.03µg/m^3.

By assuming that 40% of the TSP is PM_{10} (**NSW Minerals Council, 2000**), the predicted maximum 24-hour average PM_{10} concentration would be approximately 0.64µg/m^3. For urban areas the predicted maximum 24-hour average PM_{10} level at 50m from the rail line centre would be approximately 0.4µg/m^3.

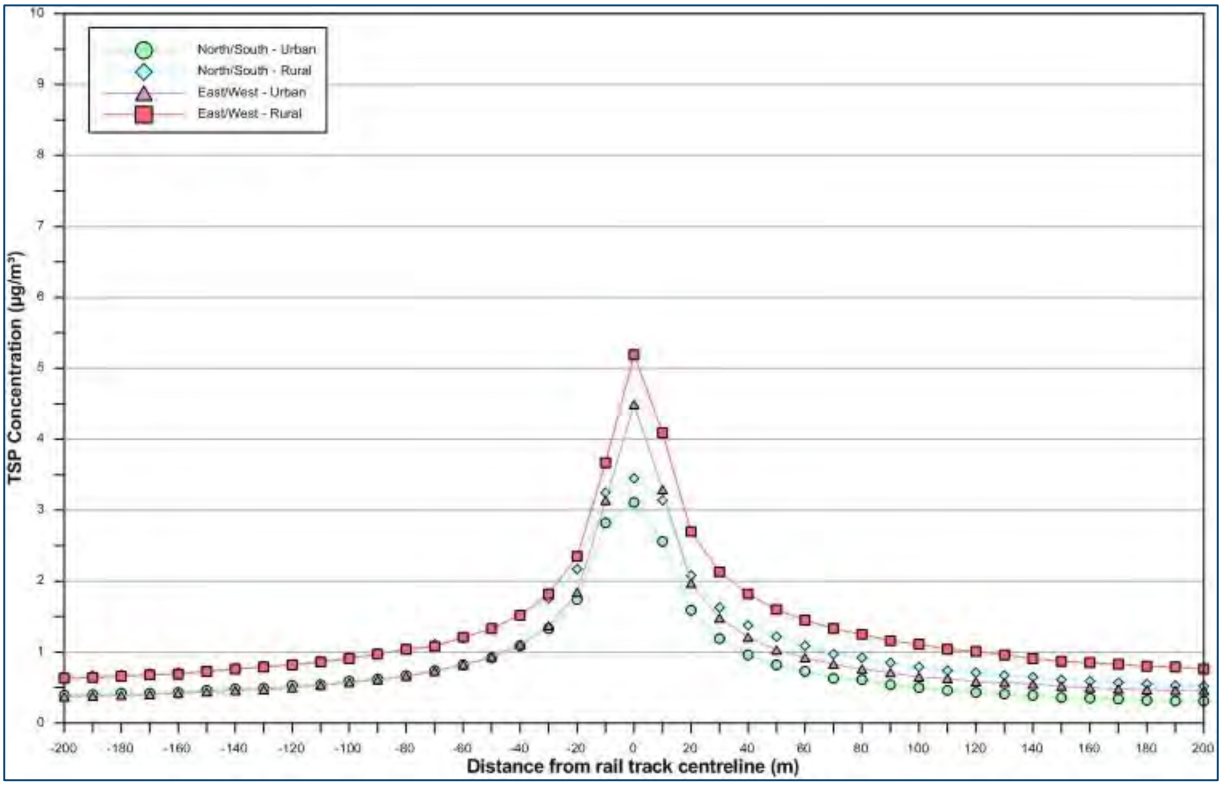

Figure 11-1: Maximum 24-hour TSP concentration based on train wagon emissions from the Project

11.3 Summary

The detailed study of dust emissions generated during rail transport of coal conducted by Katestone Environmental for Queensland Rail Limited (**Connell Hatch, 2008**) found that based on monitoring and modelling of the emissions and impacts of coal train wagons, there appears to be a minimal risk of adverse impact on human health. The study found that concentrations of coal dust at the edge of the rail corridor are below levels known to cause adverse impacts on amenity.

A more recent review of a study conducted for the Australian Rail Track Corporation Ltd (**Ryan and Wand, 2014**) for trains travelling on the Hunter Valley network found no significant difference in the particulate matter measurements for passing freight and coal trains (loaded and unloaded). The study determined that the significant increase of smaller measured particles ($PM_{2.5}$ and PM_1) associated with rail movements indicates that the elevated particle matter levels were mostly due to diesel particles associated with locomotive emissions as opposed to coal dust which tends to be in the larger particle range.

This assessment is consistent with the findings of these studies in indicating that the potential for any adverse air quality impacts associated with coal dust generated during rail transport would be low and would not make any appreciable difference to air quality.

The Project would ensure dust emissions from rail wagons are minimised where possible by streamlining and consistent profiling of coal surface within the rail wagons, minimising spillage and parasitic loading and regular collection and cleaning of any coal spillage.

12 ASSESSMENT OF BLAST FUME EMISSIONS

12.1 Preamble

Air quality impacts of blast operations at the Project are managed under the Bloomfield Group's Blast Fume Management Strategy and the Bloomfield Collieries Explosives Management Plan. The purpose of these documents is to address the likely causes of noxious gases which are produced from blasting activities, the controls that should be used to mitigate excessive blast fumes and the procedure for management of excessive blast fumes when they occur.

12.2 Approach to assessment

12.2.1 Emission estimation

Blast fume emissions (NO_2) were estimated on the basis of emission levels presented in a CSIRO study of Hunter Valley blasts (**Attala et al., 2008**). Blast fume emissions can vary greatly depending on a number of factors but largely depend on the tendency of a particular blast (or holes within the shot) to generate significant NO_2 emissions. The assessment is based on the maximum measured level of emissions presented in the CSIRO study.

12.2.2 Dispersion modelling

Dispersion modelling of the potential blast fume emissions was conducted for each indicative mine plan year. The model setup was generally in accordance with the setup discussed in **Section 7**. Blast emission sources were modelled in the centre of the active pit location during each year. It is noted that the source location would vary; however, for the purposes of this assessment it is considered that the centre of the pit would provide a suitable indication of the potential impacts.

The model was set up to generate a blast during each hour of the day when blasting is permitted between 9:00am to 5:00pm as stated in the Explosives Management Plan.

12.3 Modelling predictions

Figure H-1 to **Figure H-36** in **Appendix H** present isopleth diagrams of the predicted modelling results for the assessed maximum 1-hour average NO_2 concentrations during each potential blast hour of each year. It should be noted that the isopleth diagrams show the maximum hourly extent of all potential blasts in all daytime hours in a full year per the permitted blasting hours, and do not represent a single blast event.

The isopleth diagrams indicate that based on the potential blast hours in each day, blasts occurring between 9:00am to 3:00pm pose little potential for adverse blast fume impacts to occur. During the hours of 4:00pm and 5:00pm, there is potential for adverse blast fume impacts beyond the site boundary. The results indicate that the meteorological conditions during these periods may at times be unfavourable for blasting and the care should be taken if conducting blasting at these times.

12.4 Blast fume management measures

The modelling predictions present the potential worst-case impacts associated with blasting under all of the potential weather conditions and hours when blasting is permitted to occur. It should be noted however, that the ultimate decision to blast on each occasion would be based on the consideration of a range of variables in conjunction with skilled and experienced operator judgement of the actual conditions at the time of the event.

The Rix's Creek Mine utilises best practice blast management tools, including a blast overpressure dust and fume system based on a forecast weather data to determine if the conditions for blasting are suitable. These systems have been in place for a number of years at the site and have been proven to significantly assist the blasting operations in averting potential blast impacts.

These blast management tools indicate the potential extent of any impact at various times during the upcoming day, and allow the operator to select the least impacting time of the day at which to schedule the blast. The actual conditions leading up to the proposed time of blasting are evaluated as part of the final considerations in making the decision to initiate a blast.

It is not reasonably possible to incorporate the predictive model the human decision making element into the modelled blasting assessment results. Thus the predicted levels shown in **Appendix H** are conservative (no mitigation is applied). It is considered that the potential late evening impacts that are predicted in the modelling results would not be likely to occur in practice as the predictive system and human decision making applied for each blast has proven to be reliable at averting potential impacts at such times.

As there is no significant change in the proposed blasting regime (other than moving activities further from Singleton) it is expected that this situation would continue to be the case for the Project.

12.5 Conclusions

Overall, it is noticeable that during the middle of the day, no impacts due to blast fume emissions are predicted to occur. During these times, meteorological conditions are generally favourable for blasting.

However, in the early evening, when the assessment indicates that there is potential for impacts to arise off-site, it is recommended that careful consideration of the potential for blast fume generation and the meteorological conditions at the time be made to prevent any potential blast impacts at sensitive receptor locations.

As the Project progresses, the potential for blast fume impacts at different locations surrounding the Project will vary. Generally risks for residents near Singleton will decrease as the mining activity moves further away. It is noted that the blast management system factors in the exact location of any blast and thus automatically adjusts in regard to the mine movement over time.

The Project would continue to regularly review its blast management systems to ensure that best practice is being maintained.

13 ASSESSMENT OF ODOUR IMPACTS FROM SPREADING OF BIO-SOLIDS

13.1 Preamble

The spreading of bio-solid material is conducted to assist with the rehabilitation of the site and has been taking place at the Project for a number of years. The bio-solid materials applied at the site are typically spread within three months of the rehabilitation areas being ready, using a tractor and ripper setup with an application rate of typically 140 wet tonnes per hectare (ha).

The spreading campaigns will vary at times depending on availability of bio solids and are typically conducted for up to 2,000 tonnes of material, with constant material deliveries over a one to two week period. Spreading generally occurs between the September to April period during favourable conditions with predominate winds from the southeast, away from the majority of residents.

The Project is proposing to continue the activity of spreading of bio-solids at a rate of approximately 10,000 tonnes of material per year.

13.2 Approach to assessment

13.2.1 Emission estimation

Based on the typical application rate, it is expected that an area of approximately 14 ha may be spread with the bio-solid material during a campaign of up to 2000 tonnes. It is conservatively anticipated that spreading would occur over a two week period with a constant odour emission rate before linearly decreasing over a week.

In reality emissions begin to decrease almost immediately after actual application and tend to reduce significantly following rain.

Odour emission rate data for the bio-solids material was obtained from site specific odour measurements conducted for the bio-solids at a sewage treatment facility (**Todoroski Air Sciences, 2011**) where a specific odour emission rate of 3.4 OU.$m^3/m^2/s$ was applied.

13.2.2 Dispersion modelling

Dispersion modelling of the potential odour emissions was conducted for each indicative mine plan year. The model setup was generally in accordance with the setup discussed in **Section 7**. Odour emission sources were modelled in locations where rehabilitation is expected to occur during each year.

It is noted that the source dimension may vary depending on the availability of the bio-solids; however, for the purposes of this assessment it is considered that a maximum area of spreading would provide a suitable indication of the potential impacts.

13.3 Modelling predictions

Figure I-1 to **Figure I-4** in **Appendix I** present isopleth diagrams of the predicted 99th percentile nose-response ground level odour impacts during each modelled year. The isopleth diagrams indicate that odour levels at the assessed sensitive receptor locations resulting from estimated odour emissions emanating from the spreading of bio-solids would be below the applicable NSW Odour criteria which range from 2OU in the dense urban areas to 7OU at isolated rural receptor location.

13.4 Summary

The odour levels predicted due to the spreading of bio-solid material in this assessment were found to be below the applicable NSW Odour criteria at surrounding receptors, as can be seen in **Figure I-1** to **Figure I-4** in **Appendix I**.

The actual levels of odour are likely to be lower due to the assumptions applied in the assessment. For example, to ensure odour impacts from this activity are minimised, the Project would apply a range of mitigation and management measures that were not considered in the modelling results. The mitigation measures include the following practices.

