CLEAN TEQ
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Syerston Project

MODIFICATION 4 ENVIRONMENTAL ASSESSMENT

Appendix A

Air Quality Assessment

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SYERSTON PROJECT MODIFICATION 4
AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

RAMBOLL ENVIRON

SYERSTON PROJECT MODIFICATION 4
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Revision	Date	Made by	Checked by	Approved by	Signed
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1. INTRODUCTION

The Syerston Project (the Project) is situated approximately 350 kilometres (km) west-northwest of Sydney, near the village of Fifield, NSW (see **Appendix 1**).

Scandium21 Pty Ltd is the owner and operator of the Syerston Project and is a wholly owned subsidiary of Clean TeQ Holdings Limited (Clean TeQ) (ASX:CLQ).

Development Consent DA 374-11-00 for the Project was issued under Part 4 of the New South Wales (NSW) Environmental Planning and Assessment Act, 1979 (EP&A Act) in 2001.

The Project includes the establishment and operation of the following (see **Appendix 1**):

- mine (including the processing facility);
- limestone quarry;
- rail siding;
- gas pipeline;
- borefields and water pipeline; and
- associated transport activities and transport infrastructure (e.g. the Fifield Bypass and road and intersection upgrades).

The Project includes an initial scandium oxide focussed production phase (the Initial Production Phase) prior to shifting to scandium oxide and nickel and cobalt precipitate production by developing the full Project (the Full Production Phase).

The Initial Production Phase is a smaller-scale operation compared to the Full Project Phase and would include preferentially mining scandium-rich areas of the Syerston deposit at a run-of-mine (ROM) ore production rate of 100,000 tonnes per annum (tpa) to produce up to 1,000 tpa of nickel and cobalt metal equivalents, as either sulphide or sulphate precipitate products, and up to approximately 80 tpa of scandium oxide.

The Project would transition to the Full Production Phase once scandium-rich areas of the Syerston deposit are depleted or favourable market conditions prevail for larger scale nickel cobalt scandium production.

The mining and processing will then increase to allow for an autoclave feed rate of 2.5 million tonnes per annum (Mtpa) to produce up to 40,000 tpa of nickel and cobalt metal equivalents and up to approximately 180 tpa of scandium oxide.

Construction of the Project commenced in 2006 with the construction of some components of the borefields, however Project operations are yet to commence.

1.1 Modification overview

Clean TeQ has undertaken a Project Optimisation Study to identify opportunities to improve the overall efficiency of the Full Production Phase of the Project. The Modification involves the implementation of these opportunities and would include:

- mining in a more selective manner to initially increase the processing facility ore feed grade;
- addition of drilling and blasting at the mine site;
- adoption of the resin-in-pulp (RIP) processing method option (i.e. the counter current decantation processing method option is no longer proposed)[1];
- increased sulphur demand and sulphuric acid production to leach additional nickel, cobalt and scandium from the higher grade ore;
- increased limestone demand to neutralise the additional acid required in the acid leach circuit;
- addition of a crystalliser to the processing facility to extract ammonium sulphate from an existing waste stream for use as a fertiliser product;

[1] The approved Project includes the option to use either the RIP or counter current decantation processing method.

- changes to process input and product road transport requirements;
- addition of a water treatment plant to the processing facility to recycle process water and minimise make-up water demand;
- increased tailings storage facility capacity to hold increased tailings volume due to the additional limestone required for acid neutralisation;
- reduced evaporation pond capacity due to the recycling of process water;
- relocation of mine infrastructure to avoid resource sterilisation and improve operational efficiency;
- addition of surface water extraction from the Lachlan River to improve water supply security;
- minor changes to borefield transfer station layout and water pipeline alignment;
- short-term road transport of water from the borefield to the mine site during the initial construction phase; and
- reduced gas demand as the increased sulphuric acid production would generate additional steam for power generation.

The Modification would not involve changes to any aspects of the approved limestone quarry, rail siding or gas pipeline.

The general arrangement of the modified mine and processing facility and progressive general arrangements of the modified mine and processing facility are provided in **Appendix 1**. A detailed description of the Modification is provided in the main text of the Environmental Assessment (EA).

1.2 Report purpose and requirements

Ramboll Environ has been commissioned to complete an Air Quality Impact Assessment (AQIA) as part of the EA for the proposed Modification. While formal Secretary's Environmental Assessment Requirements have not been issued for the Modification, the NSW Department of Planning and Environment (DP&E) has provided specific advice regarding key issues for consideration in the Environmental Assessment. The AQIA has been prepared to address the specific advice relevant to air quality (**Table 1-1**).

Table 1-1: Summary of key issues for consideration for air quality

Issue for consideration	How issue is addressed
A detailed assessment should be undertaken in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*, including the new National Environment Protection Measures standards for $PM_{2.5}$ that have been incorporated into that guideline.	Refer Section 2
The assessment should include detailed measures to monitor and manage increased air quality impacts, particularly in relation to stack emissions and limestone production at the quarry. The measures proposed and presented in the EA must be developed in consultation with the EPA.	Refer Section 9. Note the Modification does not include any changes to the limestone quarry and, consistent with a letter received from the DP&E on 13 October 2017, is not considered in this report.

1.3 Previous air quality assessments of the Project

An air quality assessment was prepared for the approved Project (Zib & Associates Pty Ltd, 2000), which included dispersion modelling for the construction phase (Year 1), ongoing mining operations (Year 5, 10 and 20), the processing plant and the limestone quarry. The air quality assessment found that each component of the Project would comply with the relevant air quality goals beyond the site boundary and / or at private residences.

Subsequent modifications to the approved Project demonstrated that there would be no material change to the potential air quality impacts for the approved Project (i.e. Heggies, 2005).

2. STUDY APPROACH

2.1 Assessment approach

The approach to the assessment follows guidelines recommended in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ("the Approved Methods") (NSW EPA, 2016). Local air quality impacts are assessed using a Level 2 assessment approach (i.e. refined dispersion modelling technique using site-representative input data).

An overview of the approach to the assessment is as follows:

- The Modification is reviewed for potential emission sources and proposed mitigation measures.
- Emissions are estimated for all project related activities, using best practice emission estimation techniques.
- Dispersion modelling using a regulatory dispersion model is used to predict ground level concentrations (GLCs) for key pollutants from the Modification, at surrounding sensitive receivers.
- Cumulative impacts are assessed, taking into account the combined effect of existing baseline air quality, other significant sources of emissions, reasonably foreseeable future emissions and any indirect or induced effects.
- Estimates of the greenhouse gas (GHG) emissions are presented and benchmarked against GHG accounts for NSW and Australia.

2.2 Pollutant indicators

The key emissions to air for the Modification are gaseous emissions generated by the processing facility and fugitive dust or particulate matter (PM), generated during open cut mining. The air quality indicators considered in this report are summarised in **Table 2-1**.

Table 2-1: Air quality indicators for assessment

Phase	Emission source	Air quality indicator
Mining operations	Fugitive dust	Particulate matter (TSP[1], PM_{10}[2] and $PM_{2.5}$[3])
		Nuisance dust (dust deposition)
Processing plant	Sulphuric acid plant	Sulphuric acid mist (H_2SO_4)
		Sulphur dioxide (SO_2)
	Diesel power plant and auxiliary boiler	$PM_{2.5}$ (primarily[4])
		Oxides of nitrogen (NO_x)
		Sulphur dioxide (SO_2)
		Carbon monoxide (CO).
		Volatile organic compounds (VOCs)

Note:
1) Total Suspended Particulate matter
2) Particulate matter less than 10 microns in aerodynamic diameter
3) Particulate matter less than 2.5 microns in aerodynamic diameter
4) ~97% of diesel particulate matter (DPM) is in the $PM_{2.5}$ size fraction

2.3 Assessment criteria for gaseous pollutants

The impact assessment criteria for gaseous pollutants are summarised in **Table 2-2**. Similar to PM, the impact assessment criteria for 'criteria pollutants', as defined in the Approved Methods, are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction.

The impact assessment criteria for other gaseous pollutants are applied at, and beyond, the site boundary and reported as the 99.9th percentile of the dispersion modelling predictions. Only incremental impacts for these pollutants need be reported. Other relevant gaseous pollutants are H_2SO_4 and the various VOC components of diesel exhaust emissions[2].

Table 2-2: Impact assessment criteria for gaseous pollutants

Pollutant	Averaging period	Concentration	
		µg/m³	pphm (4)
NO_2 (1)	1-hour	246	12
	Annual	62	3
SO_2 (1)	10-minute	712	25
	1-hour	570	20
	24-hour	228	8
	Annual	60	2
CO (1)	15-minute	100,000	8,700
	1-hour	30,000	2,500
	8-hour	10,000	900
H_2SO_4 (2),(3)	1-hour	18	-
1,3-butadiene (2),(3)	1-hour	40	1.8
Benzene (2),(3)	1-hour	29	0.9

Note 1: Gas volumes for criteria pollutants expressed at 0°C and 1 atmosphere.
Note 2: Gas volumes for other gaseous pollutants expressed at 25°C and 1 atmosphere.
Note 3: Expressed as the 99.9th Percentile Value.
Note 4: pphm = parts per hundred million.

2.4 Assessment criteria for particulate matter

When first regulated, airborne PM was assessed based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometres (µm) in diameter. As air sampling technology improved and the importance of particle size and chemical composition become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$.

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the 'Approved Methods', gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

For the purpose of this report, predicted GLCs are assessed against the NSW EPA's impact assessment criteria presented in **Table 2-3**.

Table 2-3: Impact assessment criteria for PM

PM metric	Averaging period	Concentration (µg/m³)
TSP	Annual	90
PM_{10}	24 hour	50
	Annual	25
$PM_{2.5}$	24 hour	25
	Annual	8

Note: µg/m³ = micrograms per cubic metre.

[2] While many VOC species are emitted from combustion of fossil fuels, benzene and 1,3-butadiene are included in the Approved Methods, are among the species with the most stringent impact assessment criteria and have reported speciation profiles for diesel engines.

The Approved Methods specifies that the impact assessment criteria for 'criteria pollutants[3]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (consideration of existing ambient background concentration is required).

The Approved Methods also prescribes nuisance based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. The NSW EPA impact assessment criteria for dust deposition are summarised in **Table 2-4**, illustrating the maximum increase and total dust deposition rates which would be acceptable so that dust nuisance can be avoided.

Table 2-4: Dust deposition criteria

Pollutant	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust (assessed as insoluble solids)	2 g/m^2/month	4 g/m^2/month

Note: g/m^2 = grams per square metre.

2.4.1 Voluntary land acquisition and mitigation policy

In December 2014, the NSW DP&E released their Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (the VLAMP)[4]. The VLAMP describes the voluntary mitigation and land acquisition policy to address dust (and noise) impacts and outlines mitigation and acquisition criteria for PM. Essentially, the VLAMP formalises the acquisition criteria that have previously been outlined in conditions of approval for major mining and extractive industries.

Under the VLAMP, if an applicant cannot comply with the relevant impact assessment criteria, or if the mitigation or acquisition criteria may be exceeded, the applicant should consider a negotiated agreement with the affected landowner or acquire the land. In doing so, the land is then no longer subject to the impact assessment, mitigation or acquisition criteria, although provisions do apply to "use of the acquired land", primarily related to informing and protecting existing or prospective tenants.

Voluntary mitigation rights apply when a development contributes to exceedances of the criteria set out in **Table 2-5** and voluntary acquisition rights apply when a development contributes to exceedances of the criteria set out in **Table 2-6**. The criteria for voluntary mitigation and acquisition are the same, with the exception of the number of allowable days above short-term impact assessment criteria for PM_{10}, which is zero for mitigation and five for acquisition.

Voluntary mitigation rights apply to any residence on privately owned land or any workplace on privately owned land where the consequences of the exceedance, in the opinion of the consent authority, are unreasonably deleterious to worker health or the carrying out of business. Voluntary acquisition rights also apply to any residence or any workplace on privately owned land but also apply when an exceedance occurs across 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.

[3] 'Criteria pollutants' is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods, the criteria pollutants are TSP, PM_{10}, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), deposited dust, hydrogen fluoride and lead.

[4] http://www.planning.nsw.gov.au/Policy-and-Legislation/~/media/E785D4AFFE7B447487FF9D96111C502B.ashx

Table 2-5: DP&E mitigation criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
PM_{10}	24 hour	50 µg/m³ *		Human Health
	Annual	30 µg/m³ **		Human Health
TSP	Annual	90 µg/m³ **		Amenity
Deposited Dust	Annual	2 g/m²/month *	4 g/m²/month **	Amenity

Note: *Incremental increase due to development alone, with zero allowable exceedances over the life of the development.
**Cumulative impact due to the development plus background from other sources.

Table 2-6: DP&E acquisition criteria

Pollutant	Averaging period	Acquisition Criterion		Impact Type
PM_{10}	24 hour	50 µg/m³ *		Human Health
	Annual	30 µg/m³ **		Human Health
TSP	Annual	90 µg/m³ **		Amenity
Deposited Dust	Annual	2 g/m²/month *	4 g/m²/month **	Amenity

Note: *Incremental increase due to development alone, with up to 5 allowable exceedances over the life of the development.
**Cumulative impact due to the development plus background from other sources.

2.5 Dispersion model selection

Local air quality impacts are modelled using AERMOD, the United States Environmental Protection Agency's (US EPA) recommended steady-state plume dispersion model for regulatory purposes. The model is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain. AERMOD is able to predict pollutant concentrations from point, area and volume sources in addition to 'open pit' sources.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and recommended in the Approved Methods for simple near-field applications, is largely based on the ISC model. AERMOD has replaced Ausplume as the regulatory model for EPA Victoria (EPA Victoria, 2013) and will be included in the next updated to the Approved Methods. The model has been used and accepted on a number of open cut mining operations in NSW.

Compared to ISC and Ausplume, AERMOD represents an advanced new-generation model, which requires additional meteorological and land use inputs to provide more refined predictions. The most important feature of AERMOD, compared to ISC and Ausplume, is its modification of the basic dispersion model to account more effectively for a variety of meteorological factors and surface characteristics. In particular, it uses the Monin-Obukhov length scale rather than Pasquill-Gifford stability categories to account for the effects of atmospheric stratification. Whereas Ausplume and ISC parameterise dispersion based on semi-empirical fits to field observations and meteorological extrapolations, AERMOD uses surface-layer and boundary layer theory for improved characterisation of the planetary boundary layer turbulence structure. Further detail on model set up, in particular the process for preparation of meteorological data in the AERMET pre-processor, is provided in **Appendix 2**.

2.6 Cumulative impacts

Cumulative impacts are assessed by combining the contribution from the Project with the existing ambient air quality environment, which is assumed to account for all existing emission sources in the local airshed.

The proposed and approved limestone quarry is located approximately 20 km to the southeast and therefore not considered to interactive cumulatively with the Project, for the purpose of this air quality assessment. As there are no changes to the approved limestone quarry, it is not included in the modelling assessment, however the interaction between the Project and the limestone quarry is considered (i.e. emissions associated with the delivery of limestone raw material to the site). No other foreseeable future emission sources are identified for cumulative assessment.

2.7 Emissions from the combustion of diesel fuel

The combustion of diesel in mining equipment results in combustion-related emissions including $PM_{2.5}$, oxides of nitrogen (NO_x), SO_2, CO, carbon dioxide (CO_2) and volatile organic compounds (VOCs), however with the exception of PM, combustion emissions have not been quantitatively assessed. Gaseous combustion emissions from mining equipment would not result in significant off-site concentrations and are unlikely to compromise ambient air quality goals.

The US EPA AP-42 emission factors developed for coal mine emission inventories do not separate PM emissions from mechanical processes (i.e. crustal material) and diesel exhaust (combustion). However, the emissions controls applied are often only relevant to the crustal fraction of total PM, for example watering of haul roads does not control the diesel component of the emissions (US EPA, 1998a). Adjustments to the emission inventories have been made to account for this and discussed further in **Section 6**. GHG emissions from diesel combustion are considered in **Section 8**.

2.8 POEO (Clean Air) Regulation

The statutory framework for managing air emissions in NSW is provided in the Protection of the Environment Operations (POEO) Act[5] 1997 and the primary regulations for air quality made under the POEO Act are:

- Protection of the Environment Operations (Clean Air) Regulation 2010[6].
- Protection of the Environment Operations (General) Regulation 2009[7].

The Project will comply with the POEO regulations as follows:

- As a scheduled activity under the POEO regulations, the Project will operate under an environment protection licence (EPL) issued by the NSW EPA and will comply with requirements including emission limits, monitoring and pollution reduction programmes (PRPs).
- Best management practice (BMP) is a guiding principle in the POEO Act, and requires that all necessary practicable means are used to prevent or minimise air pollution in NSW. A BMP determination has been made for the Project and is outlined in **Appendix 4**, having regard to all reasonable and feasible avoidance and mitigation measures.
- The Project will manage all aspects of its operations to ensure that offensive odour does not cause 'harm to' or involve 'interfering unreasonably' with the comfort or repose of any person outside the premises. Odour management measures will be outlined in the Air Quality Management Plan.
- No open burning will be performed onsite.

[5] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
[6] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N
[7] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

3. LOCAL SETTING AND RECEPTOR LOCATIONS

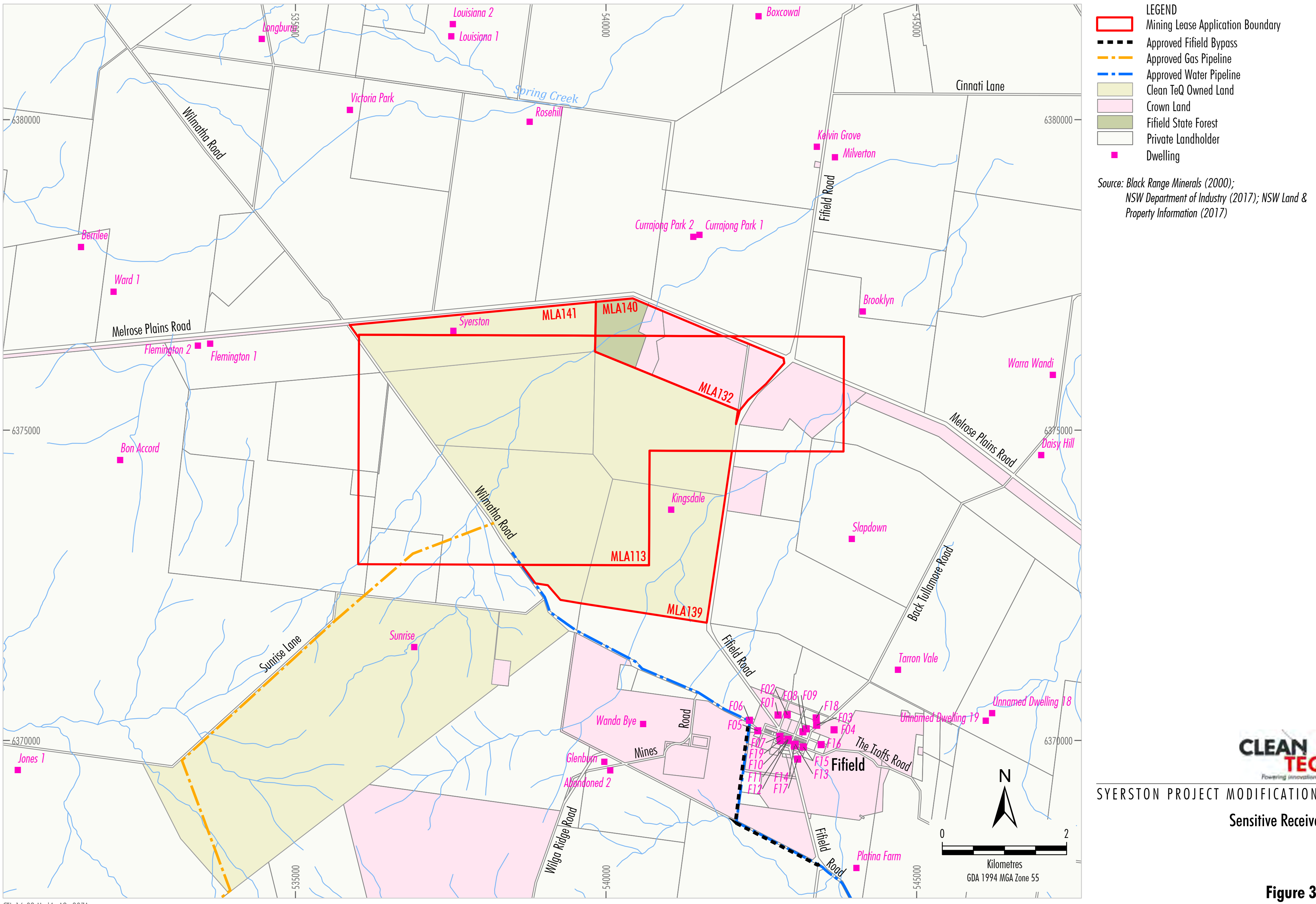
The Project is located near the village of Fifield, approximately 45 km northeast of Condobolin and 80 km northwest of Parkes, in the Central West region of NSW.