The odour intensity of the bio-solids material received is rated on-site prior to any spreading activities. If the material is considered too odorous, the material is premixed with topsoil/overburden prior to spreading.

Meteorological forecasts are analysed prior to bio-solid spreading activity with consideration of the location of nearby sensitive receptors. Spreading would only occur during favourable weather conditions, with winds tending to be generally from the majority of receptors towards the areas to be spread.

14 PARTICULATE MATTER HEALTH EFFECTS

14.1 Introduction

The following section is a summarised excerpt of private correspondence from Environmental Risk Sciences Pty Ltd to Todoroski Air Sciences.

Detailed reviews of the available studies that relate to health effects associated with exposure to particulates are available from various sources (**NEPC 2010, USEPA 2009**, **Anderson et al. 2004, WHO 2003, OEHHA 2002**). Particulate matter is comprised of a diverse range of substances, with varying morphological, chemical, physical and thermodynamic properties, across a large size range. Particulates can be derived from natural sources such as crustal dust, pollen, sea salts and moulds, and anthropogenic (human) activities including combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The most significant contributors to secondary particulates include nitrogen oxides, ammonia, sulfur oxides, and certain organic gases (emitted from vehicles, combustion, agriculture, industry and biogenic sources).

Particulate matter comprises particles which can remain suspended in the air for extended periods, and is typically classified by particle size.

14.2 Particulate size

The size of particulates is important as it determines how far from an emission source the particulates may be present in air (with larger particulates settling out first and smaller particles remaining airborne for greater distances) but also the potential for adverse effects to occur as a result of exposure.

Further to the description outlined in **Section 4.1** more detail in regard to particulate size as related to health effects is provided below.

- TSP refers to all particulate with an equivalent aerodynamic particle size below approximately 50µm diameter. Larger particles (termed "inspirable", comprise particles around 10µm and larger) that may cause nuisance and would deposit out of the air (measured as deposited dust) closer to the source. Such particles, if inhaled are mostly trapped in the upper respiratory system[3] and do not reach the lungs. Finer particles (smaller than 10µm, termed "respirable") tend to be of more concern as these particles can penetrate into the lungs. As only a fraction of TSP material is harmful to human health, it is a measure of nuisance impact, not health impact.

- PM_{10}, particulate matter below 10µm in diameter, $PM_{2.5}$, particulate matter below 2.5µm in diameter and PM_1, particulate matter below 1µm in diameter. These particles are small and have the potential to penetrate beyond the nose and upper respiratory system, with the smaller particles able to penetrate into the lower respiratory tract[4] and lungs which may result in adverse health effects (**OEHHA, 2002**).

[3] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.

[4] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

Monitoring for PM_{10} is the most commonly applied metric in local and regional air quality monitoring programs. Smaller particulates such as $PM_{2.5}$ and PM_1 are generally of most significance with respect to evaluating health effects as a higher proportion of these particles penetrate into the lungs; however, monitoring for such particulate matter is technically challenging and thus is not widely established. Therefore PM_{10} monitoring serves as a defacto method of measuring $PM_{2.5}$ (**WHO, 2005**).

Apart from small aerodynamic diameter, other factors such as the hygroscopicity, electrostatic charge, and characteristics of the human respiratory system including airway structure and geometry, as well as depth, rate and mode of breathing (e.g. nasal vs. oral/nasal) would affect the extent of particulate penetration and deposition into the lung.

A significant amount of research has been conducted on the health effects of particulates with causal effects relationships identified for exposure to $PM_{2.5}$. A more limited body of evidence suggests an association between exposure to larger particles, PM_{10} and adverse effects (**USEPA, 2009 and WHO, 2003**).

14.3 Particulates composition

Evaluation of size alone in regard to particle health impacts is difficult as particle size may not be independent of chemical composition. Certain particulate size fractions tend to contain certain chemical components, such as crustal materials in the coarse particle fraction (PM_{10} or larger) or metals in fine particulates (<$PM_{2.5}$). In addition, different sources of particulates may emit other pollutants in addition to particulate matter. For example, combustion sources, the dominant particulate source in urban areas, emit predominantly fine particulates as well as gaseous pollutants such as ozone, nitrogen dioxide, carbon monoxide and sulfur dioxide, all of which have independent health effects.

There is strong evidence (**WHO, 2003**) to conclude that fine particles (<2.5µm, $PM_{2.5}$) are more hazardous than coarse particles, primarily on the basis of studies conducted in urban air environments where there is a higher proportion of fine particulates present from fuel combustion sources, rather than from crustal origins. Studies indicate that particles generated from fossil fuel combustion may be a significant contributor to adverse health outcomes. Amongst the characteristics found to be contributing to these outcomes are high organic carbon content, metal content, presence of Poly-cyclic Aromatic Hydrocarbons (PAHs), other organic components, endotoxin and both small (<2.5µm) and extremely small size (<100nm) particulate (**USEPA 2009, WHO 2006a**, **WHO 2003**).

This does not mean that the coarse fraction of PM_{10} is not harmful, however, it appears to be a less critical source (**WHO, 2003 and USEPA, 2009**).

The observed health effects are derived from studies conducted in urban areas, whereas the actual health impacts from particulate matter in a specific location would be affected by the specific characteristics of the mix of particulate matter at the location.

Reviews of the currently available information have not been able to identify any single physical or chemical property of particles that is responsible for the array of adverse health outcomes reported in epidemiological studies (**USEPA, 2009 and WHO, 2003**). Hence, WHO (**WHO, 2006b**) and NEPC (**NEPC, 2010**) concluded that the evidence at present cannot support an indicator for a standard that is more specific than size fraction alone.

As a consequence, the potential for adverse health effects is assumed to apply equally for all sources and composition of particulates at this time.

14.4 Health effects

Adverse health effects associated with exposure to particulate matter have been primarily derived from population-based epidemiological studies. There is a paucity of reliable $PM_{2.5}$ data, hence the studies are based primarily on ambient PM_{10} data measured in urban areas.

Short term exposure (days to weeks) and long term exposure (years) to PM_{10} has been linked to adverse health effects.

Mortality effects relate to the increase in the number of deaths due to existing (underlying) respiratory or cardiovascular diseases that have been associated with exposure to PM_{10} or $PM_{2.5}$ in population-based epidemiological studies.

Morbidity effects relate to a wide range of health indicators used to define illness or the severity of illness associated with exposure to PM_{10} or $PM_{2.5}$, primarily related to the respiratory and cardiovascular system (**USEPA, 2009 and Morawska et al., 2004**) and include:

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days);
- Changes in cardiovascular risk factors such as blood pressure;
- Changes in lung function and increased respiratory symptoms (including asthma);
- Changes to lung tissues and structure; and
- Altered respiratory defence mechanisms.

These effects are commonly used as measures of population exposure to particulate matter in community epidemiological studies. While there is general agreement on the mortality effects associated with exposure to particulate matter, it is noted that there is less agreement on the wide range of morbidity indicators.

14.5 Summary of health effects

The following table presents a summary of the adverse effects associated with exposure to particulate matter in generally large cities and the susceptible populations identified (relevant to the health endpoint).

Table 14-1: Summary of potential adverse health effects from exposure to particulate matter in cities

Health-effect	Susceptible group	Comments
Short term		
Mortality	Elderly, infants, persons with chronic cardiopulmonary disease, influenza or asthma	Causal relationship has been identified for exposure to PM_{10} and $PM_{2.5}$.
Hospitalisation rates (respiratory and cardiovascular effects)	Elderly, infants, persons with chronic cardiopulmonary disease, pneumonia, influenza or asthma	Reflects substantive health impacts in terms of illness, discomfort, treatment costs, work or school time lost.
Increased respiratory symptoms	Most consistently observed in people with asthma, and children	For most, effects are transient with minimal overall health consequences. May result in some short term absence from work or school due to illness.
Decreased lung function	Observed in both children and adults	For most, effects seem to be small and transient.
Long term		
Increased mortality rates, reduced survival times, chronic cardiopulmonary disease, reduced lung function, lung cancer	Observed in population-wide epidemiological studies, including adults, children and infants. All chronically exposed are potentially affected	Long-term repeated exposure appears to increase the risk of cardiopulmonary disease and mortality. May also result in lower lung function.

14.6 Considerations relevant to mining

Table 14-1 relates to studies of human exposure to particulate matter in generally large cities, where a larger portion of the particulates are in the fine fraction that would penetrate into the lung, and also where a greater portion of the particulate matter is from combustion sources, and thus carries with it other individually toxic substances that are damaging to human health.

It is important to understand that the majority of particulate emissions from mining are dust which originates from the soil. Due to the extreme forces required at the micro level to break down a particle of dust into smaller particles in the fine fraction, mining techniques used at coal mines generally cannot breakdown rock, coal or soil material into these very fine fractions. As a result emissions from mines are predominantly in the coarse size fraction which would not penetrate as deeply into the lung, or carry additional toxic combustion substances. On average it has been measured that approximately 5 per cent of the total dust (TSP) from mining is in the $PM_{2.5}$ size fraction, and approximately 12 per cent of PM_{10} from mining is in the $PM_{2.5}$ fraction (**SPCC, 1986**).

In contrast, in the urban areas in which the majority of the health studies have been conducted, approximately 50 to 80 per cent of the PM_{10} is comprised of particles in the $PM_{2.5}$ size range, and most of these particulates originate from combustion sources.

It needs to be understood that rural populations are simply too small for conclusive epidemiological studies to be conducted in those areas, and insufficient alternative data are available for rural areas to identify specific issues that health experts can agree on. Therefore, as a matter of precaution, the findings for urban areas (as shown in **Table 14-1**) are extrapolated to cover rural areas in order to have a basis for managing exposure to particulate matter for rural populations.

This is not to say that particulate emissions from mining are harmless. Mining emissions include a component of particles in the PM_{10} and $PM_{2.5}$ range and this would include fine combustion particles from diesel equipment.

In the context of health impacts in rural areas, it needs to be noted that in many rural areas domestic wood smoke is a key issue of health impact. Wood smoke warrants close attention in any evaluation of health impact as it can be a significant, highly localised source of toxic pollution in the winter period for rural communities and individuals.

The recent studies by CSIRO (**CSIRO, 2013**) into the composition of particulate matter in the Hunter Valley found that a key source of fine particulate is wood smoke. As has occurred in many rural towns, NSW EPA has launched an initiative to target particulates in the Hunter Valley (**NSW EPA, 2013**), and a key action relates to management of wood smoke in the urban areas.

In this regard it is also important to interpret emission inventory data, such as NPI data and data from NSW EPA's air emissions inventory for the Greater Metropolitan Region (GMR) in NSW in the correct context. For example, if one compares mine dust emissions with those from wood heaters based on only the inventory data, one would see that the two produce roughly the same amount of $PM_{2.5}$ emissions. However, it would be wrong to conclude that mines and wood heaters have similar health impacts on the residential population. Unlike coal mines, wood heaters are located inside living rooms and their chimneys are closer to residents than coal mines, which means the air that the population breathes will be affected by wood heater emissions to a much greater degree.

It also needs to be noted that health should be considered in terms of risk of adverse impacts to individuals residing in a specific location, but also in regard to the impacts on the whole community. In the Hunter Valley, the community includes mine workers, and to maintain overall population health it is reasonable to also minimise mine staff exposure to pollutants that may be harmful, or to situations that may be dangerous.

14.6.1 Incremental impact considerations

A key means of assessing the health impact of a Project is to quantify the additional pollutant exposure that may arise. In this study, the incremental impacts predicted due to the operation alone are shown in the many tables and figures. For example, columns 2 to 7 in **Table 9-1** show the Project Impact. There are many other tables and figures in the report that also present such data. All of these data however relate to the whole Project, and include the impacts from many current operational activities and plant such as the coal washery, rail loader and haul roads etc.

Thus the change that arises due to the proposed changes in the Project would be less than is shown in the figures and graphs presented outside of this section.

To give an indication of the potential change in impact, and hence a better indication of the potential effect on health, some additional figures are presented below.

There are several ways to indicate the change. One is to present a comparison between the impact levels approved for the current mine, and the assessed incremental impacts from the proposed project. This comparison is shown in **Figure 14-1** to **Figure 14-3**.

It needs to be noted that the currently approved mine was assessed many years ago, using a simpler model and more conservative assumptions, thus it would be expected to present somewhat higher than actual impacts. Also the earlier assessment did not cover $PM_{2.5}$, or 24-hour PM_{10} (however a single day of worst case PM_{10} impact is shown for a scenario of high wind towards Singleton).

Nevertheless, the earlier assessment defines the currently approved zone of dust impact for the mine. When the assessment for the Project is compared with the approved mine, one can see that the level of impact would reduce significantly (e.g. approximately halve at the most impacted locations.)

This comparison would indicate that the permitted level of impact would reduce if the proposed Project goes ahead.

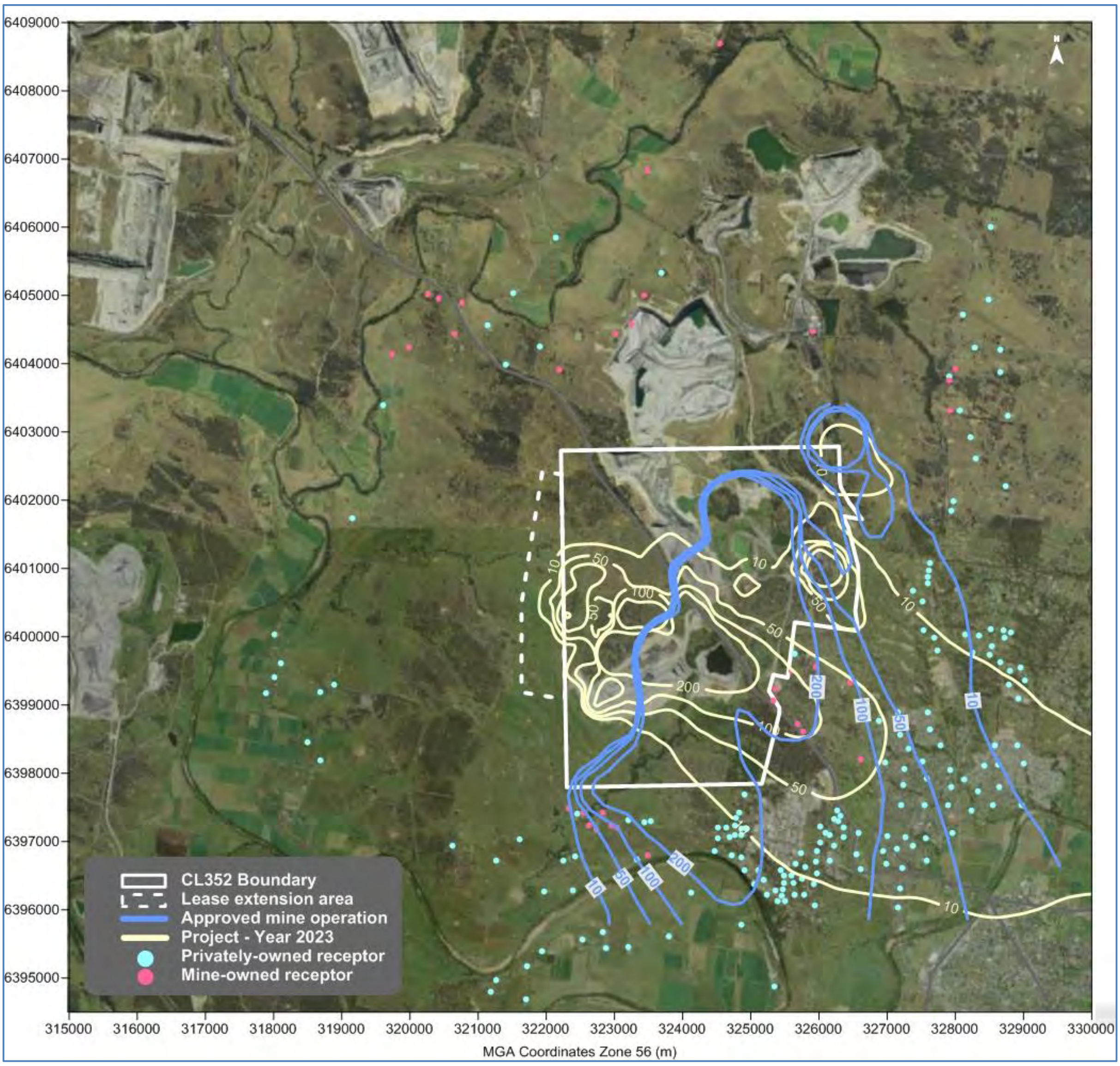

Figure 14-1: Incremental worst case single day (24hr) TSP at Singleton for approved mine (blue) vs. worst case day at Singleton NW monitor in worst case Project Year 2023 (yellow).

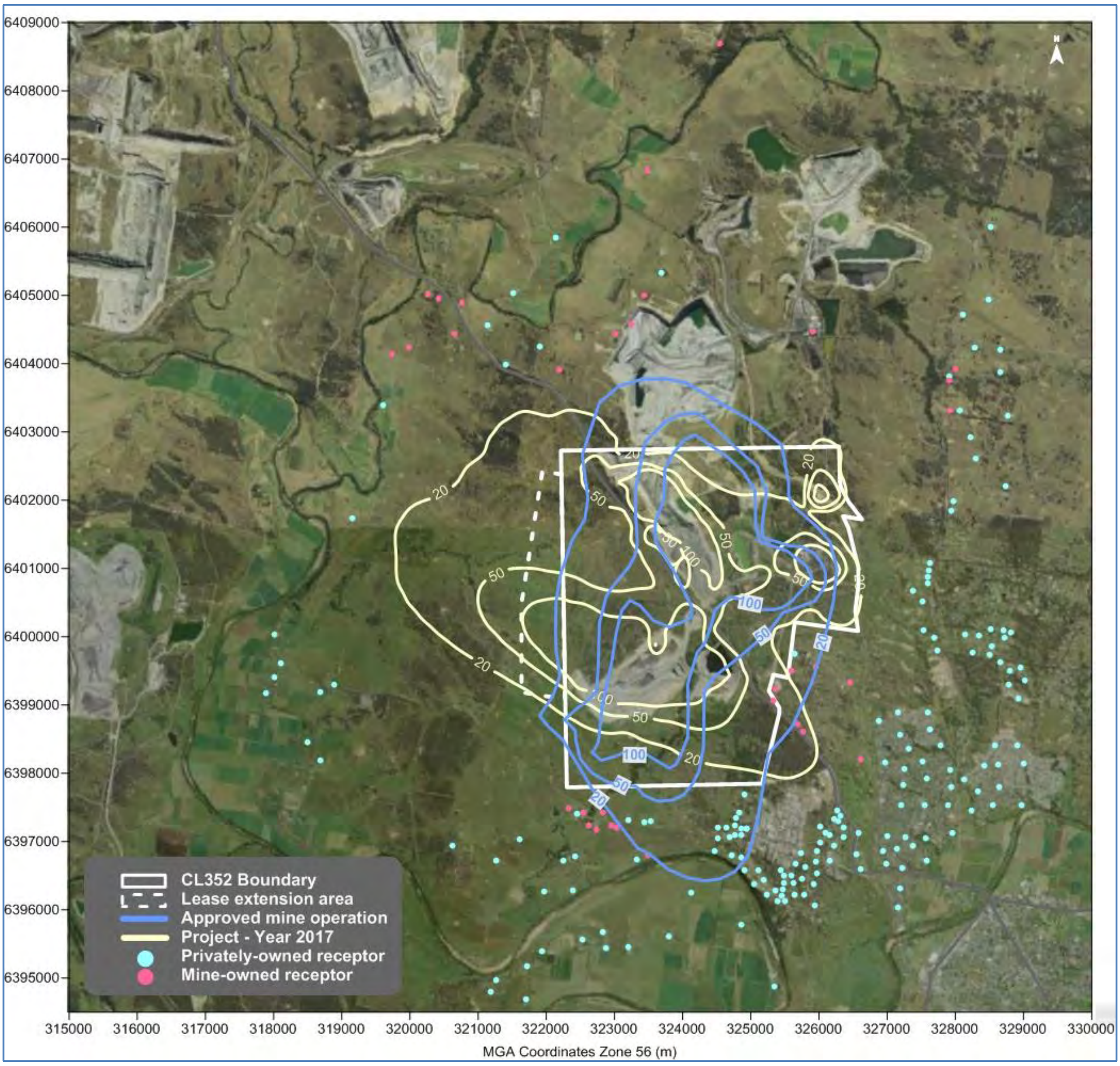

Figure 14-2: Incremental annual average PM_{10}, approved mine (blue) vs. comparable Project Year 2017 (yellow).

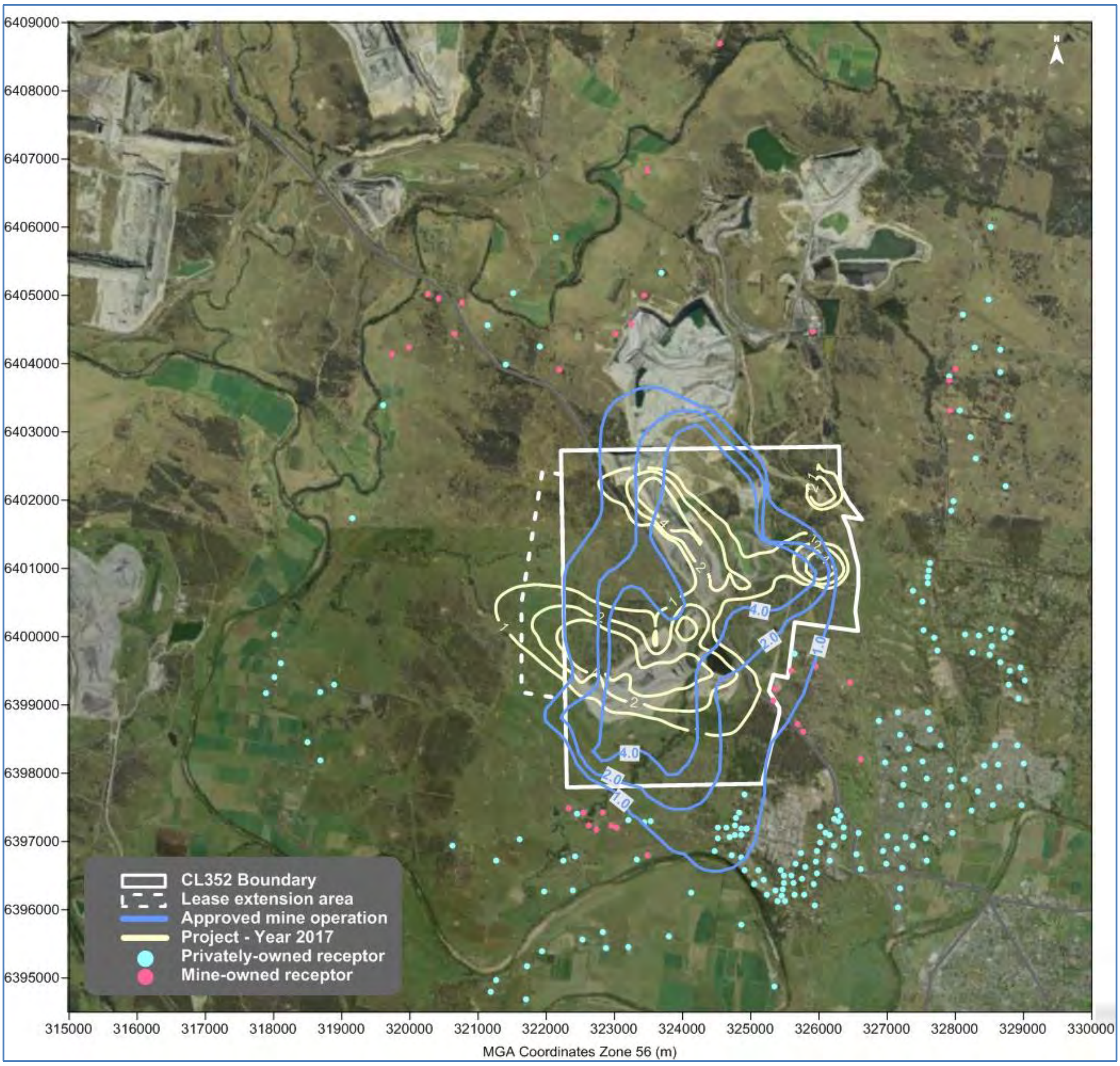

Figure 14-3: Incremental annual average Deposited dust, approved mine (blue) vs. comparable Project Year 2017 (yellow).