The region supports mainly dryland agriculture and the majority of vegetation in the area has been previously cleared for grazing or cropping. The local and regional topography is flat and the elevation of the Project sits at approximately 300 m Australian Height Datum (AHD) with very little variation in elevation across the site.

The local area contains a number of rural-residential properties situated at varying distances from the Project. The locations of the private and mine-owned receptor locations assessed in this report are shown in **Figure 3-1** (note, receptors within the town of Fifield are not labelled).

Receivers M11 (Kingsdale) and M30 (Syerston) would be removed to allow for the development of the mine and have therefore not been considered further.

A tabulated list of receptors locations is provided in **Appendix 3**.



SYERSTON PROJECT MODIFICATION 4

Sensitive Receivers

Figure 3-1

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4. OVERIVEW OF DISPERION METEOROLOGY

4.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

An on-site meteorological monitoring station was installed for the original Environmental Impact Statement (EIS) (in September 1998), however the site is no longer in use and the historical data are not available for this assessment.

Analysis of meteorology for the region is therefore presented based on the closest Bureau of Meteorology (BoM) automatic weather station (AWS) sites, as follows:

- Condobolin Airport AWS – located approximately 40 km south-southwest
- Forbes Airport AWS – located approximately 80 km south-southeast
- Parkes Airport AWS – located approximately 85 km southeast
- Trangie Airport AWS – located approximately 100 km north-northeast
- Dubbo Airport AWS – located approximately 120 km northeast
- West Wyalong Airport AWS – located approximately 103 km south

4.2 Prevailing winds

Five years of hourly data were collected from the six regional BoM AWS sites described above and the regional annual wind roses are presented in **Figure 4-1**. Most sites display a southwest component and a north/northeast component, the exception being Dubbo and Trangie which have a more dominant easterly component.

The most recent annual environmental monitoring review (AEMR) for the Northparkes Mine presents an annual wind rose for 2015 which shows a dominant north-northeast and south-southeast component. The most recent annual review (AR) for the Cowal Mine presents an annual wind rose for 2015 which shows a dominant southwest component.

The closest BoM site to the Project is at Condobolin Airport, and records dominant southwest and north/northeast components and to a lesser extent, winds from most other directions. Similar to the Condobolin Airport site, the original EIS presented a wind rose for the on-site data which showed winds from most directions with a dominant northeast and southwest component for certain hours of the day.

Based on this comparison and the relatively uncomplicated regional terrain, Condobolin Airport BoM data is considered suitable for modelling. Annual wind roses for Condobolin Airport for 2011 to 2016 (**Figure 4-2**) show consistency in wind direction, average wind speeds and the percentage occurrence of calm winds (<= 0.5 m/s). The high degree of consistency in winds across each indicates that each calendar year is suitable for modelling.

2015 is selected as the modelling year. Average winds speeds are approximately 3.6 metres per second (m/s) and the percentage occurrence of calm winds is 12%. Seasonal and diurnal wind roses for 2015 (**Figure 4-3**) demonstrate stronger winds during the day and dominant northeast winds for summer and southwest winds for autumn. Spring and winter wind roses have both northeast and southwest components.

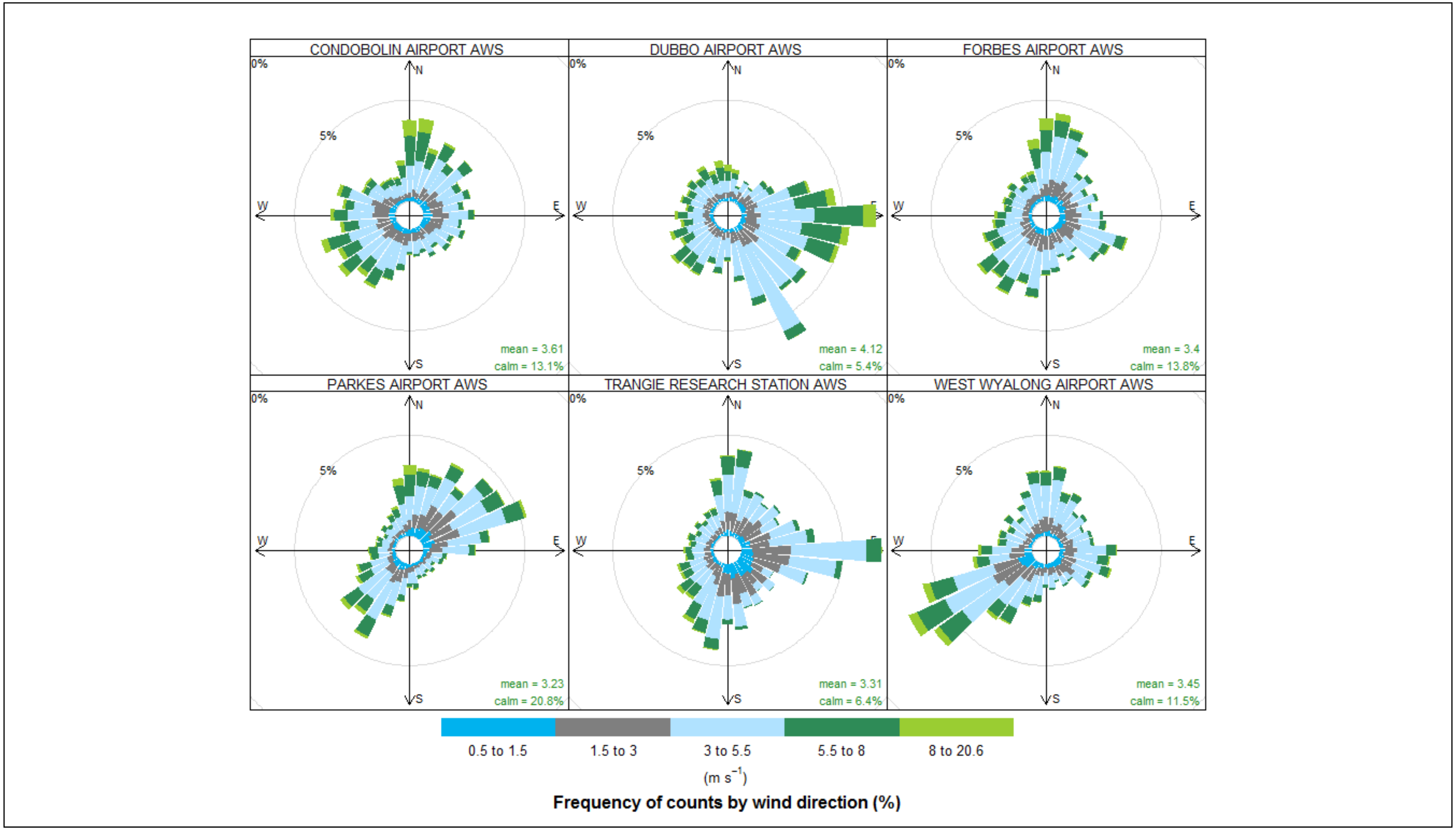


Figure 4-1: Regional wind roses for the Project

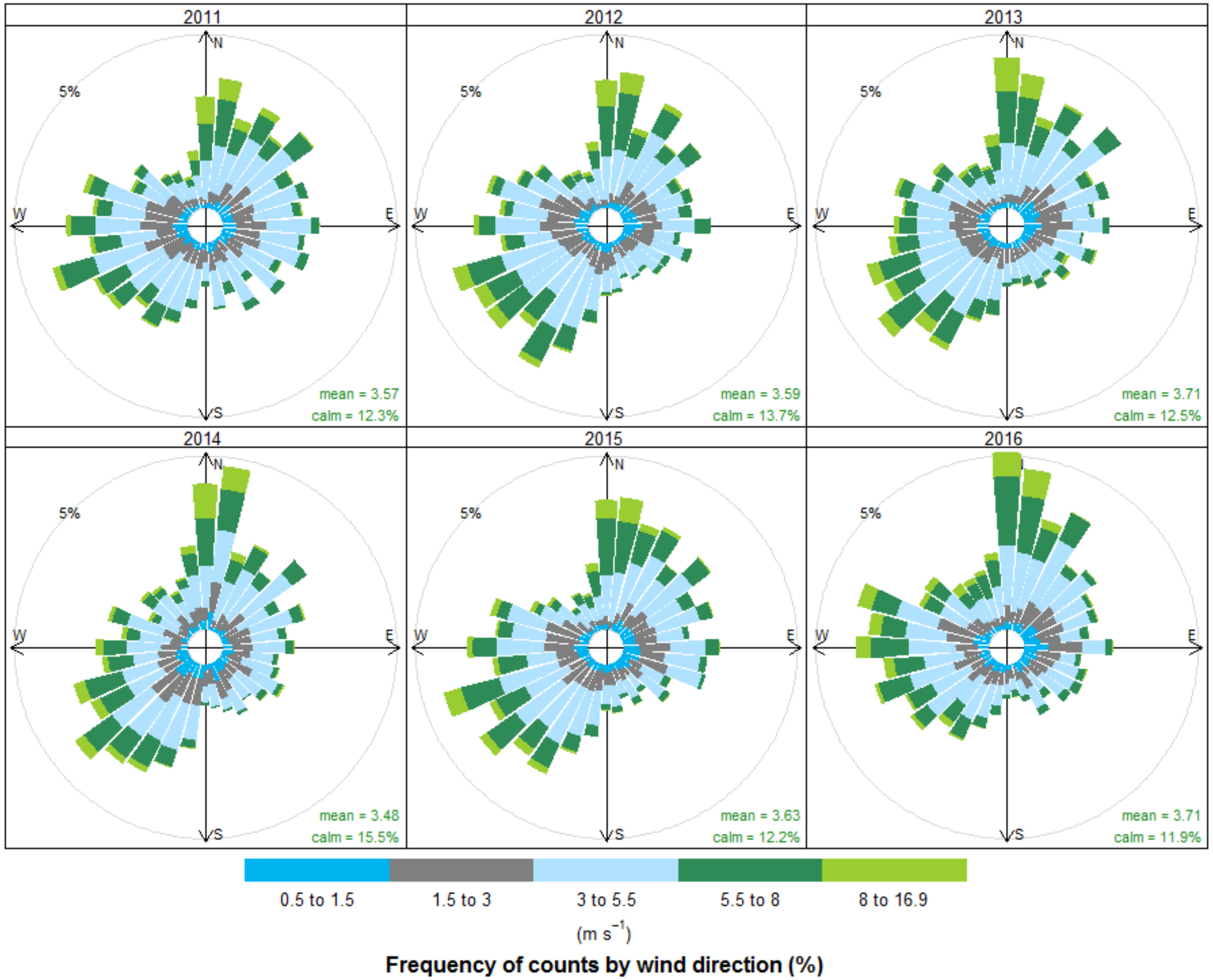


Figure 4-2: Annual wind roses for Condobolin Airport

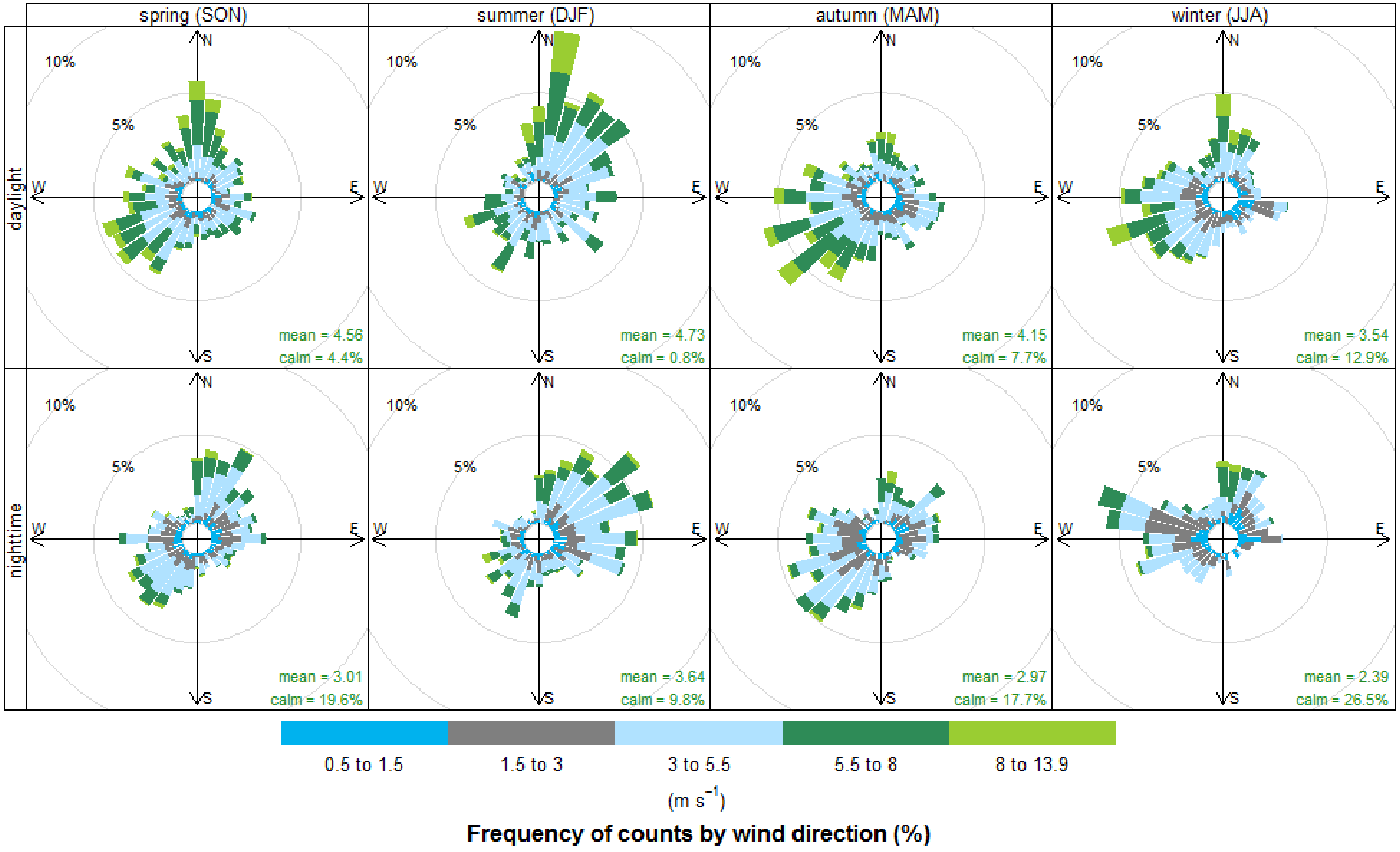
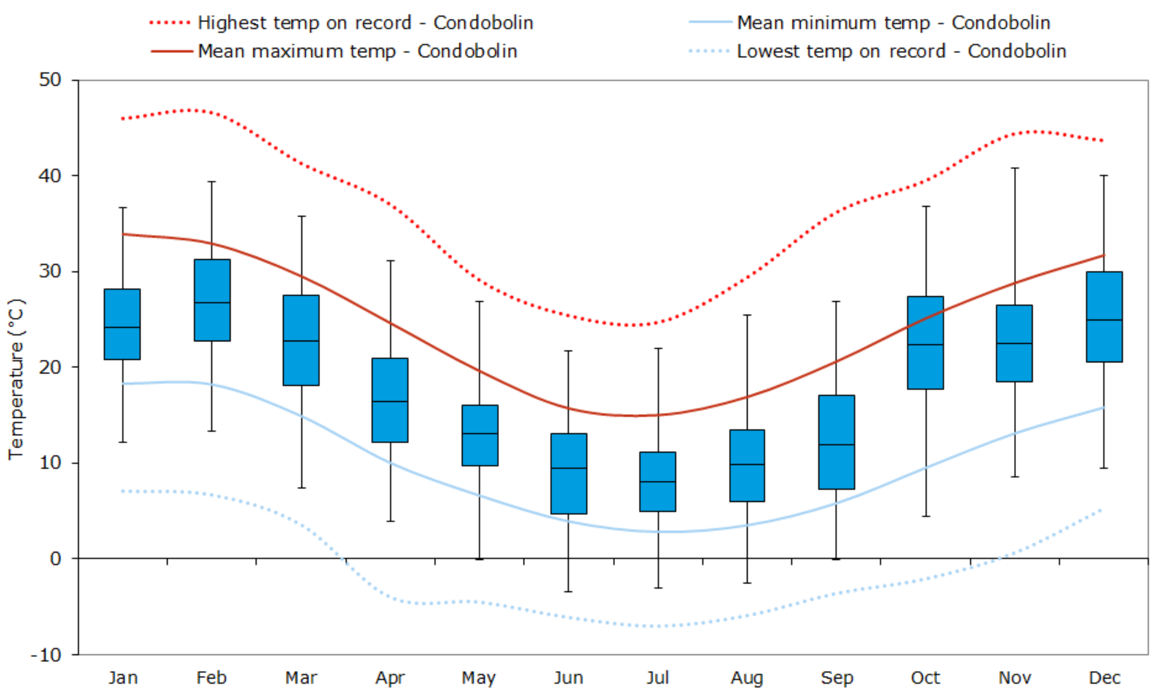


Figure 4-3: Seasonal and diurnal wind roses for Condobolin Airport

4.3 Ambient temperature

The minimum, maximum, mean and upper and lower quartile temperatures for each month of the 2015 modelling dataset are presented as a box and whisker plot shown in **Figure 4-4**. The maximum temperature occurs in November (40.1°C), while the highest mean monthly temperature occurs in February (26.8°C). The lowest recorded minimum temperature occurs in June (-3.4°C), while the lowest monthly mean occurs in July (7.9°C).

The modelling dataset is compared with long-term records at Condobolin (from 1954 to 2017). The modelling dataset correlates well with the long-term historical trends. The upper and lower quartile and mean temperatures fall within the long term mean monthly maximum and minimum temperatures. For all months, the maximum temperatures for 2015 are below the long-term records, while the minimum temperatures for 2015 are all above the long-term minimum temperatures on record.