Another way of examining this issue is to compare the recent operation of the mine with the Project.

It is noted that presently the adjacent Integra mine is in caretaker mode (has suspended mining operations), and the approved Ashton South East Open Cut Project has not yet commenced. These operations would have some effect on the background dust levels in the vicinity of the Project. (Note that in the cumulative impact assessment in this study it is assumed that both the Integra and the Ashton South East Open Cut mines are operating in the near future).

Thus a comparison has been made between the impact of the existing mine and the Project, as shown in **Figure 14-4** to **Figure 14-6**.

These figures show the incremental impacts of the existing mine in 2012, and the worst case impact year for the Project in 2023. (Note that the worst case impact year 2023 may not occur at the scale modelled, but if it does it would be for a limited duration.) The contours in the figures are selected to show the effects at the most affected receptors (between Singleton and the mine) more clearly.

The figures show that the worst case Project impacts in 2023 would be higher in some areas but also lower in other areas relative to mine operations in 2012. Generally we see that the focus of mining changes, and accordingly we also see a change in the shape of the impacted area.

The figures illustrate a relatively similar overall scale of impact that would shift in position, but would not cause levels of dust above criteria in the densely populated areas. Overall, the affected population would be small and the scale of the impact on the population would be generally consistent with that of the present mine.

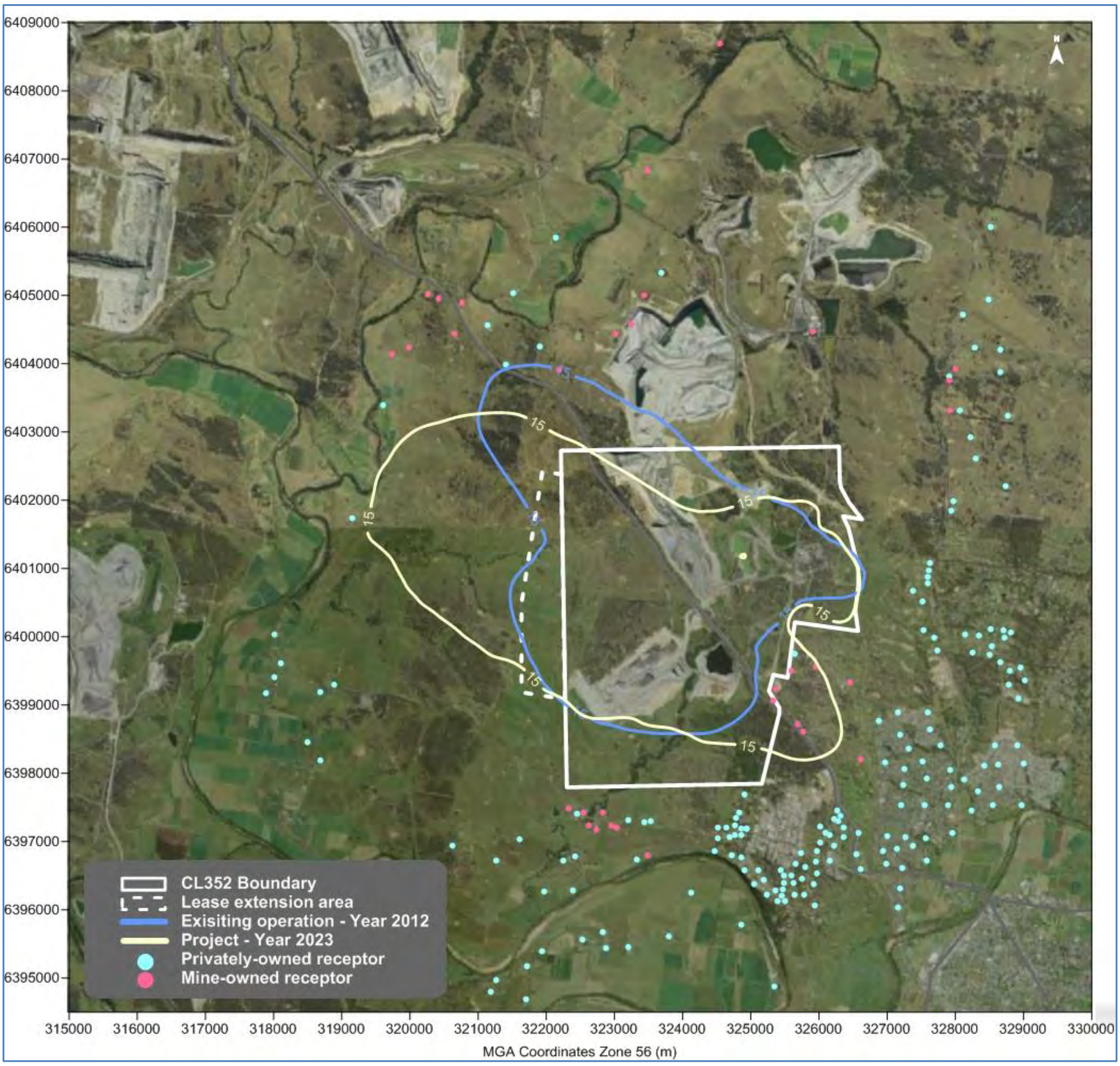

Figure 14-4: Incremental annual average PM_{10}, existing mine 2012 (blue) vs. Project worst case year 2023 (yellow).

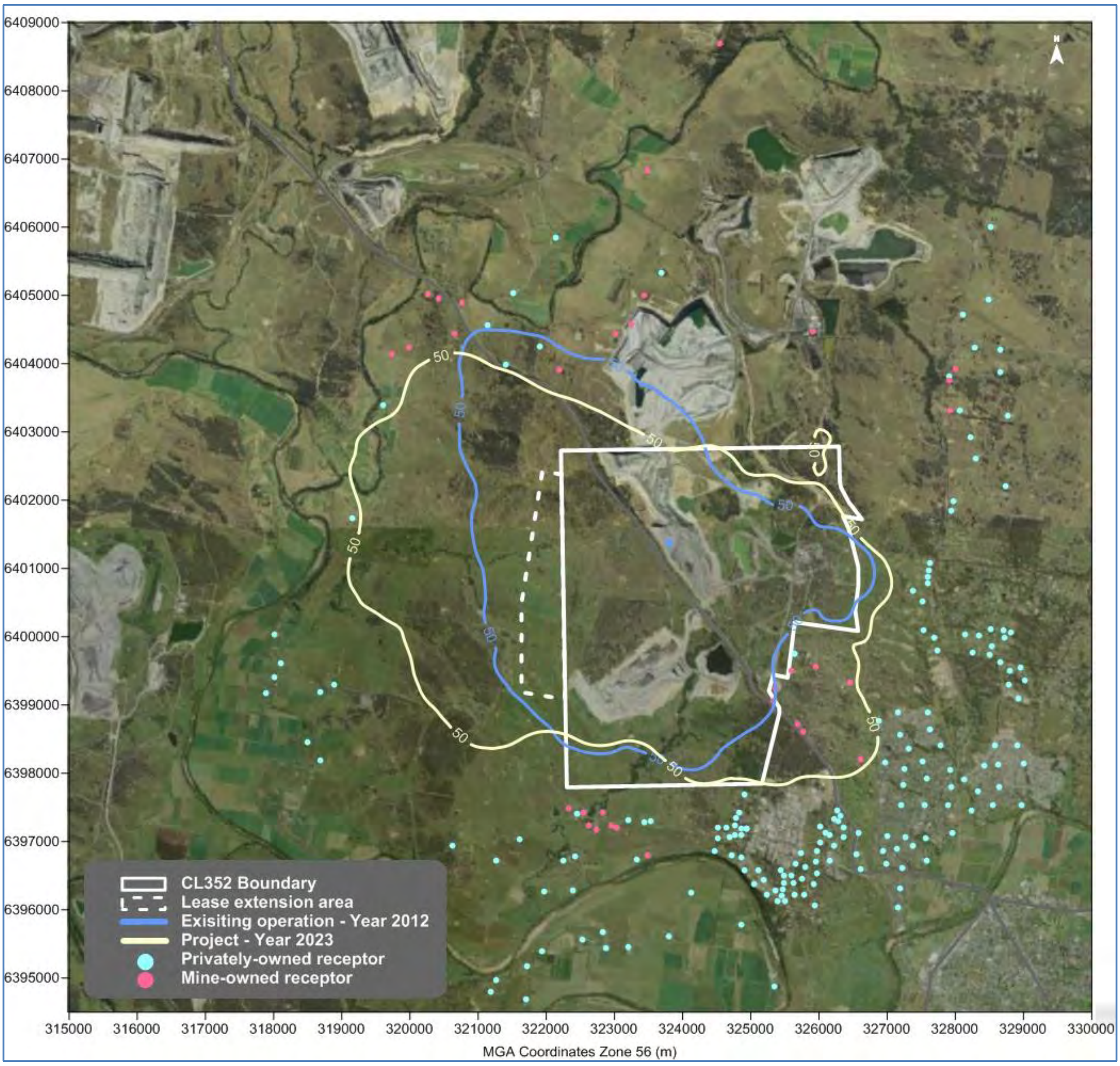

Figure 14-5: Incremental 24-hour average PM_{10}, existing mine 2012 (blue) vs. Project worst case year 2023 (yellow).