2015 data are illustrated by the 'box and whisker' plot. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values.

Figure 4-4: Comparison of long-term temperature records with modelling period

4.4 Rainfall

Precipitation is important to air pollution since it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants. Fugitive emissions may be harder to control during low rainfall periods while drier periods may also result in more frequent dust storms and bushfire activity, resulting in higher regional background dust levels. Rainfall also acts as a removal mechanism for dust, lowering pollutant concentrations by removing them more efficiently than during dry periods.

Long term rainfall records presented in **Figure 4-5** show that the highest monthly rainfall occurs in January and October while the winter months have the greatest number of raindays.

To provide a conservative (upper bound) estimate of the pollutant concentrations, wet deposition (removal of particles from the air by rainfall) was not included in the dispersion calculations for this assessment.

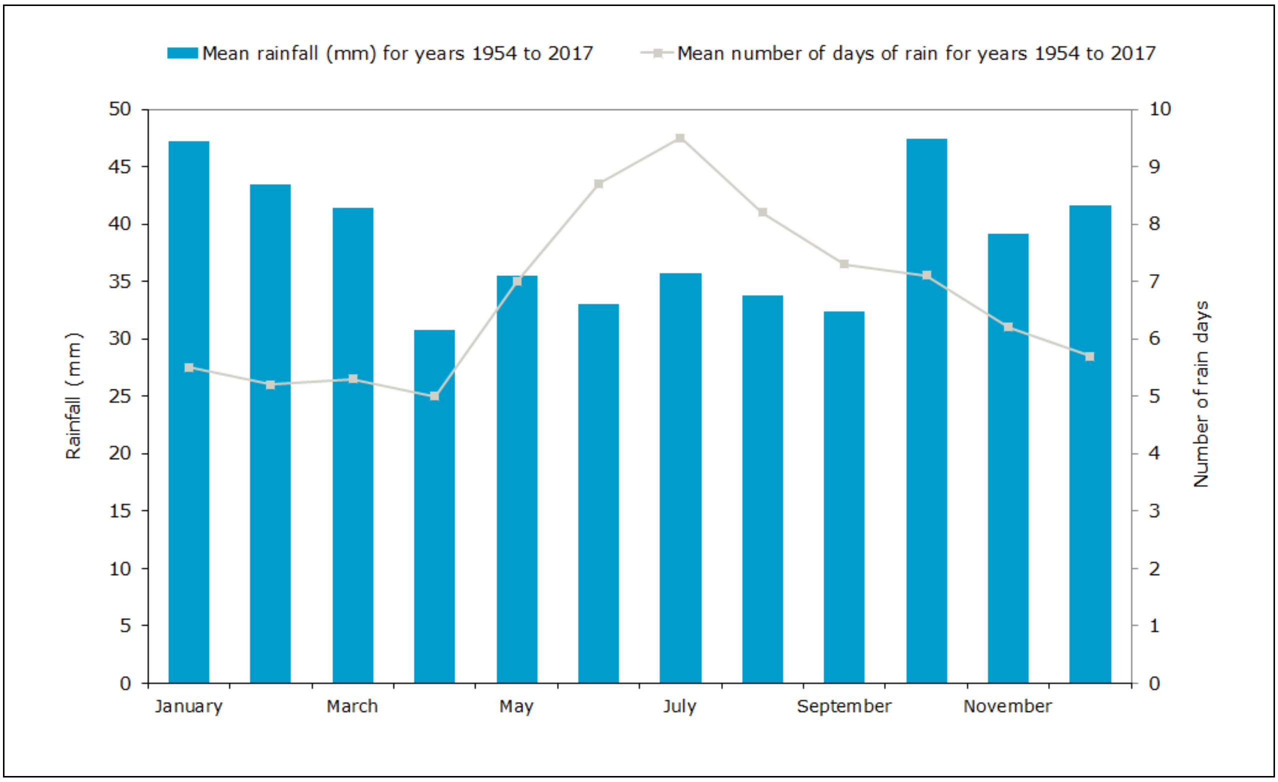


Figure 4-5: Long-term rainfall records for Condobolin AWS

4.5 Boundary layer heights

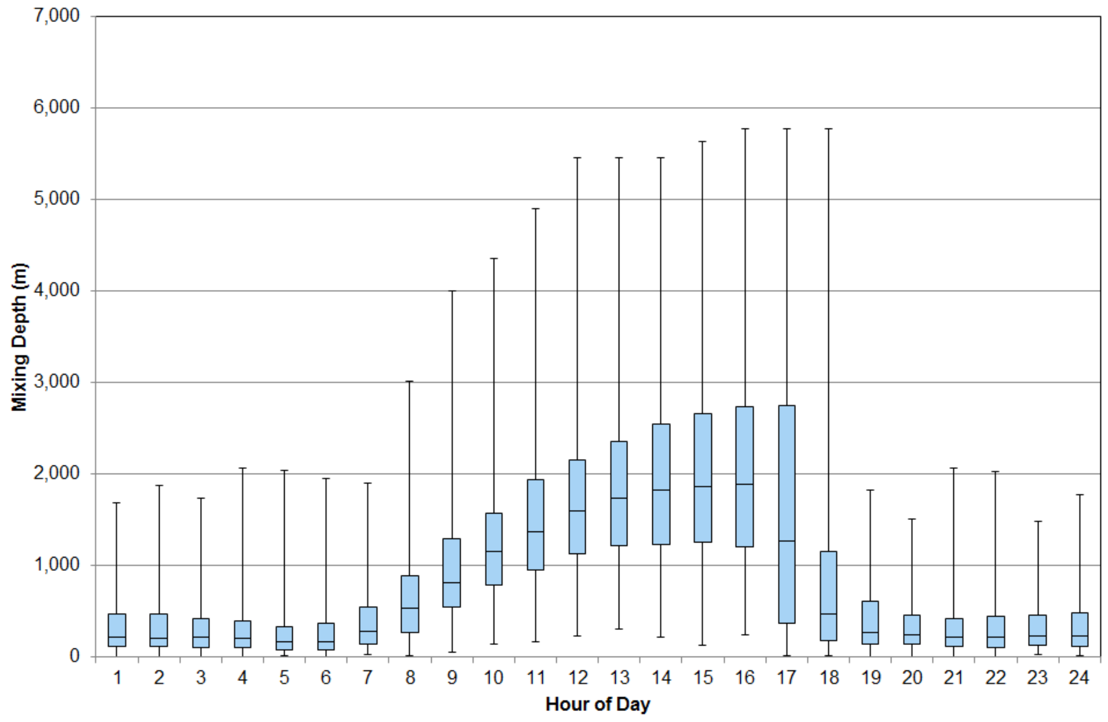
The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as a result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence and the passage of frontal systems. Due to radiative flux divergence, nights are typically characterised by weak to no vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and hence lower dilution potentials.

Hourly-varying atmospheric boundary layer heights were generated for modelling by AERMET, the meteorological processor for the AERMOD dispersion model, using a combination of surface observations from the Condobolin Airport, sunrise and sunset times and adjusted TAPM[8]-predicted upper air temperature profile (further discussion provided in **Appendix 2**).

The variation in average boundary layer heights by hour of the day is illustrated in **Figure 4-6**. The figure shows that greater boundary layer heights are experienced during the day-time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

[8] The Air Pollution Model, developed by CSIRO



Lower, middle and upper box markers indicate 25th percentile, median and 75th percentile of AERMET-generated mixing height data respectively, while upper and lower whiskers indicate maximum and minimum values.

Figure 4-6: AERMET-generated diurnal variations in average boundary layer depth

4.6 Atmospheric stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible - typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4-7 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET for modelling. The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during day-time hours and lowest during evening through to early morning hours.

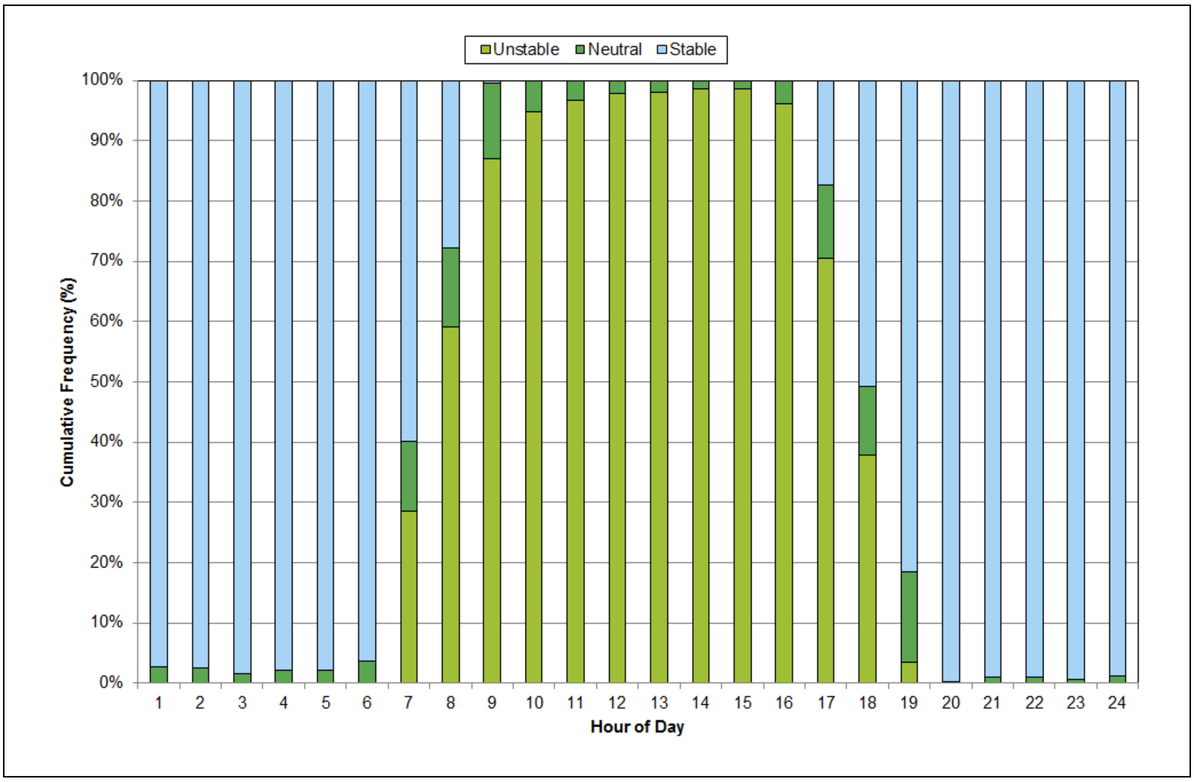


Figure 4-7: Diurnal variations in AERMET-generated atmospheric stability

5. BASELINE AMBIENT AIR QUALITY

To demonstrate compliance with applicable NSW EPA impact assessment criteria, consideration of cumulative impact is required, including how the Project will interact with existing and future sources of emissions. Given the rural setting for the Project, potential existing sources of emissions could include:

- dust entrainment due to vehicle movements along unsealed roads;
- agricultural activities;
- wind-blown dust from exposed areas;
- vehicle exhaust; or
- episodic emissions from vegetation fires or dust storms.

There are no commercial or industrial facilities in the vicinity of Fifield that either report to the National Pollutant Inventory (NPI) or hold an EPL under the POEO Act.

For this report, cumulative impacts are evaluated by adding modelling predictions to a derived baseline or background, which is assumed to include the contribution from all existing local and regional emissions sources. No potential future sources have been identified, other than the approved limestone quarry; however this is too far away to result in localised cumulative impacts and is therefore not considered.

5.1 Regional scale dust indices

The Dust Storm Index (DSI) is a continental scale measure of the frequency and intensity of wind erosion activity, based on observations of visibility made at BoM stations. The DSI is used to monitor wind erosion for reporting in National State of the Environment (SoE) reports and for the Australian Rangeland Information System (ACRIS). The ACRIS project commenced in 1992 and the most recent analysis presents DSI averages for the period 1992 to 2010.

The Project is located within the Cobar Peneplain region (shown by the number 24 in **Figure 5-1**) and has an average DSI of 3.7 (1992-2010). The DSI has increased for the three time periods reported, although the latest DSI increase is a result of the very high wind erosion activity in 2009.

A related program, called the Community DustWatch network, measures dust (as PM_{10}) via a network of instruments at DustWatch Nodes (generally using TSI DustTraks). The data are not used to report on air quality and health-related issues, rather, measurements are used as an indicator for land management (i.e. adequacy of ground cover in delivering healthy soils, clean air, functioning ecosystems and agricultural production).

The Community DustWatch network includes 'Nodes' at Condobolin and Parkes, recording hours of dust activity, defined as PM_{10} concentrations >25 µg/m³. It is useful to note that since 2010 at Condobolin, there has been, on average, only 10 hours of the year where the reported PM_{10} concentrations have been greater than 25 µg/m³. For the most recent year at the time of writing (2015), there were 23 hours where the PM_{10} concentrations measured greater than 25 µg/m³ and 7 hours were the PM_{10} concentrations measured greater than 50 µg/m³.

While these data cannot be used to derive a baseline for air quality assessment, they are useful to provide some initial context to the existing air quality environment for the region.

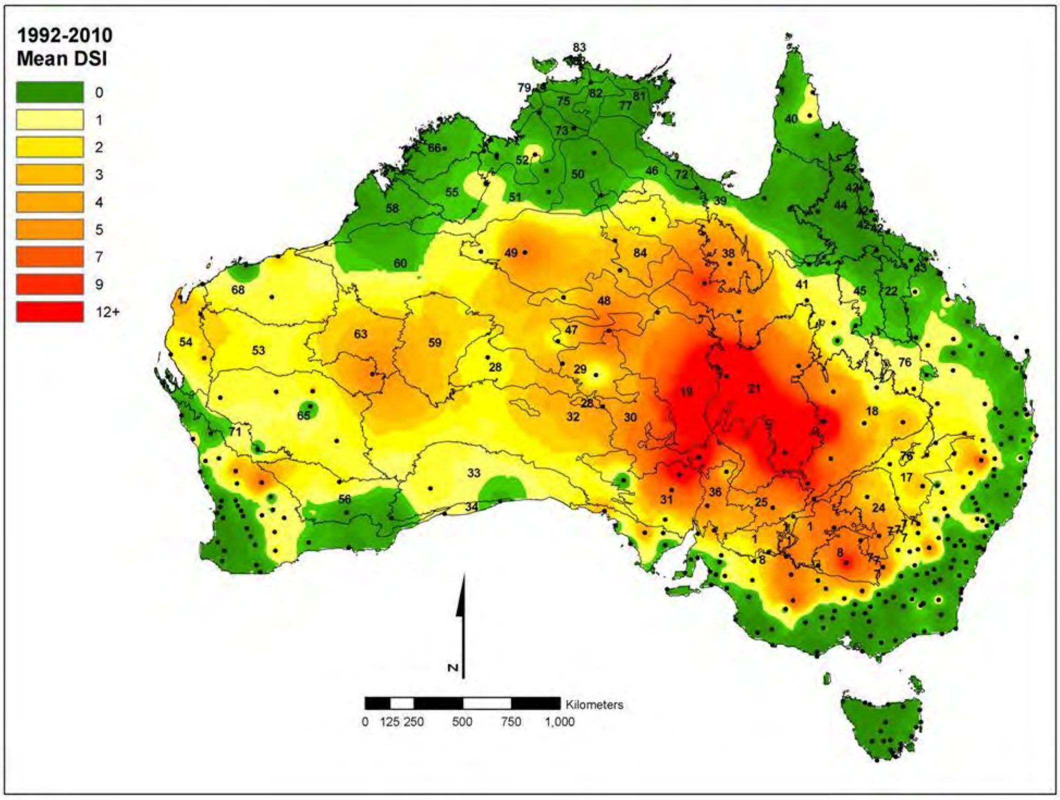


Figure 5-1: Mean dust storm index 1992-2010

Source: McTainsh et al (2011)

5.2 Site specific monitoring

Baseline monitoring was conducted for the original EIS but was limited to dust deposition at five sites for the period September 1997 to August 2000. From the available monitoring data, average dust deposition varied from 1.0 g/m^2/month to 4.9 g/m^2/month across all five sites. The average of all measured monthly dust deposition, across all sites, was 2.5 g/m^2/month. This value is typical of levels recorded in rural areas of NSW.

No other site specific baseline monitoring data are available, therefore a review of regional monitoring data is presented in subsequent sections.

5.3 Other industry operated monitoring sites

There are two operating mines within 100 km of Fifield with air quality monitoring networks used for compliance purposes; Northparkes Mine, located approximately 60 km east-southeast and Cowal Mine, located approximately 100 km south.

Compliance monitoring sites are selected to measure local dust impacts and are therefore not generally suitable for deriving background or baseline for areas removed from the influence of these local sources. In addition to these existing mining projects, rural baseline monitoring data have been collected for a proposed mine located at Bylong, approximately 250 km to the east-northeast and an approved but shelved mine at Cobbora, approximately 180 km northeast.

Publically available monitoring data for each of these sites has been reviewed and is summarised in **Table 5-1**.

For the compliance monitoring at existing sites, the 2015 annual average PM_{10} concentrations range from 10.4 µg/m³ at Northparkes to 15.1 µg/m³ at Cowal. The reported baseline for the Bylong and Cobbora projects ranged from 11.8 µg/m³ to 12.9 µg/m³.

Table 5-1: Regional air quality monitoring data from industry operated sites

Site	Metric	Value	Source/assumption
Northparkes Mine	PM_{10}	10.4 µg/m³	Estimated monthly average PM_{10} concentration, taken from graphs presented in the 2015 AEMR and averaged across three monitoring sites
	TSP	30 µg/m³	Approximate rolling annual average TSP concentration at end of 2015, taken from graphs presented in the 2015 AEMR and averaged across three monitoring sites
	Dust Deposition	2.0 g/m²/month	Approximate rolling annual average dust deposition at end of 2015, taken from graphs presented in the 2015 AEMR and averaged across 11 monitoring sites
Cowal Mine	PM_{10}	15.1 µg/m³	PM_{10} concentrations are not measured but instead derived from TSP data, based on the assumption in their Air Quality Monitoring Plan that 40% of TSP is PM_{10} [9]
	TSP	37.9 µg/m³	Average of reported monitoring data for a single site for 2015[10]
	Dust Deposition	1.3 g/m²/month	Baseline level collected before mining commenced, as reported in the Air Quality Monitoring Plan
Bylong Project	PM_{10}	12.9 µg/m³	As reported in the AQIA for the Bylong Coal Project (PEL, 2015)
	$PM_{2.5}$	6.5 µg/m³	As reported in the AQIA for the Bylong Coal Project (PEL, 2015)
	TSP	32 µg/m³	Derived from PM_{10} data, as reported in the AQIA for the Bylong Coal Project (PEL, 2015)
	Dust Deposition	1.0 g/m²/month	Average across all sites and all years, as reported in the AQIA for the Bylong Coal Project (PEL, 2015)
Cobbora Project	PM_{10}	11.8 µg/m³	Average PM_{10} concentration for modelling period as reported in the AQIA for the Cobbora Coal Project (ENVIRON, 2012)
	TSP	29.4 µg/m³	Derived from PM_{10} data, as reported in the AQIA for the Cobbora Coal Project (ENVIRON, 2012)
	Dust Deposition	1.4 g/m²/month	Average across all sites, as reported in the AQIA for the Cobbora Coal Project (ENVIRON, 2012)

5.4 Regional rural monitoring stations

The NSW Office of Environment and Heritage (OEH) operate a number of rural monitoring stations, including at Bathurst (210 km east-southeast), Wagga Wagga (260 km south), Merriwa (290 km east-northeast) and Albury (370 km south).

5.4.1 PM_{10}

The annual average PM_{10} concentrations over recent years are shown in **Table 5-2**, and range from 11 µg/m³ (2011 at Bathurst) to 22 µg/m³ (2013 at Wagga Wagga). The Bathurst monitoring site is the closest to the Project and the annual average PM_{10} concentrations at Bathurst are similar in magnitude to the rural baseline described for the Bylong and Cobbora projects. It is noted that the significantly higher ambient concentrations of PM_{10} in Wagga Wagga are thought to be mostly due to agricultural (stubble) burning and wood heater use in winter.

Exceedances of the 24-hour average criterion for PM_{10} occur occasionally, for example on average once a year at Bathurst. Long term trends in PM_{10} concentrations indicate that peak 24-hour averages are correlated with years with lower rainfall and consequently a higher risk of dust storms and bushfires.

A timeseries plot of the 24-hour average PM_{10} concentrations measured at Bathurst in 2015, 2016 and 2017 is presented in **Figure 5-2**. To create a complete dataset for cumulative assessment, gaps were filled using the other OEH rural monitoring sites.

[9] http://23crl33wq4oxpmtj2wj16cs9.wpengine.netdna-cdn.com/wp-content/uploads/2016/02/Air-Quality-Management-Plan-2.pdf
[10] http://evolutionmining.com.au/cowal/

Table 5-2: PM_{10} monitoring statistics across OEH rural sites

Site	Statistic	2011	2012	2013	2014	2015	2016
Bathurst	Mean	11	13	15	15	13	13
	Max daily	24	56	145	43	95	34
	99th percentile	22	30	45	38	37	31
	95th percentile	19	24	32	29	29	26
	Days over 50 µg/m³	0	2	3	0	2	0
Merriwa	Mean		14	15	15	13	14
	Max daily		50	43	55	83	42
	99th percentile		37	39	42	37	35
	95th percentile		31	30	32	27	26
	Days over 50 µg/m³		1	0	3	1	0
Wagga Wagga	Mean	17	19	22	21	20	21
	Max daily	56	67	111	88	145	115
	99th percentile	37	45	67	58	66	63
	95th percentile	28	37	47	44	42	48
	Days over 50 µg/m³	1	1	15	14	7	14
Albury	Mean	12	14	16	16	15	15
	Max daily	28	54	59	160	93	51
	99th percentile	25	38	48	77	34	47
	95th percentile	20	26	30	29	26	36
	Days over 50 µg/m³	1	1	2	5	2	1

5.4.2 $PM_{2.5}$

Monitoring for $PM_{2.5}$ is limited to the Wagga Wagga North and Bathurst sites, however monitoring at Bathurst only commenced in April 2016. Annual average $PM_{2.5}$ concentrations at Wagga Wagga regularly approach or exceed the impact assessment criteria, due to stubble burning and wood heater use in winter, and these data are not suitable to describe background for the Project area.

In the absence of $PM_{2.5}$ data for Bathurst for the modelling period (2015), reference is made to all available data from April 2016 to September 2017. The maximum recorded $PM_{2.5}$ for this period is 17.5 µg/m³ while the period average for the available monitoring data is 6.1 µg/m³.

A timeseries plot of the 24-hour average $PM_{2.5}$ concentrations at Bathurst is presented in **Figure** 5-2, showing available measurements from April 2016.

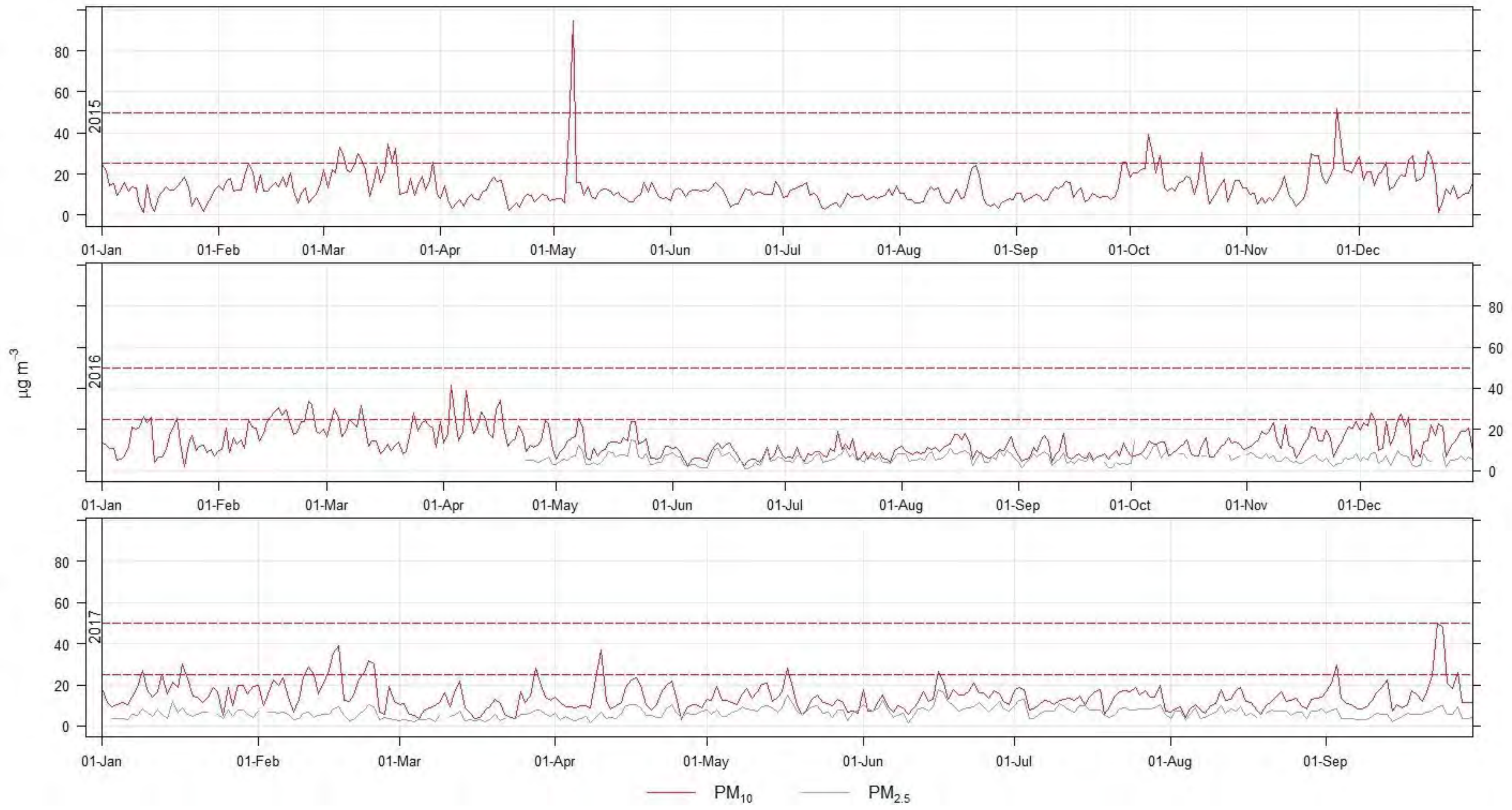


Figure 5-2: Timeseries of 24-hour average PM_{10} and $PM_{2.5}$ concentrations for Bathurst from 2015 to September 2017

5.4.3 Adopted background for cumulative assessment

Cumulative assessment for annual average PM_{10} is based on the 2015 annual average at Bathurst, while for short-term impacts, daily varying concentrations for 2015 are paired with modelling predictions for assessment of cumulative impacts.

In the absence of a contemporaneous dataset for the modelling period, cumulative assessment for annual average $PM_{2.5}$ is based on the period average of available data at Bathurst. For short term impacts, a worst case assessment is presented by combining the maximum daily concentration for the available data with the maximum modelling prediction for each receptor.

Measured annual average TSP concentrations for 2015 range from 38 µg/m³ at Cowal to 30 µg/m³ at Northparkes and the higher of these two measurements is adopted for background.

The baseline dust deposition level recorded before the Cowal Mine became operational (1.3 g/m^2/month) is similar to the historical site specific baseline reported in the EIS (1-1.4 g/m^2/month). However, the more recent 2015 average dust deposition levels across all sites at Northparkes (2 g/m^2/month) and Cowal (2.7 g/m^2/month), provide a more conservative background level for assessment.

For other gaseous pollutants, background concentrations are assumed to be negligible, as there are no significant emissions sources in the locality.

The background values are adopted for cumulative assessment are summarised in **Table 5-3**.

Table 5-3: Adopted background for cumulative assessment

Pollutant	Averaging period	Adopted background value	Source of data
PM_{10}	24-hour average	Daily varying	Bathurst daily monitoring data for 2015
	Annual average	13.4 µg/m³	2015 average concentration from Bathurst
$PM_{2.5}$	24-hour average	17.5 µg/m³	Period maximum concentration from available data at Bathurst
	Annual average	6.1 µg/m³	Period average concentration from available data at Bathurst
TSP	Annual average	38 µg/m³	Annual average TSP concentrations for Cowal in 2015.
Dust deposition	Annual average	2.7 g/m^2/month	Average of data reported at Cowal
SO_2	N/A	Negligible	There are no significant local sources of these pollutants, other than minor contributions from traffic and agricultural plant and equipment
NO_x			
CO			
H_2SO_4	N/A	N/A	Impact assessment criteria are applied to the incremental impact only.
VOCs			

6. EMISSION INVENTORY

6.1 Processing plant stack emissions

Emissions of gaseous pollutants would be generated by the processing facility during the processing of ore, as well as for power generation. The modified Project would adopt the RIP processing method, which includes the following steps:

- Ore preparation circuit – removal of oversize material and production of an ore slurry suitable for acid leaching.
- Acid leach circuit – leaching of nickel, cobalt and scandium from the ore slurry by application of sulphuric acid under high pressure and temperature in an autoclave to produce an autoclave slurry containing acid and soluble nickel and cobalt sulphates.
- RIP circuit – a two stage process that first separates scandium and then nickel and cobalt from residue solids (tailings) contained in the autoclave slurry using ion exchange resin.
- Tailings neutralisation and thickening circuit – neutralisation of residue solids slurry (tailings) with a limestone slurry prior to thickening and transfer to the tailings storage facility.
- Metals recovery circuit – recovery of scandium from the loaded resin by desorption, precipitation and calcinations, and recovery of nickel and cobalt by desorption, solvent extraction and precipitation.

With the adoption the RIP processing method instead of the approved counter current decantation processing method, the production of hydrogen sulphide, hydrogen and nitrogen would no longer be required. Some stacks previously assessed for the Project are therefore no longer required for the Modification (i.e. Extraction Fan over Sulphide Filter Vent [hydrogen sulphide], Flare Stack [hydrogen sulphide, SO_2, NO_2] and Hydrogen Reformer Stack [NO_2]).

Emission of PM from stack sources are included in the fugitive dust emissions inventories presented in **Appendix 5** and modelled together to assess the total Project impact. Stack sources are also modelled separately to assess emissions of gaseous pollutants.

The emission rates for the sulphuric acid plant are provided in **Table 6-1** and derived from the POEO Clean Air Regulation standards of concentrations (general activities). The modelled SO_2 emission rates for the modified Project are higher than what was previously modelled, which is consistent with the increase in sulphuric acid production. It is noted the processing facility would be designed to minimise emissions of gaseous pollutants, where practicable, and comply with the standards of concentration by incorporating appropriate emission control equipment (e.g. scrubbers).

Table 6-1: Emission standards and emission rates for sulphuric acid plant stack

Pollutant	Standard of concentration	Emission rate (g/s)
H_2SO_4	100 mg/m^3	5.3
SO_2	1000 mg/m^3	53.2
NOx (as NO_2)	350 mg/m^3	18.6
NOx	N/A	13.0

Emissions calculations for the diesel power plant and auxiliary boilers are provided in **Table 6-2**, estimated by Clean TeQ engineers based on the current design (energy demand) of the processing facility. It is noted that the proposed diesel power plant would operate mainly during start-up or as emergency/backup power generation. During normal operations, steam generated from the acid plant would be used for power generation in combination with the auxiliary boiler, as required.

Emission rates for NO_x from the power plant have also increased for the modified Project, in line with the production increase and also the use of diesel for power generation, as a worst case assumption. The stack parameters modelled are presented in **Table 6-3**.

Table 6-2: Stack emissions for power generation (g/s)

Stack	SO_2	CO	PM	VOCs	NO_x
Diesel Power plant	0.01	6.1	1.6	0.7	14.6
Diesel fired Auxiliary Boiler	0.01	0.4	0.1	0.02	1.8
Note: The use of diesel for power generation, in lieu of the approved gas plant, provides a worst case estimate of emissions for the two options.					

Table 6-3: Modelled stack parameters

Stack	Height (m)	Diameter (m)	Cross-sectional area (m^2)	Flow rate (Nm^3/s)	Temp (K)	Flow rate (Am^3/s)	Exit velocity (m/s)
Sulphuric acid plant stack	80	1.8	2.5	53.2	348	67.8	26.6
Diesel power plant	10	0.9	0.6	5.6	573	11.8	18.5
Diesel fired auxiliary boiler	10	0.9	0.6	8.7	453	14.4	22.7

6.2 Fugitive dust

Emissions inventories have been developed for four representative years of mining operations, selected to assess the air quality impacts of worst-case operations, as follows:

- Year 1 – representative of initial operations, with preferential mining in the scandium-rich areas, high grade ore deposits and construction of the tailings storage facility (TSF) and evaporation ponds in the south-eastern portion of the site;
- Year 6 – representative of mining across both eastern and western pits with one tailings storage facility cell in operation;
- Year 11 – representative of continued mining across both eastern and western pits with the maxim waste rock emplacement footprints and two tailings storage facility cells in operation; and
- Year 21 – representative of the final years of mining with maximum pit and waste rock emplacement footprints and three tailings storage facility cells in operations.

Consistent with the Approved Methods, emission factors developed by the US EPA[11], have been applied to estimate the amount of dust produced by each activity. The emissions inventories for each year are presented in **Appendix 5**.

Control measures are applied to the most significant emissions sources for the project, consistent with best practice emissions controls (Katestone, 2011). An overview of the BMP determination and summary of the controls is provided in **Appendix 4**.

A summary of the annual emissions is presented in **Figure 6-1**, showing Year 11 has the highest emissions for each of the particle size fractions. Further details on the emission inventory are provided in **Appendix 4**, including the assumptions, input data, emission factors and overview of the BMP determination.

[11] US EPA AP-42 Compilation of Air Pollutant Emission Factors (US EPA, 1998b; US EPA, 2004; US EPA, 2006).

As discussed in **Section 2.7**, emissions of PM_{10} and $PM_{2.5}$ from diesel combustion in mining equipment are assumed to be included in the total emissions for each relevant source and are not explicitly modelled as a separate emission source. However, adjustments have been made to account for the fact that emission reductions applied to the inventory (i.e. watering) are not relevant to the control of diesel exhaust emissions. The emissions inventory applies no controls for dozers and excavators, therefore the adjustments for diesel emissions are only needed for haul road controls. The estimated diesel emissions for hauling are subtracted from the uncontrolled haul road emissions to derive the wheel generated component of emissions for each haul road. The control for watering is then applied to the wheel generated component only, and the diesel emissions are then added back to derive the final emission estimate from haul trucks.

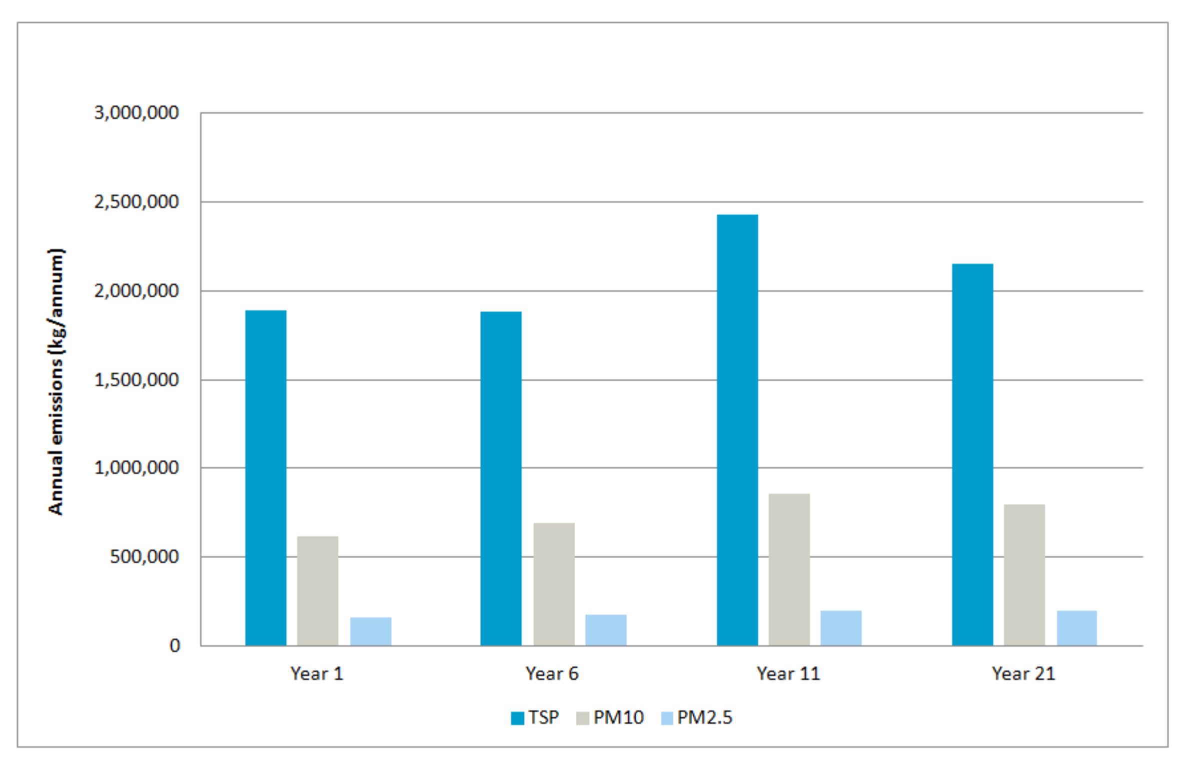


Figure 6-1: Summary of annual emissions (kg/annum)

7. DISPERSION MODELLING RESULTS

7.1 Processing plant stacks

The predicted GLCs from the processing plant stacks are presented in **Table 7-1**, showing the relevant receptor maximum concentration. Contour plots are presented in **Figure 7-1** to **Figure** 7-5. Results in **Table 7-1** for criteria pollutants are presented as discrete receptor maximums, whereas results for H_2SO_4, 1,3-butadiene and benzene are presented as the grid maximum (i.e. highest concentration across the modelling grid).

Results for NO_2 are presented based on an assumption of 100% conversion of NO_x to NO_2, which provides a conservative worst-case assessment of impact. Results for benzene and 1,3-butadiene are derived from total VOCs based on the US EPA speciate profile for diesel engines (i.e. benzene is 7.9% of total VOCs and 1,3-butadiene is 7% of total VOCs).