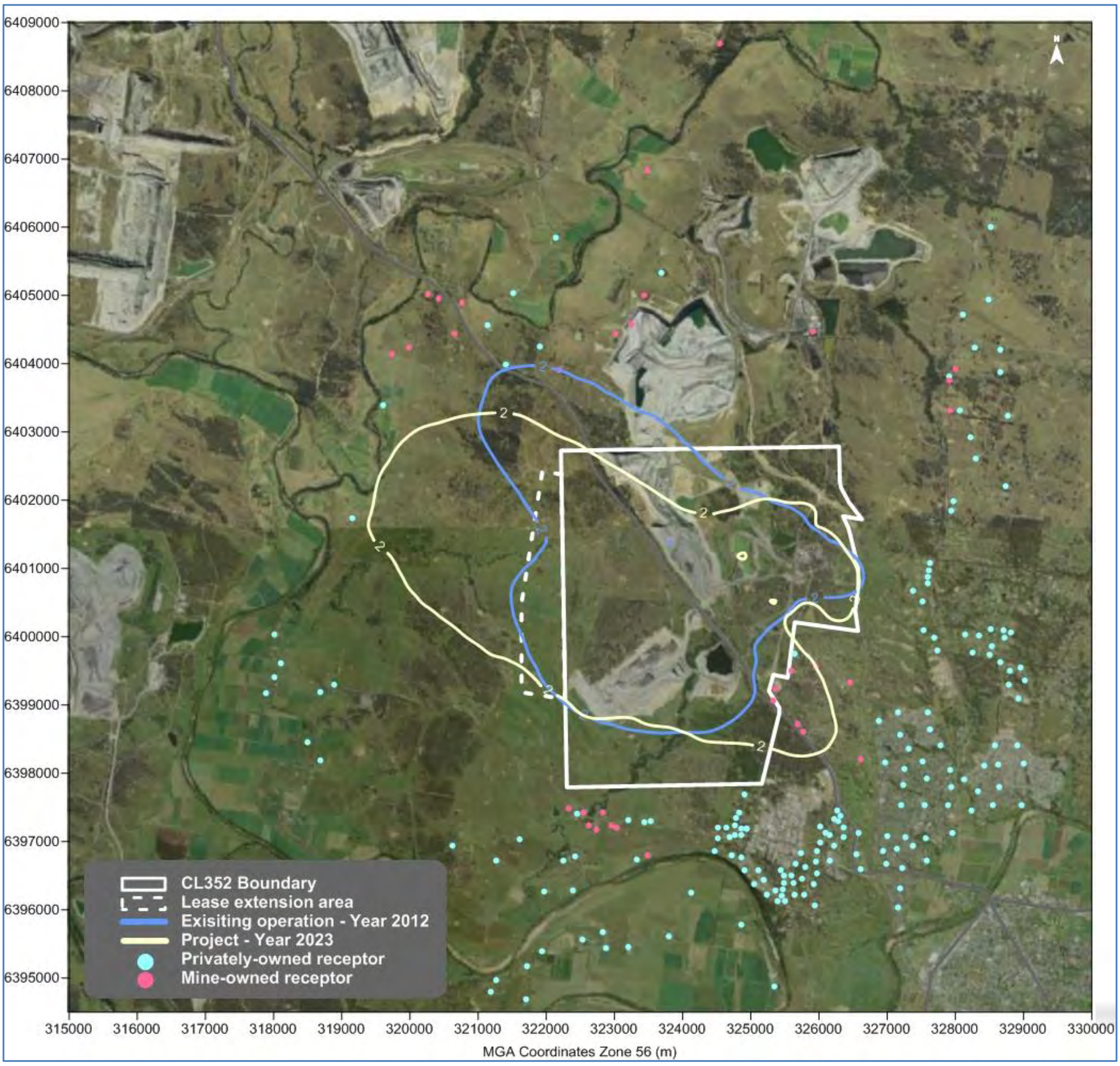

Figure 14-6: Incremental annual average $PM_{2.5}$, existing mine 2012 (blue) vs. Project worst case year 2023 (yellow).

Figure 14-1 to **Figure 14-6** show that approving the project:

- would result in a lower level of approved impact;
- there would be areas of increased effect, but also similar areas of decreased effect, relative to the existing mine in 2012, and;
- overall the net effect on the population would remain relatively small and broadly consistent with the effect of the existing operation.

Most notably, by also considering the overall assessment (including outside of this section), there are no large changes in impact in the most populated areas, and levels above criteria would not occur at any privately owned properties (except for Receptor 1 very near the mine where there is an agreement in place).

15 GREENHOUSE GAS ASSESSMENT

15.1 Introduction

Dynamic interactions between the atmosphere and surface of the earth create the unique climate that enables life on earth. Solar radiation from the sun provides the heat energy necessary for this interaction to take place, with the atmosphere acting to regulate the complex equilibrium. A large part of this atmospheric regulation occurs from the "greenhouse effect" with the absorption and reflection of the solar radiation dependent on the composition of specific greenhouse gases in the atmosphere.

Over the last century, the composition and concentration of greenhouse gases in the atmosphere has increased due to increased anthropogenic activity. Climatic observations indicate that the average pattern of global weather is changing as a result. The measured increase in global average surface temperatures indicate an unfavourable and unknown outcome if the rate of release of greenhouse gas emissions remain at the current rate.

This assessment aims to estimate the predicted emissions of greenhouse gases (GHG) to the atmosphere due to the Project and to provide a comparison of the direct emissions from the Project at the state and national level.

15.2 Greenhouse gas inventory

The National Greenhouse Accounts (NGA) Factors document published by the Department of the Environment defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions generated are from "direct" or "indirect" sources.

Scope 1 emissions encompass the direct sources from the Project defined as:

"*...from sources within the boundary of an organisation as a result of that organisation's activities*" (**Department of the Environment, 2014d**).

Scope 2 and 3 emissions occur due to the indirect sources from the Project as:

"*...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation*" (**Department of the Environment, 2014d**).

For the purpose of this assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total GHG emissions generated from the Project.

Scope 3 emissions can be a significant component of the total GHG emissions associated with a project; however, these emissions are usually not directly controlled by the Project and are considered as Scope 1 emissions from other organisations. The primary Scope 3 emissions related to the Project arise from off-site transportation of the product coal and the end use of the product coal. These emissions have been estimated in this study.

Other less significant Scope 3 emissions may also arise from a large range of other sources associated with the Project. Scope 3 emissions may include all of the emissions from the upstream and downstream activities associated with the Project. For example emissions due to commuting staff or electricity consumed by computers in writing or reading this report. These emissions cannot be reasonably quantified due to the large diversity of sources and the relatively minor individual contributions.

15.2.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the Project are the on-site combustion of diesel fuel, petrol fuel, petroleum based greases and oils, explosives, emissions of methane from the exposed coal seams, gaseous fuels and on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, petrol, petroleum based greases and oils, electricity for use on-site, the transport of product to its final destination and the final use of the product.

Estimated quantities of materials that have the potential to emit GHG emissions associated with Scope 1 and 2 emissions for the Project have been summarised in **Table 15-1** below. These estimates are based on a conservative upper limit of the assumed maximum production throughout the life of the Project. The assessment provides a reasonable worst case approximation of the potential GHG emissions for the purpose of this assessment.

Table 15-1: Summary of quantities of materials estimated for the Project

Period	ROM coal (tonnes)	Diesel (kL)	Petrol (kL)	Fuel Oil (kL)	Grease + oils (kL)	Electricity (MWh)	Explosives (tonnes)	LPG (kL)
1	2,480,617	13,955	22	425	245	10,667	9,990	0.09
2	2,384,707	13,416	21	409	236	10,255	9,604	0.09
3	2,526,474	14,213	22	433	250	10,865	10,175	0.10
4	2,479,557	13,949	22	425	245	10,663	9,986	0.09
5	2,507,484	14,106	22	430	248	10,783	10,098	0.10
6	4,043,852	22,749	36	694	400	17,390	16,286	0.15
7	4,360,063	24,528	39	748	431	18,749	17,559	0.17
8	4,127,857	23,222	37	708	408	17,751	16,624	0.16
9	2,104,903	11,841	19	361	208	9,052	8,477	0.08
10	1,728,753	9,725	15	297	171	7,434	6,962	0.07
11	2,089,848	11,757	19	358	207	8,987	8,417	0.08
12	2,075,938	11,678	18	356	205	8,927	8,360	0.08
13	1,868,482	10,511	17	320	185	8,035	7,525	0.07
14	2,015,037	11,336	18	346	199	8,665	8,115	0.08
15	2,047,463	11,518	18	351	202	8,805	8,246	0.08
16	1,730,661	9,736	15	297	171	7,442	6,970	0.07
17	1,307,518	7,356	12	224	129	5,623	5,266	0.05
18	919,819	5,175	8	158	91	3,955	3,704	0.03
19	835,992	4,703	7	143	83	3,595	3,367	0.03
20	887,454	4,992	8	152	88	3,816	3,574	0.03
21	765,250	4,305	7	131	76	3,291	3,082	0.03
Total	**45,287,731**	**254,773**	**402**	**7,768**	**4,479**	**194,749**	**182,389**	**1.7**

Scope 3 emissions for the transport and final use of the coal may have the potential to vary in the future depending on the market situation at the time. These assumptions include emission factors for the transport modes of rail and shipping and the associated average weighted distance travelled for the export coal.

15.2.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Project, emission factors obtained from the NGA Factors (**Department of the Environment, 2014d**) and other sources as required and are summarised in **Table 15-2**.

Table 15-2: Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
Diesel	38.6	69.2	0.2	0.5	kg CO_2-e/GJ	1
		5.3	-	-		3
Petrol	34.2	66.7	0.6	2.3	kg CO_2-e/GJ	1
		5.3	-	-		3
Fuel oil	39.7	72.9	0.03	0.2	kg CO_2-e/GJ	1
		5.3	-	-		3
Grease and oils	38.8	27.9	-	-	kg CO_2-e/GJ	1
		5.3	-	-		3
Electricity	-	0.86	-	-	kg CO_2-e/kWh	2
		0.13	-	-		3
Explosives	-	0.17	-	-	t CO_2-e/tonne	1
LPG	25.3	51.2	0.1	0.03	kg CO_2-e/GJ	1
Rail(1)	-	16.66	-	-	t CO_2-e/Mt-km	3
Ship(1)	-	3.657	-	-	t CO_2-e/Mt-km	3
Thermal coal(2)	27	88.2	0.03	0.2	kg CO_2-e/GJ	3
Coking coal	30	90.0	0.02	0.2	kg CO_2-e/GJ	3

(1) Todoroski Air Sciences (2014)
(2) Assumes type of coal is Bituminous

Estimates of fugitive emissions released from the extraction of coal are based on estimated quantities of the total in-situ stock of gas held within the mine's gas bearing strata and emission factors of 6.784×10^{-4} x 21 for methane and 1.861×10^{-3} for carbon dioxide (**Department of the Environment, 2014b**)

Product coal is transported to the Port of Newcastle by rail and then transferred to coal loaders before being shipped to its final destination. The approximate rail distance is taken to be 180km (return distance). The approximate shipping distance of 13,000km (return distance) is based predominately on destinations in the Asian market.

The emissions generated from the end use of coal produced by the Project have assumed that 45 per cent of the product coal is assumed to be used in power generation and that 55 per cent is assumed to be used as coking coal. To estimate emissions from power stations that may use the product coal in other countries, this assessment has assumed the emissions generated would be equivalent to those generated in NSW or Australian power stations.

15.3 Summary of greenhouse gas emissions

Table 15-3 summarises the estimated annual CO_2-e emissions due to the operation of the Project.