The predicted concentrations of all gaseous pollutants are well below the relevant criteria for each pollutant (i.e. less than 50% of the relevant criteria). Results are presented as project increment only, noting that background concentrations, with the exception of particulate matter, are expected to be minor and therefore the risk of cumulative impacts is negligible.

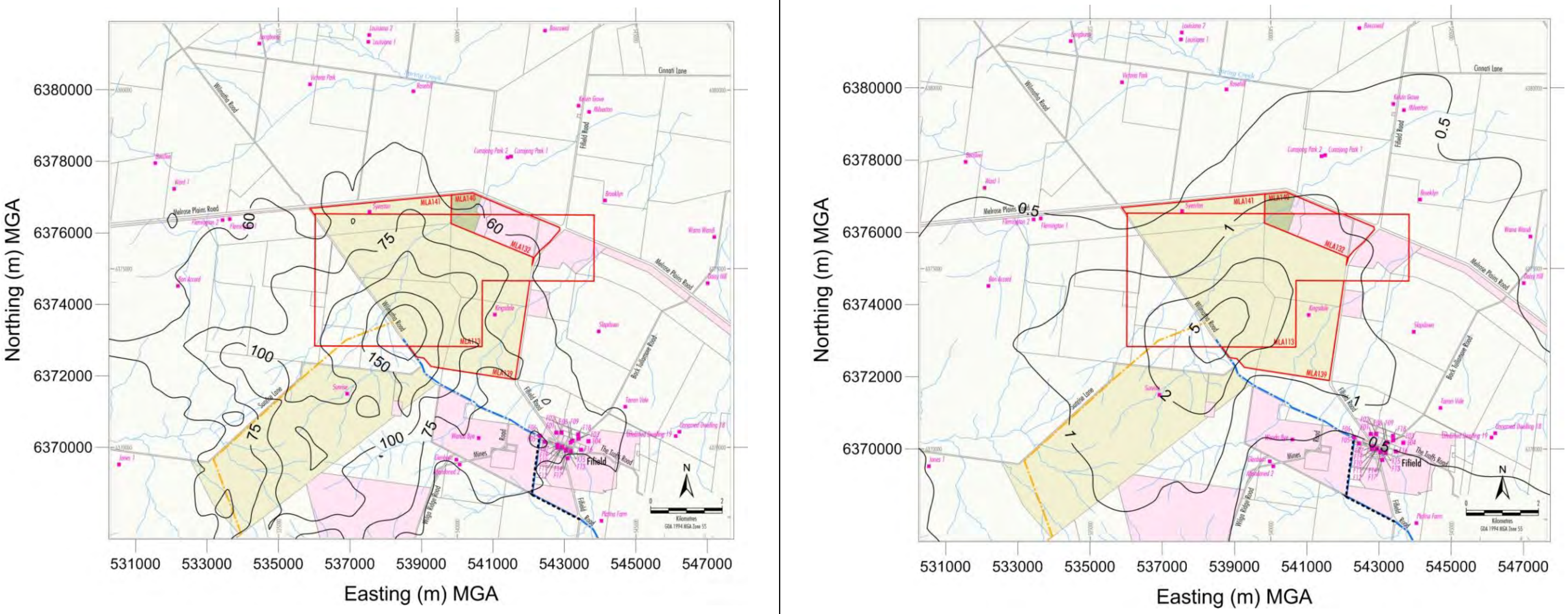
It is noted that particulate matter emissions from the stacks have been included in the assessment for fugitive dust (see **Section 0**), therefore contour plots for stacks alone are not presented (refer to **Appendix 7** for particulate matter contour plots). It is also noted that the results in **Table 7-1** are presented for $PM_{2.5}$ only as diesel particulate matter comprises approximately 97% $PM_{2.5}$ (ENVIRON, 2013).

Table 7-1: Predicted maximum concentrations (µg/m³) at receptor locations

Pollutant	Averaging period	Receptor maximum (µg/m³)	Criteria
$PM_{2.5}$	24-hr average	1.3	25
	Annual average	0.2	8
NO_2	1-hr average	97.9	246
	Annual average	1.9	62
SO_2	1-hr average	38.4	570
	24-hr average	7.6	228
	Annual average	0.7	60
CO	1-hr average	38.5	30,000
	8-hr average	14.1	10,000
H_2SO_4	1-hr average (99.9th %ile)	8.1*	18
Benzene	1-hr average (99.9th %ile)	0.9*	29
1,3-butadiene	1-hr average (99.9th %ile)	0.8*	40

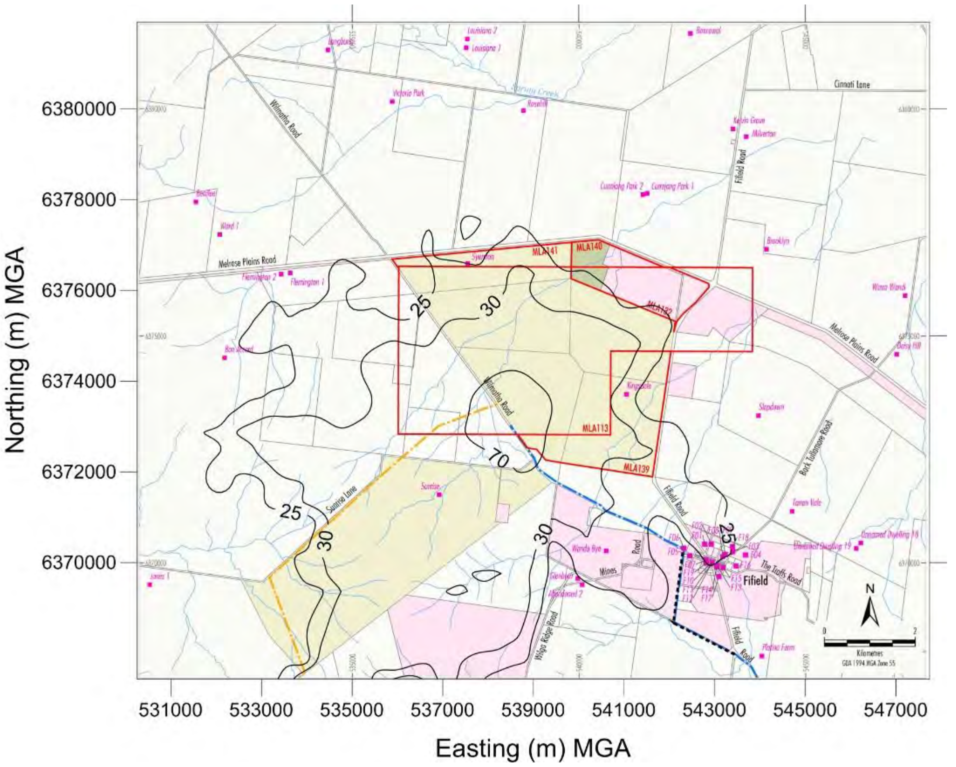
* Grid maximum.

Note: Annual average impacts associated with the diesel power plant are presented as a worst-case, as the majority of the 25 MW power demand would only be during plant start-up, after which steam generated from the acid process would be used for power generation. The exception is a 5 MW boiler which would remain operational after start-up. Furthermore, the use of diesel for power generation, in lieu of the approved gas plant, provides a worst case assessment of impacts for the two options.