Table 15-3: Summary of CO_2-e emissions for the Project (t CO_2-e)

Period (Year)	Fugitive	Diesel		Petrol		Fuel Oil		Grease + oils		Electricity		Explosives	LPG	Transport (RAIL)	Transport (SHIP)	Final use (Thermal)	Final use (Coke)
	Scope 1	Scope 1	Scope 3	Scope 1	Scope 3	Scope 1	Scope 3	Scope 1	Scope 3	Scope 2	Scope 3	Scope 1	Scope 1	Scope 3	Scope 3	Scope 3	Scope 3
1	4,007	37,652	2,855	52	4	1,235	90	266	50	9,174	1,387	1,698	71	4,533	72,129	1,623,738	2,265,745
2	3,852	36,196	2,745	50	4	1,187	86	255	48	8,819	1,333	1,633	68	4,348	69,172	1,557,172	2,172,860
3	4,081	38,348	2,908	53	4	1,258	91	270	51	9,343	1,412	1,730	72	4,593	73,085	1,645,271	2,295,792
4	4,005	37,636	2,854	52	4	1,235	89	265	50	9,170	1,386	1,698	71	4,500	71,592	1,611,667	2,248,902
5	4,051	38,060	2,886	53	4	1,249	90	268	51	9,273	1,402	1,717	72	4,504	71,661	1,613,201	2,251,042
6	6,532	61,379	4,654	85	7	2,014	146	433	82	14,955	2,261	2,769	116	7,236	115,131	2,591,802	3,616,570
7	7,043	66,179	5,018	92	7	2,171	157	467	89	16,125	2,437	2,985	125	7,888	125,495	2,825,118	3,942,136
8	6,668	62,654	4,751	87	7	2,056	149	442	84	15,266	2,308	2,826	118	7,370	117,256	2,639,623	3,683,299
9	3,400	31,949	2,423	44	3	1,048	76	225	43	7,784	1,177	1,441	60	3,770	59,982	1,350,290	1,884,179
10	2,793	26,240	1,990	37	3	861	62	185	35	6,393	966	1,184	49	3,121	49,660	1,117,922	1,559,935
11	3,376	31,721	2,405	44	3	1,041	75	224	43	7,729	1,168	1,431	60	3,738	59,480	1,338,993	1,868,416
12	3,353	31,510	2,389	44	3	1,034	75	222	42	7,677	1,161	1,421	59	3,738	59,472	1,338,825	1,868,180
13	3,018	28,361	2,150	39	3	930	67	200	38	6,910	1,045	1,279	53	3,347	53,253	1,198,823	1,672,823
14	3,255	30,585	2,319	43	3	1,003	73	216	41	7,452	1,126	1,380	58	3,609	57,424	1,292,714	1,803,838
15	3,307	31,077	2,356	43	3	1,020	74	219	42	7,572	1,145	1,402	59	3,743	59,546	1,340,475	1,870,483
16	2,796	26,269	1,992	37	3	862	62	185	35	6,400	968	1,185	49	3,183	50,648	1,140,184	1,591,000
17	2,112	19,846	1,505	28	2	651	47	140	27	4,836	731	895	37	2,337	37,186	837,130	1,168,121
18	1,486	13,961	1,059	19	1	458	33	98	19	3,402	514	630	26	1,722	27,398	616,775	860,641
19	1,350	12,689	962	18	1	416	30	90	17	3,092	467	572	24	1,514	24,094	542,387	756,840
20	1,434	13,470	1,021	19	1	442	32	95	18	3,282	496	608	25	1,494	23,765	535,000	746,532
21	1,236	11,615	881	16	1	381	28	82	16	2,830	428	524	22	1,292	20,553	462,680	645,618
Total	**73,157**	**687,397**	**52,121**	**956**	**73**	**22,552**	**1,634**	**4,849**	**921**	**167,485**	**25,317**	**31,006**	**1,295**	**81,579**	**1,297,982**	**29,219,791**	**40,772,952**

15.4 Contribution of greenhouse gas emissions

Table 15-4 summarises the emissions associated with the Project based on Scopes 1, 2 and 3.

Table 15-4: Summary of CO2-e emissions per scope (t CO_2-e)

Period	Scope 1	Scope 2	Scope 3	Scope 1+2
1	45,123	9,174	3,970,531	54,297
2	43,378	8,819	3,807,767	52,197
3	45,957	9,343	4,023,208	55,300
4	45,103	9,170	3,941,045	54,273
5	45,611	9,273	3,944,841	54,885
6	73,558	14,955	6,337,889	88,513
7	79,310	16,125	6,908,345	95,435
8	75,086	15,266	6,454,845	90,352
9	38,288	7,784	3,301,943	46,073
10	31,446	6,393	2,733,694	37,840
11	38,015	7,729	3,274,322	45,743
12	37,762	7,677	3,273,885	45,439
13	33,988	6,910	2,931,550	40,898
14	36,654	7,452	3,161,148	44,106
15	37,244	7,572	3,277,866	44,816
16	31,481	6,400	2,788,075	37,881
17	23,784	4,836	2,047,086	28,619
18	16,732	3,402	1,508,163	20,133
19	15,207	3,092	1,326,313	18,299
20	16,143	3,282	1,308,360	19,425
21	13,920	2,830	1,131,496	16,750
Total	**823,790**	**167,485**	**71,452,371**	**991,274**

The estimated annual greenhouse emissions for Australia for the 2013 to 2014 period were 542.6 Mt CO_2-e (**Department of the Environment, 2014c**). In comparison, the conservative estimated annual average greenhouse emission over the 21-year life of the Project is 0.047Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the Project in comparison to the Australian greenhouse emissions for the 2013 to 2014 period is conservatively estimated to be approximately 0.009 per cent.

At a state level, the estimated greenhouse emissions for NSW in the 2011-12 period were 154.7 Mt CO_2-e (**Department of the Environment, 2014a**). The annual contribution of greenhouse emissions from the Project in comparison to the NSW greenhouse emissions for the 2011-12 period is conservatively estimated to be approximately 0.031 per cent.

The estimated greenhouse gas emissions generated in all three scopes are based on approximated maximum quantities of materials. Therefore the estimated emissions for the Project are considered conservative.

15.5 Greenhouse gas management

The Project will utilise various mitigation measures to minimise the overall generation of greenhouse gas emissions. These measures would include developing a basis for identifying and implementing energy efficiency opportunities and mitigation measures for various activities.

Examples of various mitigation and energy management measures to reduce GHG emissions are as follows:

- Monitor the consumption of fuel and regularly maintain diesel powered equipment to ensure operational efficiency;
- Monitor the total site electricity consumption and investigate avenues to minimise the requirement;
- Conduct a review of alternative renewable energy sources;
- Provide energy awareness programs for staff and contractors; and
- Minimise the production of waste generated on site.

16 SUMMARY AND CONCLUSIONS

This study has identified the potential air quality impacts that may arise from the Project. The assessment utilises air dispersion modelling and focuses on potential dust impacts from the Project in isolation and cumulatively with other nearby mines and background levels of dust. The assessment also investigates the potential air quality impacts associated with diesel fuel combustion, blast fume emissions and odour from the spreading of bio-solids.

The assessment finds that one receptor (Receptor 1) is likely to be significantly impacted by the Project. This receptor and the Project are understood to have in place a negotiated agreement which includes continuation of existing acquisition rights from the Development Consent of 19th October 1989.

The assessment also found that impacts would occur at eight other receptor locations. All of these locations are in the acquisition zone of other mines due to those mine's impacts. These receptors would be impacted regardless of the Project. It should also be noted that if the activity at the other mines as modelled in this assessment occurs in future years, some of these receptors would not exist (as they would be demolished and within the mine pit of other proposed mines).

It is important to note that the assessment of impacts made in this study is conservative, and would overestimate the likely actual impacts that may arise.

Overall, the assessment is consistent with the expected outcomes of the Project, which are to see a shift in impact westwards when the focus of activity moves from the existing north pit to the west pit and then to shift further to the northwest away from Singleton as mining progresses in that direction.

The potential rates of activity that would occur when mining nearer to the receptors in Singleton is lower than when mining activity is further away. This is not accidental and is the result of several rounds of iterative modelling for various mine plans. This modelling identified the need to minimise activity during the times the Project activity was close to Singleton. As such, the Project has purposely limited its rate of activity and scale to ensure that there is only a generally small change in impact at any location and no significant increase or adverse effect is likely at the great majority of potential receptors due to the Project.

No likely odour, blast, diesel or rail transport related impacts were identified for the Project.

The greenhouse gas assessment conservatively calculates the annual Scope 1 and Scope 2 emission generated from the Project to be 0.047Mt CO_2-e. Relative to the annual greenhouse gas emissions from Australia and NSW, it is estimated the proposal would contribute approximately 0.009 per cent and 0.031 per cent respectively.

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Appendix A

Peak-to-mean ratios

Peak-to-mean ratios

The following table shows the recommended factors to be applied for estimating peak concentrations from different source types, stabilities and distances.

Source Type	Pasquill-Gifford stability class	Near field P/M 60*	Far field P/M 60*
Area	A, B, C, D	2.5	2.5
	E, F	2.3	1.9
Line	A-F	6	6
Surface point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

*Ratio of peak 1-second average concentrations

Appendix B

Sensitive Receptor Locations

Figure B-1: Sensitive receptor locations assessed in this study

Table B-1: List of sensitive receptors assessed in this study

Receptor ID	Easting	Northing	Receptor ID	Easting	Northing	Receptor ID	Easting	Northing
1	325644	6399746	71	327586	6397927	141	323334	6396729
2	327976	6401989	72	327523	6398179	142	322385	6396278
3	328732	6402211	73	326937	6396864	143	322423	6396784
4	328302	6402615	74	327550	6397535	144	322254	6396714
5	328222	6402921	75	327891	6397537	145	321965	6396265
6	328773	6403241	76	327151	6398893	146	321606	6397025
7	328060	6403313	77	327791	6398406	147	321265	6396714
8	327912	6403816	78	327258	6398070	148	320621	6396931
9	328282	6404236	79	327187	6398558	149	318687	6399196
10	328107	6404721	80	327321	6398353	150	318503	6398456
11	328480	6404940	81	327227	6396602	151	318677	6398187
12	328518	6405999	82	326992	6396668	152	324855	6397195
13	328662	6404211	83	327165	6396029	153	324853	6397094
14	328661	6403877	84	327183	6396306	154	324764	6397088
15	327732	6399795	85	328241	6397461	155	324765	6397237
16	327685	6399991	86	328643	6397801	156	324686	6397065
17	327534	6400103	87	328546	6397528	157	324643	6397208
18	327521	6400512	88	328999	6398135	158	324511	6397046
19	327374	6400673	89	328422	6398106	159	324511	6397205
20	327592	6400790	90	328337	6397742	160	323531	6397300
21	327596	6400878	91	328124	6397905	161	323433	6397286
22	327612	6400969	92	328913	6398413	162	323200	6397319
23	327628	6401078	93	328971	6397532	163	322455	6397410
24	327942	6401850	94	328580	6398401	164	318885	6399294
25	328931	6399102	95	328628	6398125	165	317882	6399178
26	328789	6399292	96	325467	6396301	166	324474	6396855
27	328522	6400109	97	325957	6396711	167	318017	6400033
28	328803	6399500	98	325800	6396627	168	318103	6399609
29	328951	6399545	99	325969	6396536	169	318012	6399408
30	329025	6399354	100	325749	6396452	170	319612	6403390
31	328530	6399855	101	325781	6396216	171	319147	6401741
32	328245	6399770	102	325917	6396379	172	321904	6404248
33	328140	6400031	103	325945	6396063	173	321409	6403988
34	328343	6400014	104	325736	6396824	174	321134	6404567
35	328657	6399633	105	325653	6396669	175	322139	6405852
36	328721	6399983	106	325437	6396572	176	321519	6405042
37	328500	6399744	107	325592	6396508	177	323690	6405337
38	328821	6400065	108	325490	6396507	M1	323440	6405005
39	328702	6400101	109	325629	6396393	M2	323241	6404588
40	326227	6396945	110	325483	6396384	M3	323010	6404446
41	326160	6397090	111	325647	6396221	M4	322178	6403915
42	326090	6397129	112	325498	6396125	M5	320658	6404436
43	326015	6396985	113	325461	6396205	M6	319988	6404245
44	326009	6397222	114	325387	6396118	M7	319723	6404136
45	326150	6396726	115	325352	6396277	M8	322321	6397484
46	325971	6396856	116	325234	6396218	M9	322552	6397416
47	326220	6397330	117	325184	6396437	M10	322617	6397240
48	326290	6397292	118	325104	6396577	M11	322824	6397416
49	326355	6397211	119	325041	6396374	M12	322729	6397168

Receptor ID	Easting	Northing	Receptor ID	Easting	Northing	Receptor ID	Easting	Northing
50	326360	6397067	120	324907	6396578	M13	322954	6397232
51	326607	6396594	121	324854	6396765	M14	323035	6397201
52	326547	6396819	122	324721	6396795	M15	323482	6396792
53	326573	6397129	123	321710	6395169	M16	326608	6398212
54	326309	6397371	124	321707	6394687	M17	325771	6398612
55	326269	6397452	125	321936	6395384	M18	325692	6398717
56	327957	6397132	126	322527	6395565	M19	325333	6399067
57	327207	6397529	127	322876	6395433	M20	325360	6399234
58	327238	6397832	128	322832	6395678	M21	326455	6399334
59	327624	6398640	129	323209	6395456	M22	325593	6399501
60	327919	6398052	130	323794	6395608	M23	325955	6399570
61	326876	6398764	131	324125	6396248	M24	327921	6403311
62	327589	6398900	132	324862	6395789	M25	327916	6403746
63	327561	6397042	133	325339	6394874	M26	328007	6403925
64	327937	6397796	134	321192	6394797	M27	325914	6404474
65	326968	6398160	135	321270	6394970	M28	324552	6408686
66	327144	6396898	136	324944	6397182	M29	320256	6405016
67	326997	6397083	137	324778	6397344	M30	320414	6404954
68	327262	6397056	138	324833	6397429	M31	320758	6404892
69	327371	6396942	139	324936	6397191	M32	323491	6406834
70	327573	6396718	140	324910	6397691			