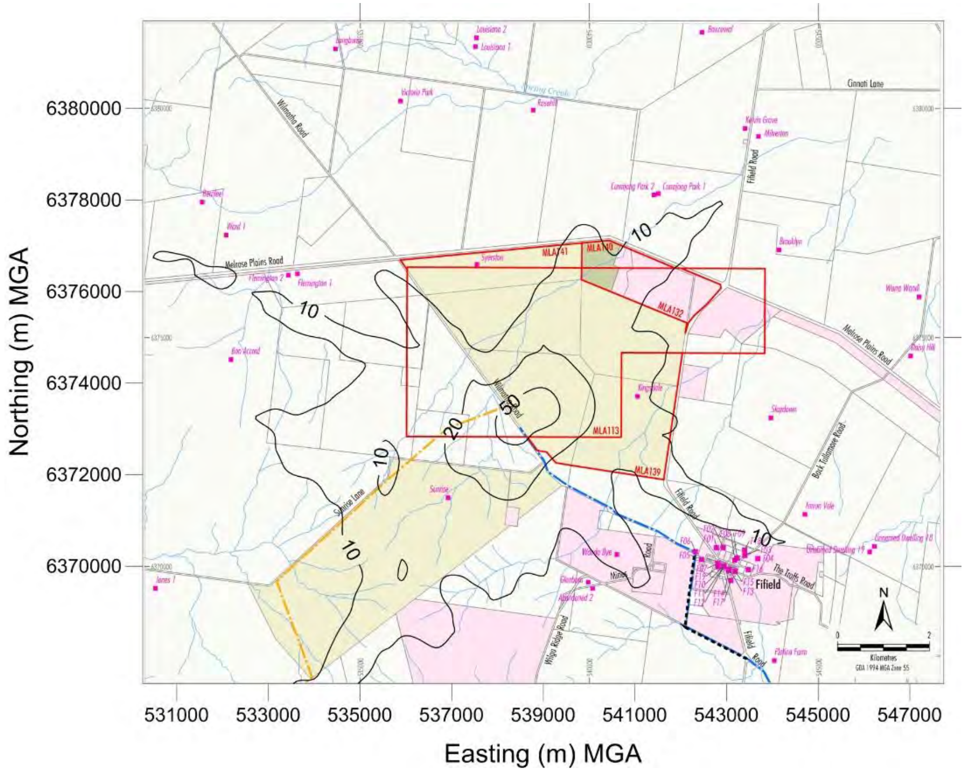


1-hour maximum	Annual average

Figure 7-1: Predicted Project-only 1-hour and annual average NO_2

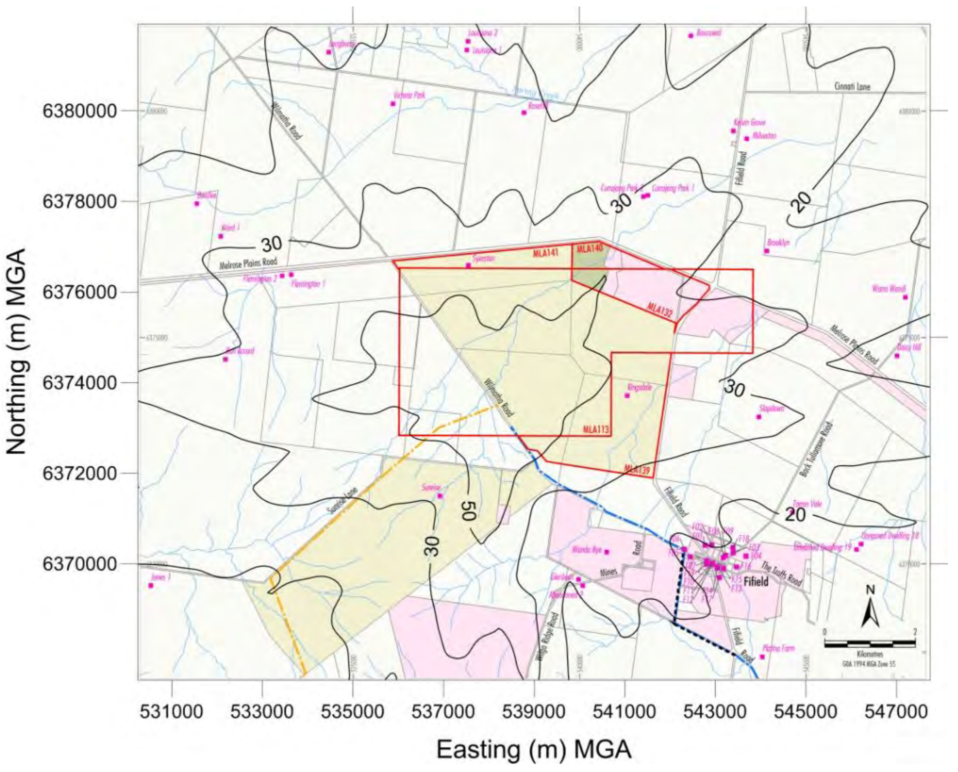


1-hour maximum

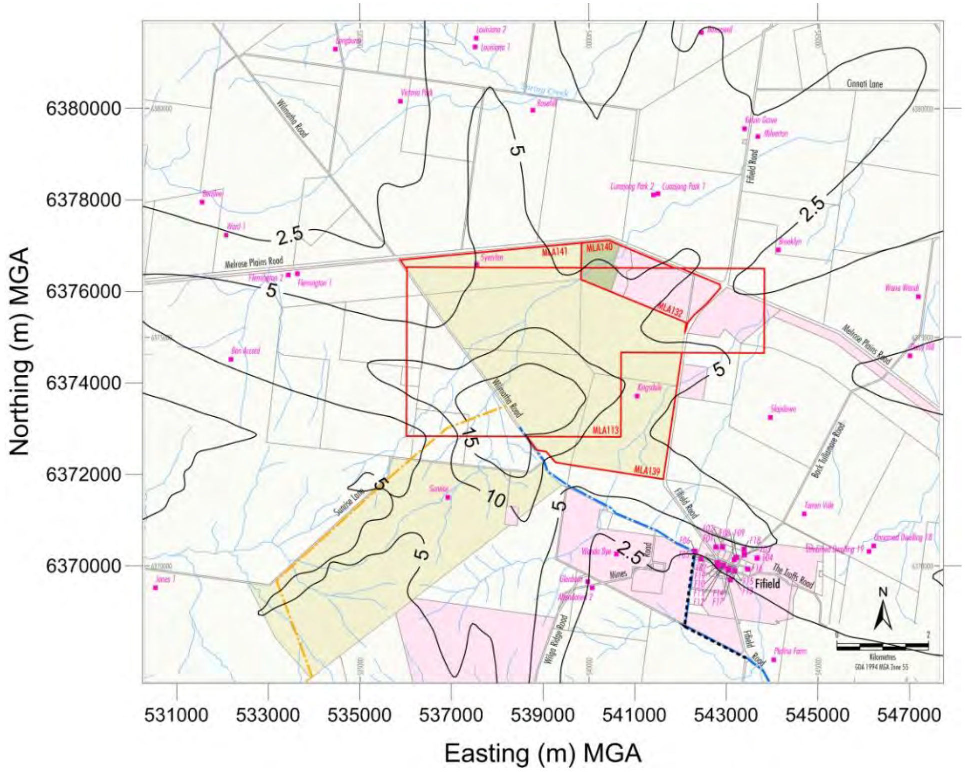


8-hour maximum

Figure 7-2: Predicted Project-only 1-hour and 8-hour average CO

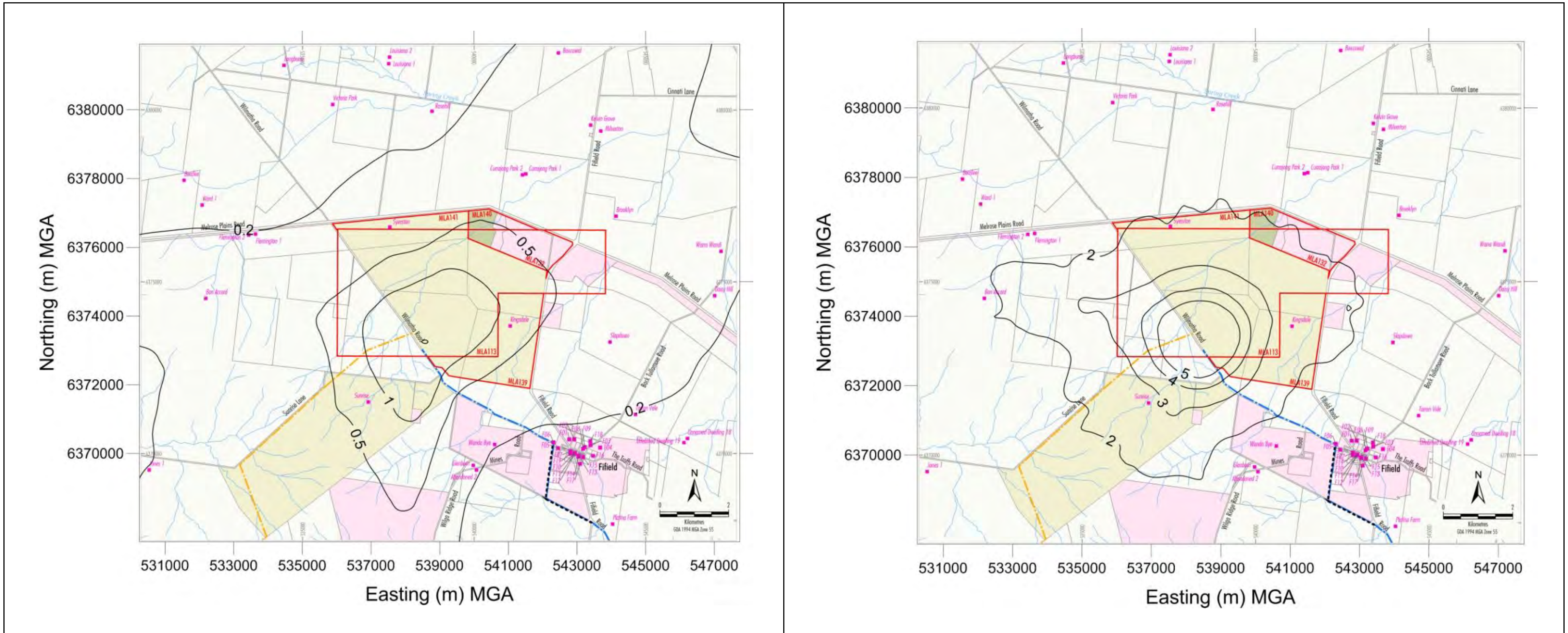


1-hour maximum



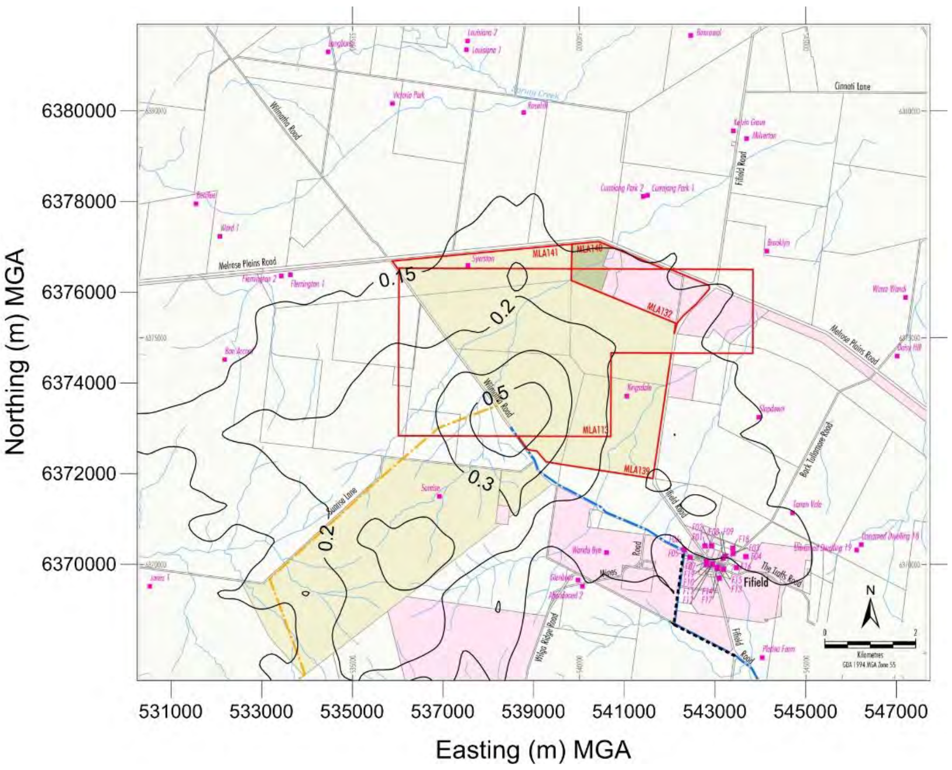
24-hour maximum

Figure 7-3: Predicted Project-only 1-hour and 24-hour average SO_2

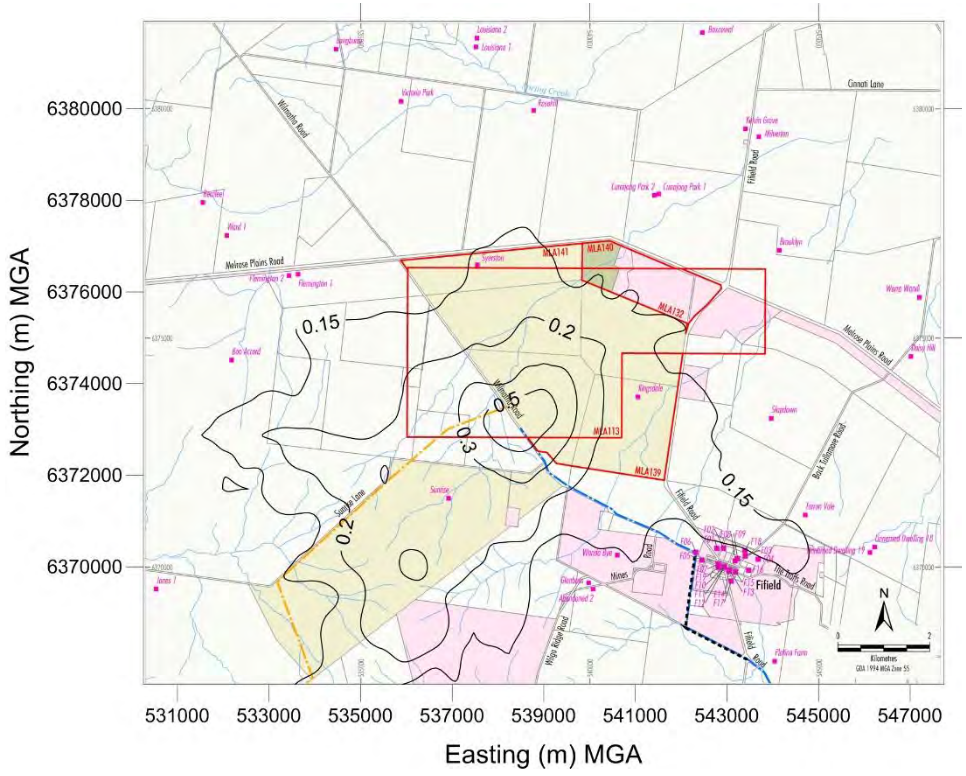


Annual average SO_2	1-hour average H_2SO_4 (99.9th %ile)

Figure 7-4: Predicted Project-only annual average SO_2 and 1-hour average H_2SO_4



1-hour average benzene (99.9^{th} %ile)



1-hour average 1,2-butadiene (99.9^{th} %ile)

Figure 7-5: Predicted Project-only 1-hour average VOCs

Potential for acid rain

The phenomenon known as acid rain is a process whereby emissions such as SO_x and NO_x react with water in the atmosphere and subsequently fall to the ground as wet or dry deposition. Significant acid rain problems have historically occurred in industrialised areas with high emission loads of SO_x and NO_x (e.g. from coal fired electrical power generation). The issue of acid rain has received less attention in Australia when compared with the Northern Hemisphere due to, for example, the lack of large industrial areas and the lower sulphur content of fuels. Actions over the past 20 years in the US and Europe (i.e. US Clean Air Act Acid Rain Program, EU Sulphur Protocol and Convention on Long-Range Transboundary Air Pollution), have led to significant reductions in the adverse effects of acid deposition in the Northern Hemisphere.

Given the scale of emissions associated with the modified Project, any potential impacts from acid rain are considered insignificant. Furthermore, the process of acid rain formation occurs as pollutants are transported over relatively large distances and over time transform to acid particles and vapours in the atmosphere. Therefore, in the unlikely event acid rain would occur, it would not occur in the vicinity of the modified Project. For the modified Project, we have assessed emissions of SO_2 and NO_2 against human health based impact assessment criteria and present ground level concentrations in the vicinity of the modified Project. When compared against air quality objectives for ecosystem health, biodiversity and agriculture[12], it is clear that the potential impacts from acid deposition are insignificant. Is it also noted that assessment of sulphuric acid mist as a pollutant in this report is not related to the phenomenon of acid rain.

7.2 Particulate matter from mining operations

No exceedances of the relevant criteria were predicted at any private receptors in Years 1, 6, 11 and 21 for:

- annual average dust deposition levels (both incremental and cumulative);
- cumulative annual average TSP concentrations;
- cumulative annual average and 24-hr PM_{10} concentrations; and
- cumulative annual average and 24-hr $PM_{2.5}$ concentrations.

The predicted Project-only and cumulative modelling results are presented in tabular form for each receptor in **Appendix 6**. The modelling results are also presented as contour plots in **Appendix 7**, showing the extent of predicted impacts across private and mine-owned land.

7.3 Voluntary land acquisition on vacant land

Voluntary land acquisition criteria also applies if the development contributes to an exceedance on more than 25% of privately owned land upon which a dwelling could be built under existing planning controls. Analysis of the contour plots presented in **Appendix 7** indicates that Project-only 24-hour PM_{10} concentrations would not exceed 50 µg/m³ across more than 25% of any private land.

To assess against voluntary land acquisition criteria for cumulative annual average PM_{10} and TSP, a background value is added to the incremental contour plots presented in **Appendix 7** for the year with the highest modelling predictions (year 11). Based on this, no additional land would be subject to voluntary land acquisition as the cumulative annual average PM_{10} and TSP contours at the voluntary land acquisition criteria level do not extent beyond the mining lease.

Similarly, for dust deposition, the project only contribution does not exceed 2 g/m^2/month across more than 25% of any private property and the cumulative contribution does not exceed 4 g/m^2/month across more than 25% of any private property.

[12] As prescribed in the Queensland Environmental Protection (Air) Policy 2008.

8. GREENHOUSE GAS ASSESSMENT

The estimation of GHG emissions for the Project is based on the Australian Government Department of the Environment and Energy (DEE) National Greenhouse Accounts Factors (NGAF) workbook (DoE, 2016). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE, 2014).

Emissions are estimated using the fuel energy contents and Scope 1, 2 and 3 emission factors (EF) in the NGAF workbook.

8.1 Emission sources

The GHG emissions sources included in this assessment are listed in **Table 8-1**, representing the most significant sources associated with the Project. GHG emissions associated with operations at the limestone quarry and rail siding are not included, as the Modification does not propose any changes to these components of the Project. However the interaction between the mine and processing facility and the limestone quarry is considered (i.e. emissions associated with the delivery of limestone raw material to the site) and emissions from the transportation of raw materials and product by rail is also included.

Other minor sources of GHG emissions, such as those generated by employee travel and waste disposal, are anticipated to be negligible in comparison and have not been considered in this assessment.

Table 8-1: Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel) by onsite plant and equipment.	None	Indirect upstream emissions from the extraction, production and transport of diesel fuel.
Direct CO_2 emissions from the processing plant stacks.		Downstream emissions generated from transportation (rail) of raw material (sulphur) and product from the rail siding to Newcastle.
Direct emissions from fuel combustion (diesel) for raw material and product transportation by truck		

8.2 Activity data

Activity data for the emission estimates is summarised in **Table 8-2**, along with the assumptions/inputs used to derive the values.

Table 8-2: Activity data and assumptions

Activity	Value	Source of information / assumptions
Diesel - onsite mining equipment	9032 kL/annum	Derived from published fuel consumption data[13] (l/hr) for the main items in the proposed mining fleet. An average of the reported range in fuel consumption for medium load activity is used, for an assumed annual equipment utilisation of 80%.
Diesel - limestone delivery from quarry	360 kL/annum	Assumed to be transported in Clean TeQ operated trucks and derived based on diesel fuel consumption for artic trucks[14] (l/km). The estimated VKT per annum is estimated based on a return travel distance of 40 km and the number of trips required to transport 790,000 tonnes of limestone for a payload of 50 tonnes.

[13] https://www.holtcat.com/Documents/PDFs/2012PerformanceHandbook/Edition%2041%20Full.pdf

[14] http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

Activity	Value	Source of information / assumptions
Diesel - sulphur delivery from rail siding	199 kL/annum	Derived based on diesel fuel consumption for artic trucks (l/km). The estimated VKT per annum is estimated based on a return travel distance of 50 km and the number of trips required to transport 350,000 tonnes of sulphur for a payload of 50 tonnes.
Diesel - product delivery to rail siding	N/A	Assumed to be back loaded to sulphur delivery trucks
Diesel power plant[1]	1.7 kg/s	Client supplied emission rate
PAL vent scrubber stack	2.7 kg/s	Client supplied emission rate
Partial neutralisation vent scrubber stack	6.1 kg/s	Client supplied emission rate
RIP vent scrubber stack	0.6 kg/s	Client supplied emission rate
Diesel - rail transportation (sulphur and product)	141 kL/annum	Derived based on a fuel consumption rate for locomotives of 4.03 l/kt-km. The estimated kt-km per annum is estimated based on a return travel distance of 1000 km and the tonnes transferred per annum.
Note: Annual emissions associated with the diesel power plant are presented as a worst-case, as the majority of the 25 MW power demand would only be during plant start-up or as emergency/back-up power generation. During normal operations, steam generated from the acid process would be used for power generation in combination with the 5 MW auxiliary boiler, as required. Furthermore, the use of diesel for power generation, in lieu of the approved gas plant, provides a worst case estimate of GHG emissions for the two options.		

8.3 Emission estimates

The estimated annual GHG emissions for each source are presented in **Table 8-3**. Annual Scope 1 emissions represent approximately 0.2% of total GHG emissions for NSW and 0.06% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2015[15].

Table 8-3: Estimated GHG emissions (tonnes CO_2-e)

Scope	Activity	GHG emissions (tonnes CO_2-e)
Scope 1	Diesel - onsite mining equipment	24,474
	Diesel - limestone delivery from quarry	979
	Diesel - sulphur delivery from rail siding	542
	Diesel - product delivery to rail siding	N/A
	Diesel power plant	45,570
	PAL vent scrubber stack	72,375
	Partial neutralisation vent scrubber stack	163,514
	RIP vent scrubber stack	16,083
Scope 3	Diesel - onsite mining equipment	1,255
	Diesel - limestone delivery from quarry	50
	Diesel - sulphur delivery from rail siding	28
	Diesel - product delivery to rail siding	N/A
	Diesel power plant	403
	Diesel - rail transportation (sulphur and product)	24,474

[15] http://ageis.climatechange.gov.au/

9. MANAGEMENT AND MONITORING

The adoption of the RIP processing method instead of the approved counter current decantation processing method (as described in Section 6.1) removes three previously assessed stack emission sources, and hydrogen sulphide would no longer be produced and emitted from the processing facility. Management and monitoring of these emissions would therefore no longer be required for the modified Project. This represents a significant improvement to the approved impacts of the processing facility, as hydrogen sulphide has the potential to materially affect amenity (e.g. due to odour).

As described in Section 6.3, the processing facility would be designed to minimise emissions of gaseous pollutants where practicable, and the estimated emissions used in the assessment of stack emissions account for the use of emission control equipment incorporated into the processing operations (e.g. scrubbers).

The proposed dust management measures for the Project are outlined in **Appendix 4**. Other control measures, while not explicitly applied as reduction factors in the emission calculations, are accounted for in the modelled emissions on the basis of the mine plan, including:

- Site-wide vehicle speed limits.
- Progressive rehabilitation of disturbed areas.
- Minimising the double handling of material, wherever practicable (i.e. direct haul and dump to ROM pad/hopper).
- Avoiding disturbance, or temporary rehabilitation of long-term soil stockpiles.
- Proactive, reactive or corrective measures, for example during periods of dry, windy conditions where watering is not sufficient, certain activities may be ceased or relocated to more sheltered areas.

In addition to the preventative measures outlined above, reactive or corrective measures would be employed. For example, during periods of dry, windy conditions, watering may be increased or certain activities may be ceased or relocated to more sheltered areas.

Further details would be provided in the Air Quality Management Plan for the Project, in accordance with Condition 23, Schedule 3 of Development Consent DA 374-11-00.

9.1 Monitoring

The monitoring requirements for the Project will be outlined in the Air Quality Management Plan for the Project, which would be developed following receipt and review of the revised approval conditions and the Project EPL.

Modelling predictions indicate that the risk from the modified Project is low and additional exceedances of criteria for gaseous pollutants and particulate matter (including cumulative 24-hour PM_{10} and $PM_{2.5}$ concentrations) are unlikely.

Notwithstanding, it is anticipated that meteorological monitoring, regular stack monitoring and monthly dust deposition monitoring would be undertaken for the Project in accordance with the Project EPL.

Monitoring results would be used to inform air quality management as the mine is developed.

10. CONCLUSION

Ramboll Environ has been commissioned to complete an Air Quality Impact Assessment for a proposed Modification to the approved Project, based on the Project Optimisation Study which identified opportunities to improve the overall efficiency of the Full Production Phase of the Project.

The components of the Modification that are particularly important from an air quality perspective include mining in a more selective manner to initially increase the processing facility ore feed grade and adoption of the RIP processing method option (as opposed to the other approved processing method, involving counter current decantation).

The Modification would not involve changes to any aspects of the approved limestone quarry, rail siding or gas pipeline and these are not considered in the AQIA.

Air quality impacts are assessed using a Level 2 assessment approach in accordance with the Approved Methods.

Emissions inventories have been developed for the processing operations and four representative years of mining operations, selected to assess the air quality impacts of worst-case operations. The selected representative years of mining operations are consistent with the air quality assessment for the approved Project, however emission factors and controls have been updated to reflect current best practice and contemporary approaches to emission estimation.

The adoption the RIP processing method for the modified Project eliminates emissions sources that were previously assessed for the Project (i.e. Extraction Fan over Sulphide Filter Vent [hydrogen sulphide], Flare Stack [hydrogen sulphide, SO_2, NO_2] and Hydrogen Reformer Stack [NO_2]). The emission rates for the sulphuric acid plant are derived from the POEO Clean Air Regulation standards of concentrations (general activities). The modelled SO_2 emission rates for the modified Project are higher than what was previously modelled, which is consistent with the increase in sulphuric acid production. Emissions calculations for the diesel power plant and auxiliary boilers are based on the current design (energy demand) of the processing facility. It is noted that the proposed power plant would operate mainly during start-up or as emergency/backup power generation. During normal operations, steam generated from the process itself would be used for power generation in combination with the auxiliary boiler. Emission rates for NO_x from the power plant have also increased for the modified Project, in line with the production increase and the worst case assumption of diesel for power generation.

Dispersion modelling was used to predict GLCs for key pollutants from the modified Project, at surrounding private and mine-owned receptors. Cumulative impacts were assessed by taking into account the existing ambient baseline air quality. Consistent with the air quality assessment for the approved Project, cumulative impacts focus on emissions of particulate matter as background concentrations for gaseous pollutants are assumed to be minor or negligible. However, the focus for the modified Project shifts from TSP to "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$.

Consistent with the air quality assessment for the approved Project, the predicted concentrations of gaseous pollutants are well below the relevant criteria beyond the site boundary and/or at privately-owned receptors (i.e. less than 50% of the relevant criteria).

Also consistent with the air quality assessment for the approved Project, the predicted Project-only and cumulative annual average PM_{10}, $PM_{2.5}$ and TSP concentrations and dust deposition levels indicate that no private receptors would experience exceedances of the NSW EPA’s impact assessment criteria. The predicted cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations demonstrated no additional exceedances of the impact assessment criteria at private receptors.

Annual average Scope 1 emissions represent approximately 0.2% of total GHG emissions for NSW and 0.06% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2015.

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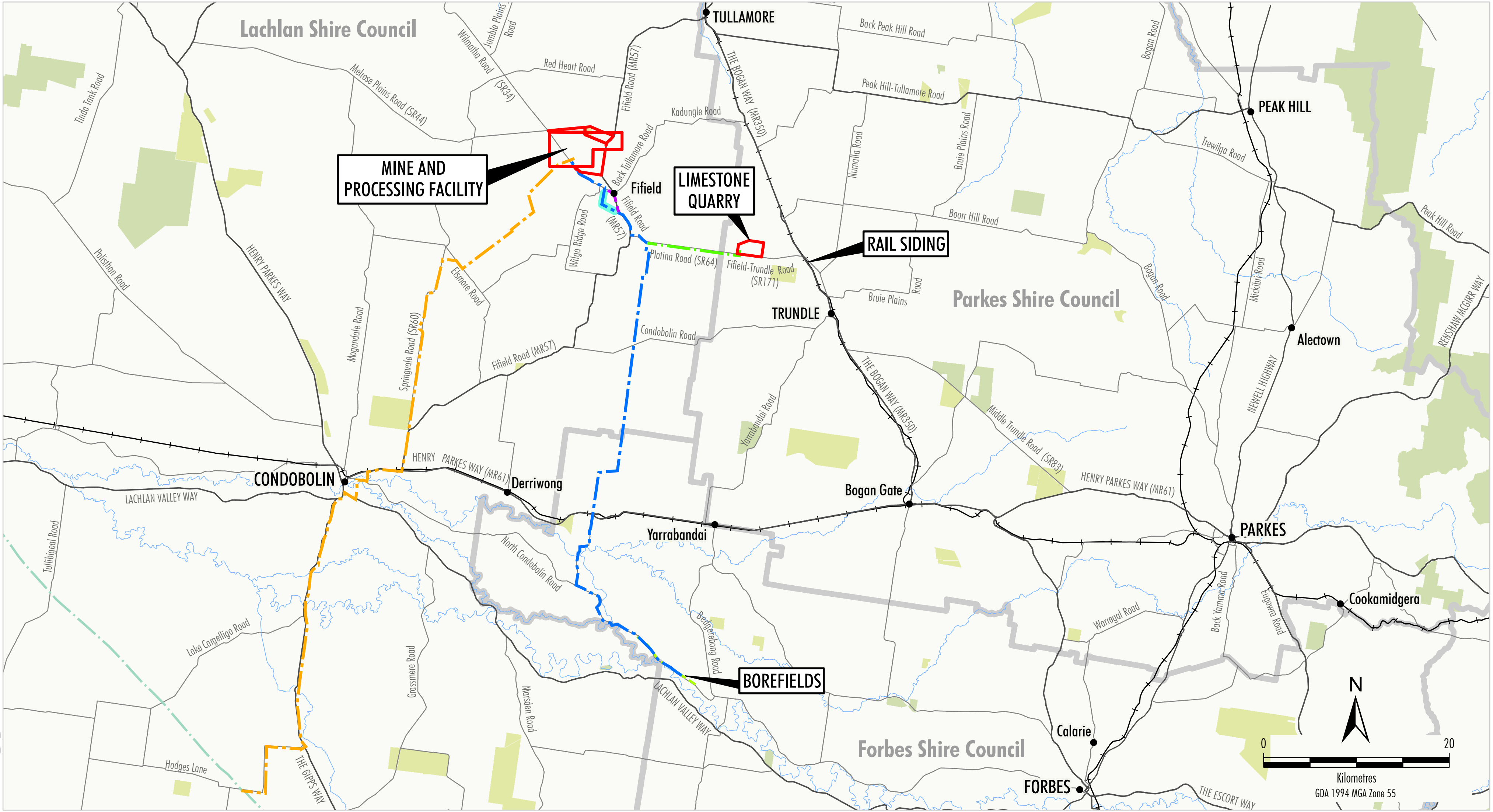
APPENDIX 1
FIGURES



LEGEND
- National Park/Conservation Area
- State Forest
- Local Government Boundary
- Existing Gas Pipeline
- Mining Lease Application Boundary
- Approved Water Pipeline
- Approved Limestone Quarry Water Pipeline
- Approved Gas Pipeline
- Approved Borefield Infrastructure Corridor
- Modified Water Pipeline Alignment Option
- Approved Fifield Bypass

Source: Black Range Minerals (2000); NSW Department of Industry (2017); NSW Land & Property Information (2017); Office of Environment and Heritage NSW (2017)

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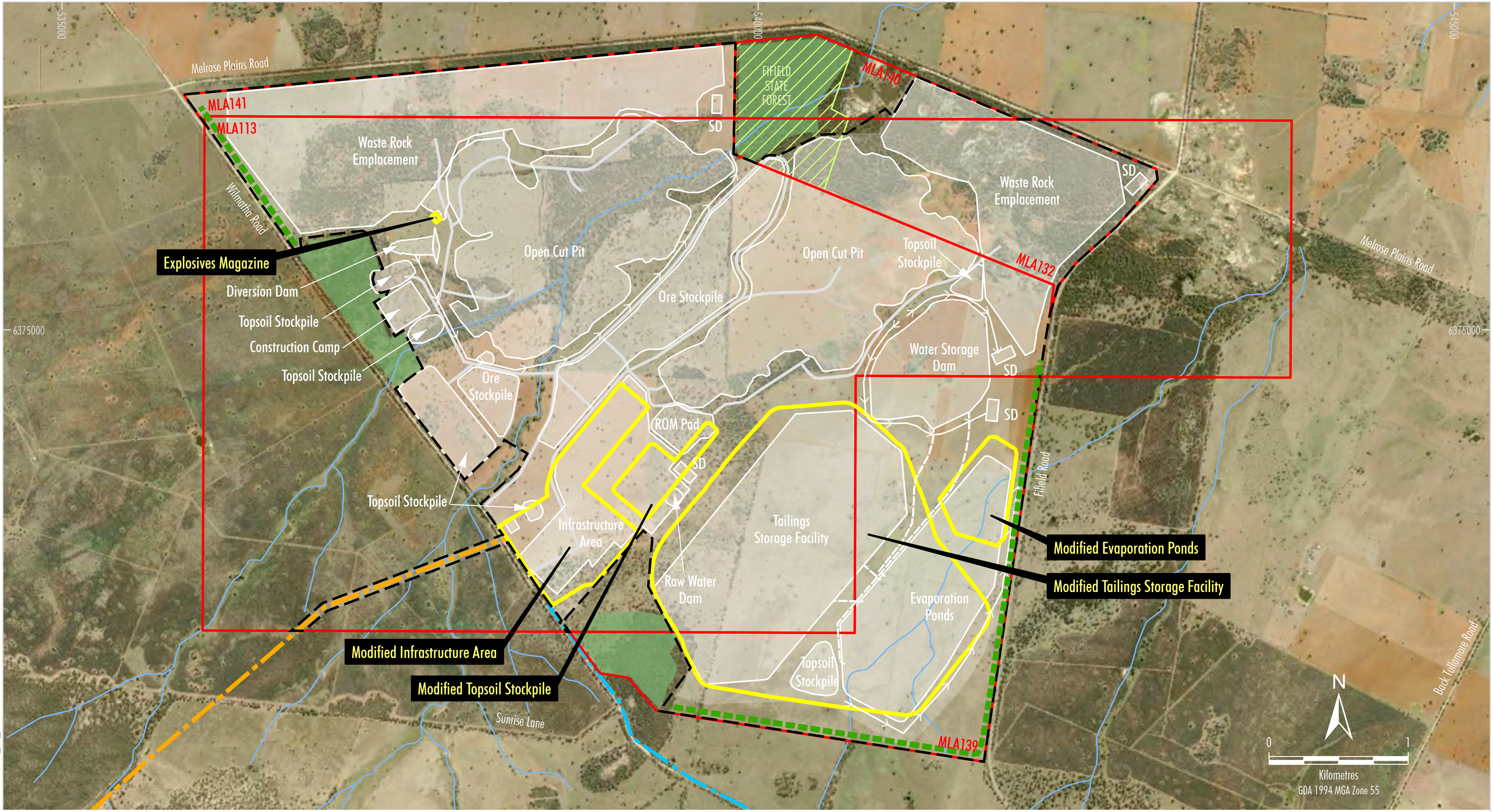
SYERSTON PROJECT MODIFICATION 4
Regional Location

Figure A1-1



LEGEND

- State Forest
- Mining Lease Application Boundary
- Approved Surface Development Area
- Approved Mine Footprint
- Diversion Structure
- Key Site Water Pipeline
- Approved Gas Pipeline
- Approved Water Pipeline
- Vegetation Screening
- Existing Open Woodland
- Modified Layout

Source: Black Range Minerals (2005); NSW Department of Industry (2017); NSW Land and Property Information (2017)
NSW Imagery: © Department of Finance, Services & Innovation (2017)

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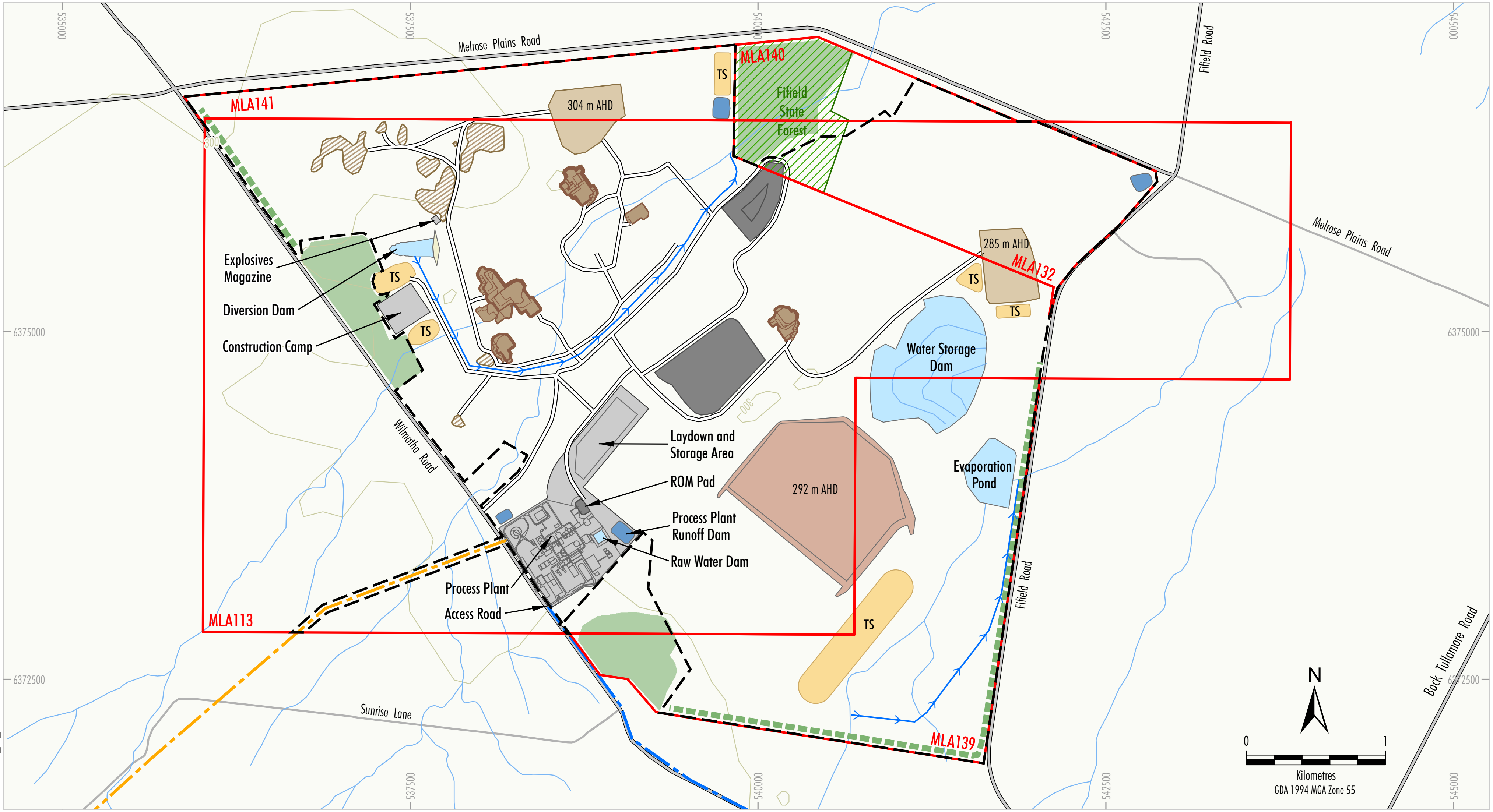
SYERSTON PROJECT MODIFICATION 4

Indicative Modified Mine and Processing Facility General Arrangement

Figure A1-2



LEGEND

- Mining Lease Application Boundary
- Approved Surface Development Area
- Open Cut Pit (Scandium Oxide)
- Open Cut Pit
- Waste Rock Emplacement
- Tailings Storage Facility
- TS Topsoil Stockpile
- Ore Stockpile
- Mine Infrastructure Area
- Sediment Dam
- Diversion Structure
- Gas Pipeline
- Water Pipeline
- Vegetation Screening
- Existing Open Woodland to be Maintained
- State Forest

Source: Black Range Minerals (2000); NSW Department of Industry (2017); NSW Land & Property Information (2017)

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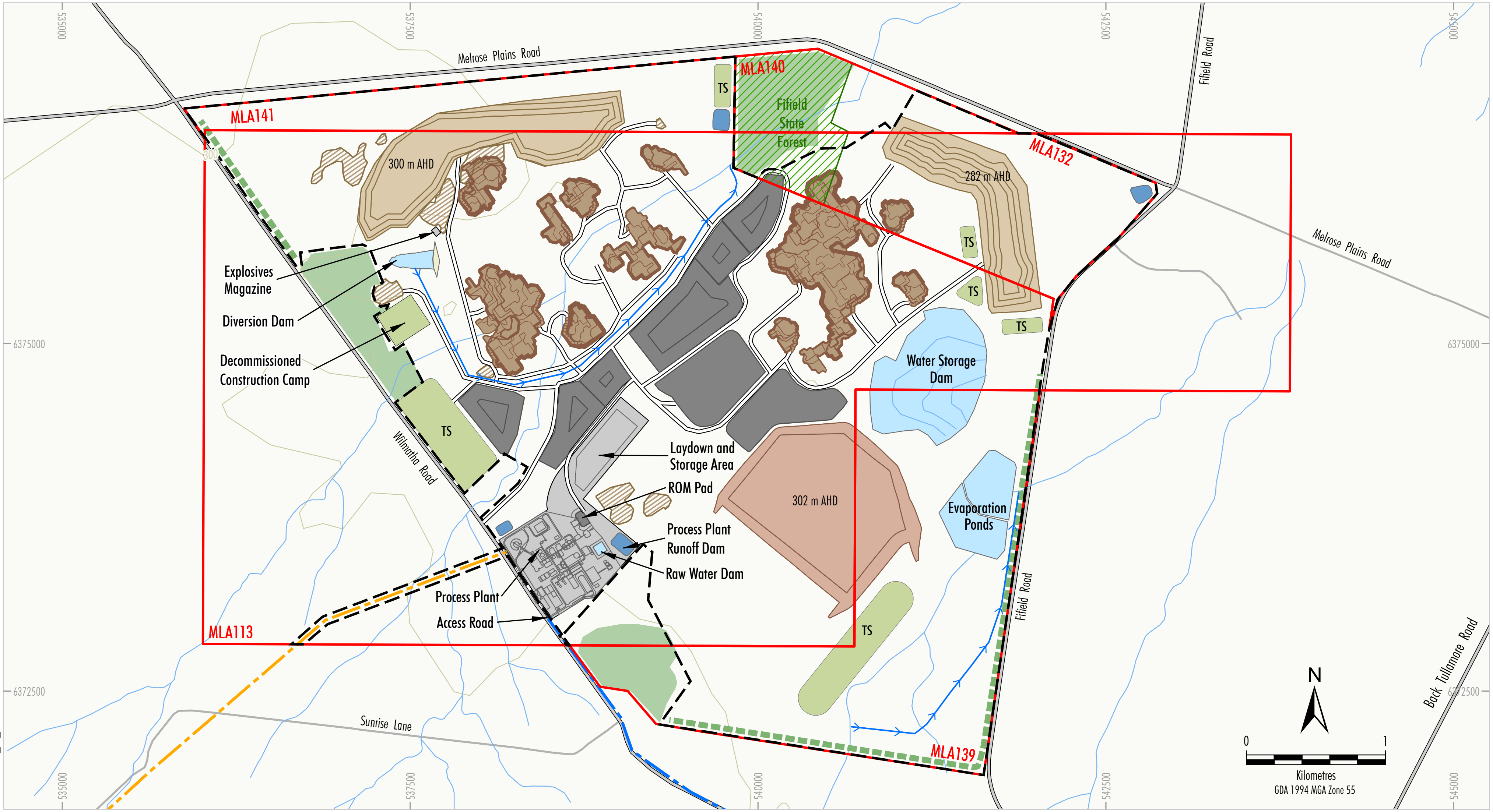
SYERSTON PROJECT MODIFICATION 4

Modified Mine and Processing Facility Conceptual General Arrangement Year 1

Figure A1-3



LEGEND

- Mining Lease Application Boundary
- Approved Surface Development Area
- Open Cut Pit (Scandium Oxide)
- Open Cut Pit
- Waste Rock Emplacement
- Tailings Storage Facility
- TS Topsoil Stockpile
- Ore Stockpile
- Mine Infrastructure Area
- Sediment Dam
- Initial Rehabilitation
- Diversion Structure
- Gas Pipeline
- Water Pipeline
- Vegetation Screening
- Existing Open Woodland to be Maintained
- State Forest

Source: Black Range Minerals (2000); NSW Department of Industry (2017); NSW Land & Property Information (2017)

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SYERSTON PROJECT MODIFICATION 4

Modified Mine and Processing Facility Conceptual General Arrangement Year 6

Figure A1-4

LEGEND

- Mining Lease Application Boundary
- Approved Surface Development Area
- Open Cut Pit (Scandium Oxide)
- Open Cut Pit
- Waste Rock Emplacement
- Tailings Storage Facility
- TS Topsoil Stockpile
- Ore Stockpile
- Mine Infrastructure Area
- Sediment Dam
- Initial Rehabilitation
- Intermediate/Advanced Rehabilitation
- Diversion Structure
- Gas Pipeline
- Water Pipeline
- Vegetation Screening
- Existing Open Woodland to be Maintained
- State Forest

Source: Black Range Minerals (2000); NSW Department of Industry (2017); NSW Land & Property Information (2017)

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SYERSTON PROJECT MODIFICATION 4

Modified Mine and Processing Facility
Conceptual General Arrangement
Year 11

Figure A1-5

LEGEND

- Mining Lease Application Boundary
- Approved Surface Development Area
- Open Cut Pit (Scandium Oxide)
- Open Cut Pit
- Waste Rock Emplacement
- Tailings Storage Facility
- TS Topsoil Stockpile
- Ore Stockpile
- Mine Infrastructure Area
- Sediment Dam
- Initial Rehabilitation
- Intermediate/Advanced Rehabilitation
- Diversion Structure
- Gas Pipeline
- Water Pipeline
- Vegetation Screening
- Existing Open Woodland to be Maintained
- State Forest

Source: Black Range Minerals (2000); NSW Department of Industry (2017); NSW Land & Property Information (2017)

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SYERSTON PROJECT MODIFICATION 4

Modified Mine and Processing Facility Conceptual General Arrangement Year 21

Figure A1-6

APPENDIX 2
OVERVIEW OF DISPERSION MODELLING

Air quality modelling is presented using the AERMOD system, which is composed of two pre-processors that generate the input files required by the AERMOD dispersion model: AERMET (for the preparation of meteorological data) and AERMAP (for the preparation of terrain data).

AERMET is run using the 'onsite' processing option using hourly measurements for 2015 from the Condobolin meteorological station. Gaps in the dataset were supplemented with prognostic meteorological data from TAPM. TAPM was also used to derive a vertical temperature profile for modelling. The TAPM vertical temperature profile was adjusted by first substituting the predicted 10 metre (m) above ground temperature with the hourly measured temperature at 10 m. The difference between the TAPM predicted temperature and the measured 10 m temperature was applied to the entire predicted vertical temperature profile. This modified vertical profile was used in combination with the ambient air temperature throughout the day to calculate convective mixing heights between sunrise and sunset and included in the AERMET input data.

Values for surface roughness length, albedo, and Bowen ratio were selected using the AERSURFACE Utility by assigning appropriate land use types in the vicinity of the Project. Surface roughness length is the height at which the mean horizontal wind speed approaches zero and is related to the roughness characteristics of the surrounding area. For example, low flat landscapes are assigned a lower surface roughness length than urban or forest areas. Bowen ratio relates to the amount of moisture at the surface and plays an important role in deriving Monin-Obukhov length and therefore atmospheric stability. Albedo is defined as the fraction of incoming solar radiation reflected from the ground when the sun is overhead.

Terrain data for the wider modelling domain was sourced from NASA's Shuttle Radar Topography Mission (SRTM) data. This data set provided a high-resolution topography at approximately 30 m spacing.

Mining activities (hauling, dozers, excavators, wind erosion etc.) are represented by a series of volume sources located according to the general mine plan for each year. For modelling volume sources, estimates of horizontal spread (initial sigma y [σy]) and vertical spread (initial sigma z [σz]) need to be assigned. For sources other than hauling, values assigned for sigma y are based on a source separation of either 50 m or 100 m, selected depending on the size of the source. A release height of 2 m is used to assign values for sigma z. For hauling, sigma y is assigned based on source separation (divided by 4.3) and sigma z based on recommendations made in the US EPA Haul Road Workgroup.

Modelling of fugitive dust was completed for three size fractions; TSP, PM_{10} and $PM_{2.5}$ based on particle diameter of 20, 5 and 1 micron respectively.