Appendix C

Monitoring Data

Table C-1: HVAS PM_{10} Monitoring data (µg/m³)

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
1/01/2010	ND	17.0	17.0	3/01/2012	14.0	11.0	42.0
7/01/2010	ND	22.0	15.0	9/01/2012	27.0	21.0	24.0
13/01/2010	ND	49.0	46.0	15/01/2012	10.0	9.0	9.0
19/01/2010	ND	58.0	63.0	21/01/2012	19.0	18.0	17.0
25/01/2010	ND	34.0	32.0	27/01/2012	9.0	9.0	10.0
31/01/2010	ND	16.0	14.0	2/02/2012	6.0	4.0	1.0
6/02/2010	ND	ND	12.0	8/02/2012	16.0	17.0	14.0
12/02/2010	ND	ND	ND	14/02/2012	13.0	11.0	10.0
18/02/2010	ND	26.0	36.0	20/02/2012	16.0	16.0	20.0
24/02/2010	ND	10.0	36.0	26/02/2012	20.0	15.0	17.0
2/03/2010	ND	28.0	28.0	3/03/2012	6.0	6.0	12.0
8/03/2010	ND	8.0	33.0	9/03/2012	29.0	23.0	26.0
14/03/2010	ND	48.0	10.0	15/03/2012	15.0	16.0	15.0
20/03/2010	ND	ND	40.0	21/03/2012	13.0	13.0	12.0
26/03/2010	38.0	43.0	ND	27/03/2012	16.0	14.0	11.0
1/04/2010	16.0	20.0	5.0	2/04/2012	18.0	19.0	18.0
7/04/2010	11.0	13.0	ND	8/04/2012	22.0	22.0	23.0
13/04/2010	31.0	28.0	ND	14/04/2012	21.0	17.0	18.0
19/04/2010	5.0	9.0	ND	20/04/2012	25.0	23.0	23.0
25/04/2010	ND	ND	ND	26/04/2012	25.0	19.0	28.0
1/05/2010	16.0	45.0	36.0	2/05/2012	29.0	25.0	23.0
7/05/2010	36.0	ND	ND	8/05/2012	52.0	32.0	29.0
13/05/2010	43.0	53.0	26.0	14/05/2012	30.0	23.0	24.0
19/05/2010	21.0	26.0	ND	20/05/2012	36.0	28.0	30.0
25/05/2010	11.0	17.0	ND	26/05/2012	25.0	18.0	30.0
31/05/2010	ND	ND	ND	1/06/2012	9.0	15.0	13.0
6/06/2010	19.0	26.0	100.0	7/06/2012	0.5	6.0	5.0
12/06/2010	3.0	11.0	33.0	13/06/2012	3.0	10.0	4.0
18/06/2010	ND	21.0	ND	19/06/2012	17.0	14.0	21.0
24/06/2010	ND	12.0	17.0	25/06/2012	30.0	28.0	36.0
30/06/2010	ND	1.0	13.0	1/07/2012	22.0	21.0	27.0
6/07/2010	ND	18.0	ND	7/07/2012	15.0	14.0	15.0
12/07/2010	ND	ND	3.0	13/07/2012	6.0	24.0	7.0
18/07/2010	ND	3.0	ND	19/07/2012	21.0	18.0	19.0
24/07/2010	ND	24.0	ND	25/07/2012	10.0	11.0	13.0
30/07/2010	ND	21.0	ND	31/07/2012	27.0	25.0	22.0
5/08/2010	ND	11.0	ND	6/08/2012	64.0	28.0	58.0
11/08/2010	ND	ND	ND	12/08/2012	13.0	13.0	15.0
17/08/2010	27.0	ND	30.0	18/08/2012	50.0	18.0	38.0
23/08/2010	ND	ND	20.0	24/08/2012	23.0	10.0	21.0
29/08/2010	22.0	ND	ND	30/08/2012	56.0	22.0	42.0
4/09/2010	8.0	ND	7.0	5/09/2012	94.0	61.0	68.0
10/09/2010	18.0	ND	10.0	11/09/2012	51.0	38.0	28.0
16/09/2010	22.0	ND	16.0	17/09/2012	32.0	26.0	25.0
22/09/2010	25.0	ND	24.0	23/09/2012	57.0	32.0	25.0
28/09/2010	33.0	ND	26.0	29/09/2012	23.0	27.0	20.0
4/10/2010	4.0	ND	6.0	5/10/2012	80.0	31.0	52.0
10/10/2010	9.0	ND	ND	11/10/2012	23.0	11.0	20.0
16/10/2010	13.0	ND	ND	17/10/2012	78.0	33.0	63.0
22/10/2010	31.0	ND	ND	23/10/2012	30.0	52.0	18.0
28/10/2010	17.0	ND	ND	29/10/2012	9.0	10.0	10.0
3/11/2010	ND	ND	ND	4/11/2012	36.0	24.0	22.0
9/11/2010	30.0	ND	29.0	10/11/2012	12.0	14.0	33.0
15/11/2010	ND	ND	15.0	16/11/2012	14.0	16.0	17.0
21/11/2010	10.0	ND	10.0	22/11/2012	25.0	22.0	28.0
27/11/2010	13.1	12.9	13.8	28/11/2012	11.0	12.0	12.0
3/12/2010	9.4	9.8	6.1	4/12/2012	23.0	20.0	31.0

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
9/12/2010	42.1	21.3	34.6	10/12/2012	4.0	7.0	6.0
15/12/2010	25.1	25.2	ND	16/12/2012	25.0	22.0	32.0
21/12/2010	34.9	21.1	27.5	22/12/2012	12.0	12.0	14.0
27/12/2010	7.1	9.0	24.4	28/12/2012	19.0	20.0	22.0
2/01/2011	30.2	23.7	30.4	3/01/2013	15.0	16.0	21.0
8/01/2011	11.0	11.8	13.9	9/01/2013	67.0	44.0	51.0
14/01/2011	22.2	18.8	22.1	15/01/2013	12.0	7.0	9.0
20/01/2011	10.3	11.4	28.4	21/01/2013	13.0	15.0	14.0
26/01/2011	42.3	37.9	61.1	27/01/2013	9.0	9.0	26.0
1/02/2011	107.0	51.5	122.0	2/02/2013	6.0	8.0	6.0
7/02/2011	13.7	12.5	19.0	8/02/2013	32.0	30.0	29.0
13/02/2011	8.6	9.4	11.7	14/02/2013	13.0	7.0	6.0
19/02/2011	29.4	22.9	37.8	20/02/2013	5.0	8.0	10.0
25/02/2011	23.6	20.4	46.4	26/02/2013	11.0	11.0	9.0
3/03/2011	25.0	18.0	45.0	4/03/2013	6.0	11.0	10.0
9/03/2011	33.0	23.0	52.0	10/03/2013	14.0	11.0	11.0
15/03/2011	20.0	18.0	24.0	16/03/2013	26.0	21.0	27.0
21/03/2011	8.0	11.0	12.0	22/03/2013	86.0	34.0	51.0
27/03/2011	10.0	12.0	17.0	28/03/2013	39.0	32.0	38.0
2/04/2011	27.0	26.0	41.0	3/04/2013	14.0	15.0	13.0
8/04/2011	7.0	7.0	11.0	9/04/2013	7.0	10.0	8.0
14/04/2011	33.0	22.0	19.0	15/04/2013	52.0	43.0	42.0
20/04/2011	38.0	35.0	30.0	21/04/2013	7.0	8.0	8.0
26/04/2011	8.0	9.0	8.0	27/04/2013	41.0	35.0	48.0
2/05/2011	23.0	24.0	20.0	3/05/2013	28.0	30.0	24.0
8/05/2011	24.0	21.0	24.0	9/05/2013	9.0	7.0	12.0
14/05/2011	15.0	9.0	13.0	15/05/2013	33.0	18.0	26.0
20/05/2011	31.0	34.0	26.0	21/05/2013	47.0	34.0	48.0
26/05/2011	6.0	8.0	7.0	27/05/2013	20.0	22.0	14.0
1/06/2011	12.0	15.0	12.0	2/06/2013	4.0	8.0	5.0
7/06/2011	40.0	18.0	23.0	8/06/2013	11.0	13.0	10.0
13/06/2011	5.0	9.0	7.0	14/06/2013	12.0	8.0	17.0
19/06/2011	22.0	17.0	19.0	20/06/2013	15.0	13.0	11.0
25/06/2011	25.0	28.0	25.0	26/06/2013	17.0	16.0	20.0
1/07/2011	8.0	9.0	7.0	2/07/2013	10.0	10.0	11.0
7/07/2011	25.0	10.0	18.0	8/07/2013	19.0	19.0	19.0
13/07/2011	30.0	13.0	30.0	14/07/2013	12.0	17.0	11.0
19/07/2011	12.0	22.0	14.0	20/07/2013	1.0	4.0	6.0
25/07/2011	24.0	29.0	19.0	26/07/2013	33.0	27.0	29.0
31/07/2011	29.0	27.0	27.0	1/08/2013	10.0	10.0	13.0
6/08/2011	45.0	32.0	20.0	7/08/2013	23.0	11.0	21.0
12/08/2011	25.0	19.0	14.0	13/08/2013	37.0	23.0	36.0
18/08/2011	29.0	10.0	15.0	19/08/2013	68.0	20.0	50.0
24/08/2011	13.0	10.0	8.0	25/08/2013	35.0	21.0	30.0
30/08/2011	17.0	15.0	14.0	31/08/2013	31.0	24.0	30.0
5/09/2011	40.0	32.0	27.0	6/09/2013	56.0	43.0	49.0
11/09/2011	18.0	11.0	18.0	12/09/2013	50.0	32.0	33.0
17/09/2011	54.0	29.0	36.0	18/09/2013	22.0	16.0	22.0
23/09/2011	56.0	41.0	47.0	24/09/2013	90.0	35.0	68.0
29/09/2011	12.0	9.0	14.0	30/09/2013	64.0	40.0	35.0
5/10/2011	13.0	10.0	10.0	6/10/2013	55.0	39.0	40.0
11/10/2011	30.0	19.0	26.0	12/10/2013	46.0	37.0	32.0
17/10/2011	13.0	13.0	38.0	18/10/2013	40.0	34.0	51.0
23/10/2011	35.0	27.0	5.0	24/10/2013	60.0	35.0	44.0
29/10/2011	29.0	21.0	23.0	30/10/2013	15.0	13.0	12.0
4/11/2011	15.0	12.0	11.0	5/11/2013	19.0	17.0	17.0
10/11/2011	68.0	42.0	45.0	11/11/2013	4.0	5.0	4.0
16/11/2011	30.0	28.0	27.0	17/11/2013	5.0	7.0	5.0

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
22/11/2011	19.0	19.0	17.0	23/11/2013	9.0	9.0	8.0
28/11/2011	14.0	20.0	12.0	29/11/2013	45.0	20.0	31.0
4/12/2011	25.0	18.0	19.0	5/12/2013	53.0	19.0	44.0
10/12/2011	9.0	8.0	10.0	11/12/2013	46.0	30.0	41.0
16/12/2011	15.0	15.0	13.0	17/12/2013	11.0	9.0	19.0
22/12/2011	8.0	8.0	8.0	23/12/2013	129.0	53.0	84.0
28/12/2011	16.0	17.0	14.0	29/12/2013	31.0	27.0	34.0

ND = No Data

Table C-2: HVAS TSP Monitoring data (µg/m³)

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
1/01/2010	29.8	29.6	37.2	3/01/2012	32.0	28.0	66.0
7/01/2010	28.1	33.0	47.8	9/01/2012	62.0	46.0	103.0
13/01/2010	103.0	113.0	106.0	15/01/2012	20.0	19.0	20.0
19/01/2010	135.0	133.0	173.0	21/01/2012	29.0	31.0	30.0
25/01/2010	43.8	63.2	79.3	27/01/2012	22.0	19.0	22.0
31/01/2010	47.5	24.2	40.9	2/02/2012	8.0	7.0	5.0
6/02/2010	36.1	18.7	24.4	8/02/2012	27.0	29.0	26.0
12/02/2010	217.0	90.8	ND	14/02/2012	21.0	20.0	18.0
18/02/2010	33.9	28.6	51.8	20/02/2012	32.0	25.0	38.0
24/02/2010	57.2	52.9	54.9	26/02/2012	34.0	27.0	37.0
2/03/2010	29.9	27.0	28.5	3/03/2012	27.0	19.0	28.0
8/03/2010	80.7	65.0	92.2	9/03/2012	83.0	62.0	83.0
14/03/2010	23.3	12.5	15.3	15/03/2012	32.0	40.0	41.0
20/03/2010	158.0	88.7	92.0	21/03/2012	44.0	38.0	52.0
26/03/2010	8.1	86.6	107.0	27/03/2012	38.0	27.0	27.0
1/04/2010	34.4	34.1	42.0	2/04/2012	35.0	39.0	40.0
7/04/2010	19.0	22.6	29.2	8/04/2012	56.0	51.0	56.0
13/04/2010	102.0	61.9	90.0	14/04/2012	42.0	35.0	45.0
19/04/2010	21.3	25.0	34.7	20/04/2012	58.0	54.0	60.0
25/04/2010	23.9	40.2	40.6	26/04/2012	73.0	52.0	98.0
1/05/2010	13.6	26.6	37.8	2/05/2012	22.0	66.0	74.0
7/05/2010	147.0	96.8	90.0	8/05/2012	138.0	86.0	94.0
13/05/2010	212.0	127.0	136.0	14/05/2012	127.0	78.0	95.0
19/05/2010	109.0	60.4	59.4	20/05/2012	101.0	69.0	79.0
25/05/2010	21.1	25.5	21.7	26/05/2012	63.0	42.0	89.0
31/05/2010	33.1	21.3	26.6	1/06/2012	24.0	27.0	28.0
6/06/2010	33.5	70.0	39.3	7/06/2012	4.0	12.0	16.0
12/06/2010	70.7	38.0	168.0	13/06/2012	9.0	29.0	14.0
18/06/2010	70.5	44.9	58.0	19/06/2012	61.0	51.0	103.0
24/06/2010	22.3	22.4	37.9	25/06/2012	90.0	77.0	112.0
30/06/2010	142.0	72.8	88.8	1/07/2012	78.0	51.0	98.0
6/07/2010	44.5	38.6	43.2	7/07/2012	40.0	34.0	42.0
12/07/2010	23.0	22.8	17.1	13/07/2012	20.0	52.0	24.0
18/07/2010	44.1	31.4	44.4	19/07/2012	65.0	45.0	79.0
24/07/2010	53.4	39.6	59.5	25/07/2012	21.0	23.0	39.0
30/07/2010	45.2	29.7	37.4	31/07/2012	72.0	99.0	71.0
5/08/2010	77.6	47.3	79.4	6/08/2012	208.0	37.0	138.0
11/08/2010	43.0	34.7	41.0	12/08/2012	44.0	69.0	60.0
17/08/2010	89.2	66.7	91.7	18/08/2012	132.0	44.0	123.0
23/08/2010	71.4	34.4	39.6	24/08/2012	81.0	72.0	101.0
29/08/2010	85.5	65.7	98.4	30/08/2012	124.0	59.0	139.0
4/09/2010	51.9	35.7	38.9	5/09/2012	201.0	154.0	194.0
10/09/2010	63.3	47.7	78.0	11/09/2012	121.0	99.0	99.0
16/09/2010	205.0	95.3	112.0	17/09/2012	76.0	62.0	63.0
22/09/2010	110.0	95.8	147.0	23/09/2012	172.0	111.0	97.0
28/09/2010	141.0	89.0	ND	29/09/2012	61.0	78.0	50.0
4/10/2010	10.9	9.5	11.3	5/10/2012	173.0	72.0	143.0

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
10/10/2010	28.4	29.4	43.7	11/10/2012	81.0	31.0	57.0
16/10/2010	64.4	102.0	52.6	17/10/2012	163.0	89.0	128.0
22/10/2010	84.6	56.3	74.4	23/10/2012	52.0	130.0	67.0
28/10/2010	15.4	33.5	55.0	29/10/2012	33.0	26.0	36.0
3/11/2010	20.8	59.9	83.7	4/11/2012	79.0	45.0	62.0
9/11/2010	60.5	38.3	38.6	10/11/2012	44.0	37.0	63.0
15/11/2010	61.9	60.0	73.0	16/11/2012	52.0	41.0	51.0
21/11/2010	17.7	20.0	25.0	22/11/2012	78.0	45.0	68.0
27/11/2010	30.3	35.4	43.7	28/11/2012	30.0	28.0	34.0
3/12/2010	13.2	14.9	18.4	4/12/2012	83.0	56.0	89.0
9/12/2010	148.0	62.2	99.7	10/12/2012	17.0	31.0	21.0
15/12/2010	66.0	51.3	79.3	16/12/2012	63.0	51.0	72.0
21/12/2010	115.0	62.0	94.9	22/12/2012	38.0	31.0	46.0
27/12/2010	23.2	23.9	48.0	28/12/2012	62.0	49.0	62.0
2/01/2011	69.3	54.0	77.0	3/01/2013	43.0	27.0	59.0
8/01/2011	18.3	21.6	20.5	9/01/2013	180.0	138.0	166.0
14/01/2011	51.1	49.8	51.5	15/01/2013	27.0	25.0	27.0
20/01/2011	21.2	26.2	42.6	21/01/2013	40.0	30.0	36.0
26/01/2011	102.0	86.0	95.8	27/01/2013	19.0	12.0	16.0
1/02/2011	316.0	153.0	156.0	2/02/2013	17.0	41.0	23.0
7/02/2011	66.2	36.5	48.2	8/02/2013	73.0	53.0	84.0
13/02/2011	20.8	56.5	65.0	14/02/2013	26.0	20.0	21.0
19/02/2011	77.6	54.2	57.5	20/02/2013	11.0	17.0	51.0
25/02/2011	50.7	38.7	77.7	26/02/2013	35.0	21.0	23.0
3/03/2011	98.0	50.0	78.0	4/03/2013	15.0	27.0	25.0
9/03/2011	93.0	70.0	91.0	10/03/2013	27.0	31.0	26.0
15/03/2011	45.0	38.0	42.0	16/03/2013	60.0	53.0	66.0
21/03/2011	23.0	22.0	21.0	22/03/2013	199.0	107.0	196.0
27/03/2011	40.0	33.0	33.0	28/03/2013	100.0	84.0	116.0
2/04/2011	50.0	68.0	62.0	3/04/2013	25.0	27.0	27.0
8/04/2011	26.0	20.0	24.0	9/04/2013	22.0	28.0	23.0
14/04/2011	102.0	70.0	80.0	15/04/2013	125.0	97.0	122.0
20/04/2011	97.0	68.0	70.0	21/04/2013	20.0	19.0	24.0
26/04/2011	20.0	20.0	22.0	27/04/2013	92.0	77.0	101.0
2/05/2011	57.0	47.0	46.0	3/05/2013	93.0	86.0	84.0
8/05/2011	78.0	51.0	71.0	9/05/2013	24.0	20.0	40.0
14/05/2011	101.0	49.0	75.0	15/05/2013	117.0	75.0	108.0
20/05/2011	90.0	59.0	59.0	21/05/2013	161.0	109.0	190.0
26/05/2011	40.0	28.0	32.0	27/05/2013	45.0	43.0	26.0
1/06/2011	25.0	27.0	25.0	2/06/2013	16.0	19.0	21.0
7/06/2011	128.0	57.0	91.0	8/06/2013	37.0	36.0	34.0
13/06/2011	15.0	17.0	20.0	14/06/2013	54.0	32.0	63.0
19/06/2011	50.0	43.0	69.0	20/06/2013	44.0	36.0	48.0
25/06/2011	53.0	58.0	52.0	26/06/2013	56.0	44.0	60.0
1/07/2011	21.0	20.0	26.0	2/07/2013	30.0	28.0	39.0
7/07/2011	78.0	74.0	84.0	8/07/2013	64.0	55.0	73.0
13/07/2011	112.0	66.0	115.0	14/07/2013	22.0	27.0	26.0
19/07/2011	60.0	30.0	65.0	20/07/2013	27.0	18.0	35.0
25/07/2011	91.0	60.0	81.0	26/07/2013	111.0	84.0	125.0
31/07/2011	88.0	72.0	80.0	1/08/2013	23.0	22.0	54.0
6/08/2011	133.0	87.0	97.0	7/08/2013	116.0	54.0	117.0
12/08/2011	114.0	45.0	43.0	13/08/2013	118.0	99.0	159.0
18/08/2011	115.0	40.0	47.0	19/08/2013	192.0	72.0	220.0
24/08/2011	34.0	25.0	29.0	25/08/2013	125.0	78.0	286.0
30/08/2011	31.0	32.0	34.0	31/08/2013	89.0	67.0	102.0
5/09/2011	105.0	78.0	78.0	6/09/2013	165.0	130.0	151.0
11/09/2011	67.0	31.0	68.0	12/09/2013	155.0	89.0	120.0
17/09/2011	157.0	107.0	152.0	18/09/2013	60.0	51.0	76.0

Date	Rix's Creek	Mines Rescue	Retreat	Date	Rix's Creek	Mines Rescue	Retreat
23/09/2011	147.0	94.0	129.0	24/09/2013	138.0	114.0	196.0
29/09/2011	33.0	26.0	38.0	30/09/2013	135.0	107.0	118.0
5/10/2011	24.0	20.0	26.0	6/10/2013	140.0	106.0	127.0
11/10/2011	119.0	61.0	89.0	12/10/2013	52.0	88.0	116.0
17/10/2011	34.0	35.0	19.0	18/10/2013	75.0	72.0	141.0
23/10/2011	93.0	67.0	127.0	24/10/2013	134.0	91.0	123.0
29/10/2011	92.0	68.0	68.0	30/10/2013	39.0	33.0	49.0
4/11/2011	43.0	37.0	46.0	5/11/2013	45.0	41.0	56.0
10/11/2011	195.0	112.0	162.0	11/11/2013	25.0	22.0	27.0
16/11/2011	71.0	56.0	66.0	17/11/2013	15.0	20.0	20.0
22/11/2011	41.0	30.0	41.0	23/11/2013	14.0	16.0	19.0
28/11/2011	29.0	29.0	40.0	29/11/2013	113.0	51.0	93.0
4/12/2011	57.0	57.0	50.0	5/12/2013	133.0	55.0	147.0
10/12/2011	18.0	18.0	21.0	11/12/2013	123.0	86.0	129.0
16/12/2011	25.0	25.0	37.0	17/12/2013	25.0	23.0	95.0
22/12/2011	14.0	14.0	17.0	23/12/2013	317.0	153.0	233.0
28/12/2011	31.0	31.0	26.0	29/12/2013	57.0	54.0	70.0

ND = No Data