APPENDIX 3
ASSESSMENT LOCATIONS

Table A3-1: Assessment locations

Property ID	Property Name	Location (m MGA, Zone 55)		Elevation (m AHD)
		Easting	Northing	
Private receptors				
M01	Longburra	534460	6381299	298.71
M02	Victoria Park	535880	6380159	287.93
M03	Ward 1	532074	6377231	300
M04	Abandoned 2	540068	6369522	311.44
M05	Berrilee	531549	6377952	299.7
M06	Bon Accord	532179	6374519	305.77
M07	Boxcowal	542455	6381666	268.2
M08	Currajong Park 2	541407	6378116	275.99
M09	Daisy Hill	547007	6374597	270.19
M10	Glenburn	539974	6369660	312.13
M12	Louisiana 1	537510	6381346	285.53
M13	Louisiana 2	537536	6381538	286.87
M14	Platina Farm	544033	6367948	283.47
M16	Tarron Vale	544700	6371139	288.23
M17	Jones 1	530531	6369523	294.93
M18	Unnamed Dwelling 18	546216	6370438	279.48
M19	Unnamed Dwelling 19	546115	6370320	280.17
M20	Unnamed Dwelling 20	546165	6367633	289.07
M21	Warra Wandi	547194	6375889	264.73
M22	Brooklyn	544134	6376913	273.8
M23	Currajong Park 1	541505	6378145	275.81
M24	Flemington 1	533630	6376389	293.87
M25	Flemington 2	533432	6376363	298
M26	Kelvin Grove	543396	6379565	268.33
M27	Milverton	543687	6379393	266.57
M28	Rosehill	538772	6379967	272.38
M29	Slapdown	543958	6373248	280.6
M31	Wanda Bye	540599	6370264	307

Property ID	Property Name	Location (m MGA, Zone 55)		Elevation (m AHD)
		Easting	Northing	
Private receptors				
M32	Fifield Town Hall	542918	6369990	300
M33	Fifield Fire Station	542895	6369968	298.9
M34	Fifield Hotel	542872	6370013	300.5
M35	St Dympna's Catholic Church	542799	6370059	298.39
F01	Fifield Residences	542770	6370414	302.13
F02		542918	6370415	298.73
F03		543390	6370245	295.5
F04		543672	6370175	296.83
F05		542504	6370163	307
F06		542310	6370326	298.8
F07		542800	6370068	298.8
F08		543170	6370138	295.96
F09		543224	6370187	296.3
F10		542932	6370017	300.9
F11		542932	6370001	300.37
F12		542932	6370001	300.37
F13		543045	6369937	301.08
F14		543033	6369911	297.5
F15		543178	6369894	294.73
F16		543463	6369933	295.45
F17		543086	6369700	296.53
F18		543384	6370362	295.72
F19		542808	6369999	297.2
Mine-owned receptors				
M11	Kingsdale	541049	6373716	284.2
M15	Sunrise	536914	6371503	312.49
M30	Syerston	537544	6376597	316.87

Note: m AHD = metres Australian Height Datum

APPENDIX 4
PARTICULATE MATTER EMISSIONS INVENTORY DEVELOPMENT

Overview

Dust emissions were estimated using US EPA AP-42 emission factors and predictive equations taken from the following chapters:

- Chapter 11.9 Western Surface Coal Mining.
- Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.
- Chapter 13.2.2 Unpaved Roads.
- Chapter 13.2.4 Aggregate Handling and Storage Piles.
- Chapter 13.2.5 Industrial Wind Erosion.

The material properties listed in **Table A4-1** are used as input to the various emission factor equations listed in **Table A4-2** to derive site specific uncontrolled emission factors for each source. The values chosen are consistent with the inputs used for the original EIS for the approved project. Emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates. Fine particles (PM_{10} and $PM_{2.5}$) were estimated using the fraction specific equations or ratios for the different particle size fractions available within the literature (shown in **Table A4-2**).

Table A4-1: Material properties

Properties	Value
Silt content of waste / ore	10 %
Moisture content of waste / ore	2 %
Moisture content of limestone	1 %
Moisture content of sulphur	0.5 %
Moisture content of waste / ore	5 %

Best Management Practice Determination

In June 2011 the NSW EPA published the best practice document 'NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining' (Katestone, 2011). Although specific to coal mines, many of the best practice measures are relevant and applicable to other types of mining and extractive industries. An overview of the BMP determination for the Project, and the emission reductions applied, is presented in **Table A4-3**.

Diesel emission estimates

Emissions of PM_{10} and $PM_{2.5}$ from diesel combustion in mining equipment are assumed to be included in the total emissions for each relevant source and are not explicitly modelled as a separate emission source. However, adjustments have been made to account for the fact that emission reductions applied to the inventory (i.e. watering) are not relevant to control of diesel exhaust emissions. The emissions inventory applies no controls for dozers and excavators, therefore the adjustments for diesel emissions are only needed for haul road controls.

Emissions are calculated based on fuel based emission factors and fuel consumption derived from published fuel consumption data for the proposed haul truck fleet. An average of the reported range in fuel consumption for medium load activity is used, for an assumed annual equipment utilisation of 80%

The estimated diesel emissions for hauling are based on the assumption that new mining equipment would be purchased for the Project that is capable of achieving emission performance equivalent to US EPA Tier 2 emissions performance, as a minimum.The emission performance for the Project, therefore, would be at least 50% lower than the NSW fleet average presented in NSW EPA (2014).

Table A4-2: Equations and emission factors

Inventory activity	Units	TSP emission factor/equation	PM_{10} emission factor/equation	$PM_{2.5}$ emission factor/equation	EF source
Material handling (loading trucks, unloading trucks, rehandle, conveyor transfer)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP42 13.2.4
Dozers on waste / ore and FEL on ore / product reclaim	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	AP42 11.9
Wind erosion from exposed ground	kg/ha/yr	0.85×1000	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Stockpile wind erosion and maintenance	kg/ha/hr	1.8 * u	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Hauling on unsealed roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP42 13.2.2
Grading roads	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP42 11.9
Ore preparation (sizing)	kg/t	0.0125	0.0043	0.0003	AP42 11.19.2

Note: VKT = vehicle kilometre travelled; U/u = wind speed (m/s); M = moisture content (%); s = silt content (%); W = vehicle weight (t); S = speed (km/hr); ha = hectares.

Table A4-3: BMP determination and emission controls

Activity	BMP	Applied?	Control %	Comment
Hauling	Speed reduction	Yes	N/A	Speed restrictions would apply for the Project, however controls are not applied in the emission inventory.
	Surface improvements	No	N/A	Haul roads will be actively maintained and watered, however specific surface improvements outlined in Katestone (2011) are not practical for this Project and cannot be implemented.
	Surface treatments	Yes	75%	75% control is assumed on the basis of Level 2 watering.
	Use of larger trucks	Yes	N/A	98 t trucks planned for ore and waste hauling.
	Conveyors	No	N/A	Use of conveyors in lieu of hauling is not practical for this Project.
Wind erosion on exposed areas	Minimise pre-strip	Yes	N/A	Incorporated into mine planning, however controls are not applied in the emission inventory.
	Surface stabilisation	Yes	65% - 95%	Controls are applied in the emissions inventory for inactive dump areas or initial rehab (85% for crusting), and soil stockpiles (65% for crusting). Controls are based on ACARP project C22027 (Roddis *et al.*, 2015).
	Wind speed reduction	No	N/A	Not practical for the Project.
Waste dumps	Avoidance	No	N/A	No in-pit dumping proposed.
	Minimising drop heights	Yes	N/A	Would apply for the Project and implemented through driver training, however controls are not applied in the emission inventory.
	Water application	No	N/A	Water application across the large areas of waste dumps is not considered feasible for this Project.
	Modify activities in windy conditions	Yes	N/A	Would apply for the Project and implemented through the Air Quality Management Plan, however controls are not applied in the emission inventory.
	Minimise dozer travel movements	Yes	N/A	Operational efficiency implemented through mine planning and operator training.
	Keep travel routes moist	No	N/A	Not practical for this Project.
Ore handling and processing	Avoidance	Yes	N/A	Achieved through bypassing ore stockpiles where possible and direct dump to ROM pad.
	Minimising drop heights	Yes	30%	Would apply for the Project and implemented through driver training.
	Enclosure of dump hopper	No	N/A	High moisture content for ore negates the need for watering
	Water application	No	N/A	High moisture content for ore negates the need for watering
	Dust extraction	No	N/A	Not practical for the Project.
Stockpiles	Water sprays	No	N/A	Not practical for the Project.

APPENDIX 5
PARTICULATE MATTER EMISSION INVENTORIES

Table A5-1: Year 1 emissions (kg/annum)

Activity	TSP	PM_{10}	$PM_{2.5}$
Eastern pit			
Drilling	1,926	1,136	66
Blasting	1,640	853	49
Excavator ripping and loading trucks in pit	10,906	5,158	781
In pit haulage	24,962	6,469	695
Out of pit haulage to waste rock dump	69,729	18,071	1,941
Trucks unloading at waste rock dump	4,231	2,001	303
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	0	0	0
Out of pit haulage - to high grade ore stockpile	2,796	725	78
Out of pit haulage - to ROM pad	13,982	3,624	389
Western pit			
Drilling	7,704	4,545	262
Blasting	6,559	3,411	197
Excavator ripping and loading trucks in pit	43,625	20,633	3,124
In pit haulage	99,847	25,877	2,780
Out of pit haulage to waste rock dump	232,429	60,237	6,471
Trucks unloading at waste rock dump	16,925	8,005	1,212
Dozers operating in pit/dump	155,036	37,465	16,279
Out of pit haulage to TSF	28,786	7,460	801
Trucks unloading at TSF	898	425	64
Dozers shaping TSF	25,103	6,066	2,636
Out of pit haulage - to low grade ore stockpile	0	0	0
Out of pit haulage - to high grade ore stockpile	78,299	20,292	2,180
Out of pit haulage - to ROM pad	60,402	15,654	1,682
Evaporation Ponds			
Excavator ripping and loading trucks	11,230	5,311	804
Haulage to western dump	49,348	12,680	1,268
Trucks unloading at western dump	898	425	64
Haulage to eastern dump	16,038	4,157	447
Trucks unloading at eastern dump	1,460	690	105
Haulage to TSF	23,440	6,075	653
Trucks unloading at TSF	2,134	1,009	153
Dozers shaping evaporation ponds	25,103	6,066	2,636
Ore storage and processing			
Unload low grade ore to stockpile	0	0	0
Recover low grade ore from stockpile	0	0	0
Haulage of low grade ore to ROM	0	0	0
Unload high grade ore to stockpile	3,054	1,445	219
Recover high grade ore from stockpile	6,109	2,889	438
Haulage of high grade ore to ROM	69,910	18,118	1,946
Unload at ROM pad (low grade and high grade)	6,109	2,889	438
Load ore to hopper (FEL)	102,621	24,799	10,775
Ore preparation (sizing)	34,000	11,696	790

Activity	TSP	PM_{10}	$PM_{2.5}$
Limestone delivery - haulage to ROM pad	26,182	6,727	673
Limestone - unloading to ROM pad	5,868	2,775	420
Limestone - re-handle to process plant	5,868	2,775	420
Sulphur delivery - haulage to hopper	9,256	2,378	238
Unloading elemental sulphur to hopper	1,642	777	118
Conveyor transfer sulphur to process plant or stockpile	3,285	1,554	235
Loading sulphur stockpile	5,475	2,589	392
Product reclaim (FEL)	11,137	2,456	1,169
Loading trucks with product	150	71	11
Product haulage (back loaded to sulphur trucks)	0	0	0
Rejects			
Loading oversize ore to trucks	1,145	542	82
Haulage oversize to dump	41,946	10,778	1,078
Unload at dump	1,145	542	82
Wind erosion of exposed ground			
Scandium pits	18,564	9,282	1,392
Active pit - eastern	3,740	1,870	281
Active pit - western	18,080	9,040	1,356
Active dump - eastern	16,915	8,458	1,269
Inactive dump - eastern (initial rehab)	0	0	0
Active dump - western	17,085	8,543	1,281
Inactive dump - western (initial rehab	0	0	0
Low grade ore stockpile	24,035	12,017	1,803
High grade ore stockpile	55,318	27,659	4,149
ROM pad	1,431	715	107
TSF	74,800	37,400	5,610
Soil stockpiles - active	8,298	4,149	622
Soil stockpiles - inactive	11,647	5,824	874
Limestone stockpile	46	23	3
Product storage area	56	28	4
Evaporation Ponds	11,815	5,908	886
Miscellaneous			
Grading roads	16,698	5,834	518
Stacks	53,927	53,927	53,927
Total (kg/yr)	**1,888,033**	**620,597**	**163,275**

Table A5-2: Year 6 emissions (kg/annum)

Activity	TSP	PM_{10}	$PM_{2.5}$
Eastern pit			
Drilling	4,815	2,841	164
Blasting	4,099	2,132	123
Excavator ripping and loading trucks in pit	27,793	13,145	1,991
In pit haulage	63,613	16,536	1,819
Out of pit haulage to waste rock dump	106,869	27,780	3,056
Trucks unloading at waste rock dump	10,809	5,112	774

Activity	TSP	PM_{10}	$PM_{2.5}$
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	10,602	2,756	303
Out of pit haulage - to high grade ore stockpile	15,079	3,920	431
Out of pit haulage - to ROM pad	52,304	13,596	1,496
Western pit			
Drilling	4,815	2,841	164
Blasting	4,099	2,132	123
Excavator ripping and loading trucks in pit	27,793	13,145	1,991
In pit haulage	63,613	16,536	1,819
Out of pit haulage to waste rock dump	106,869	27,780	3,056
Trucks unloading at waste rock dump	10,809	5,112	774
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	3,675	955	105
Out of pit haulage - to high grade ore stockpile	14,702	3,822	420
Out of pit haulage - to ROM pad	24,738	6,431	707
Ore storage and processing			
Unload low grade ore to stockpile	618	292	44
Recover low grade ore from stockpile	1,235	584	88
Haulage of low grade ore to ROM	14,136	3,675	404
Unload high grade ore to stockpile	2,471	1,168	177
Recover high grade ore from stockpile	4,941	2,337	354
Haulage of high grade ore to ROM	56,545	14,698	1,617
Unload at ROM pad (low grade and high grade)	6,176	2,921	442
Load ore to hopper (FEL)	102,621	24,799	10,775
Ore preparation (sizing)	34,375	11,825	799
Limestone delivery - haulage to ROM pad	26,182	6,727	673
Limestone - unloading to ROM pad	5,868	2,775	420
Limestone - re-handle to process plant	5,868	2,775	420
Sulphur delivery - haulage to hopper	9,256	2,378	238
Unloading elemental sulphur to hopper	1,642	777	118
Conveyor transfer sulphur to process plant or stockpile	3,285	1,554	235
Loading sulphur stockpile	5,475	2,589	392
Product reclaim (FEL)	11,137	2,456	1,169
Loading trucks with product	150	71	11
Product haulage (back loaded to sulphur trucks)	0	0	0
Rejects			
Loading oversize ore to trucks	561	266	40
Haulage oversize to dump	20,562	5,283	528
Unload at dump	561	266	40
Wind erosion of exposed ground			
Scandium pits	20,400	10,200	1,530
Active pit - eastern	56,185	28,093	4,214
Active pit - western	9,397	4,698	705
Active dump - eastern	54,570	27,285	4,093
Inactive dump - eastern (initial rehab)	0	0	0

Activity	TSP	PM_{10}	$PM_{2.5}$
Active dump - western	10,761	5,381	807
Inactive dump - western (initial rehab	0	0	0
Low grade ore stockpile	171,484	85,742	12,861
High grade ore stockpile	107,202	53,601	8,040
ROM pad	1,431	715	107
TSF	67,320	33,660	5,049
Soil stockpiles - active	13,181	6,590	989
Soil stockpiles - inactive	18,502	9,251	1,388
Limestone stockpile	46	23	3
Product storage area	56	28	4
Miscellaneous			
Grading roads	16,698	16,698	518
Stacks	53,927	53,927	53,927
Total (kg/yr)	**1,882,401**	**691,875**	**175,639**

Table A5-3: Year 11 emissions (kg/annum)

Activity	TSP	PM_{10}	$PM_{2.5}$
Eastern pit			
Drilling	5,778	3,409	197
Blasting	4,919	2,558	148
Excavator ripping and loading trucks in pit	33,352	15,775	2,389
In pit haulage	229,006	59,240	6,269
Out of pit haulage to waste rock dump	273,110	70,649	7,477
Trucks unloading at waste rock dump	12,970	6,135	929
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	28,498	7,372	780
Out of pit haulage - to high grade ore stockpile	2,036	527	56
Out of pit haulage - to ROM pad	41,560	10,751	1,068
Western pit			
Drilling	3,852	2,273	131
Blasting	3,280	1,705	98
Excavator ripping and loading trucks in pit	22,235	10,516	1,592
In pit haulage	152,670	39,494	4,179
Out of pit haulage to waste rock dump	106,078	27,441	2,904
Trucks unloading at waste rock dump	8,647	4,090	619
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	5,127	1,326	140
Out of pit haulage - to high grade ore stockpile	2,488	644	68
Out of pit haulage - to ROM pad	31,665	8,191	867
Ore storage and processing			
Unload low grade ore to stockpile	1,482	701	106
Recover low grade ore from stockpile	2,965	1,402	212
Haulage of low grade ore to ROM	33,927	8,776	929
Unload high grade ore to stockpile	618	292	44
Recover high grade ore from stockpile	1,235	584	88

Activity	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Haulage of high grade ore to ROM	14,136	3,657	387
Unload at ROM pad (low grade and high grade)	6,176	2,921	442
Load ore to hopper (FEL)	102,621	24,799	10,775
Ore preparation (sizing)	34,375	11,825	799
Limestone delivery - haulage to ROM pad	26,182	6,727	673
Limestone - unloading to ROM pad	5,868	2,775	420
Limestone - re-handle to process plant	5,868	2,775	420
Sulphur delivery - haulage to hopper	9,256	2,378	238
Unloading elemental sulphur to hopper	1,642	777	118
Conveyor transfer sulphur to process plant or stockpile	3,285	1,554	235
Loading sulphur stockpile	5,475	2,589	392
Product reclaim (FEL)	11,137	2,456	1,169
Loading trucks with product	150	71	11
Product haulage (back loaded to sulphur trucks)	0	0	0
Rejects			
Loading oversize ore to trucks	561	266	40
Haulage oversize to dump	20,562	5,283	528
Unload at dump	561	266	40
Wind erosion of exposed ground			
Scandium pits	20,400	10,200	1,530
Active pit - eastern	128,180	64,090	9,614
Active pit - western	15,173	7,586	1,138
Active dump - eastern	105,400	52,700	7,905
Inactive dump - eastern (initial rehab)	2,678	1,339	201
Active dump - western	26,775	13,388	2,008
Inactive dump - western (initial rehab	3,188	1,594	239
Low grade ore stockpile	171,484	85,742	12,861
High grade ore stockpile	56,081	28,040	4,206
ROM pad	1,431	715	107
TSF	143,820	71,910	10,787
Soil stockpiles - active	9,061	4,530	680
Soil stockpiles - inactive	12,718	6,359	954
Limestone stockpile	46	23	3
Product storage area	56	28	4
Miscellaneous			
Grading roads	11,132	3,889	345
Stacks	53,927	53,927	53,927
Total (kg/yr)	**2,427,382**	**860,226**	**197,589**

Table A5-4: Year 21 emissions (kg/annum)

Activity	TSP	PM_{10}	$PM_{2.5}$
Eastern pit			
Drilling	4,815	2,841	164
Blasting	4,099	2,132	123
Excavator ripping and loading trucks in pit	27,793	13,145	1,991
In pit haulage	190,838	49,510	5,363
Out of pit haulage to waste rock dump	49,477	12,836	1,390
Trucks unloading at waste rock dump	10,809	5,112	774
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	38,168	9,902	1,073
Out of pit haulage - to high grade ore stockpile	0	0	0
Out of pit haulage - to ROM pad	38,168	9,902	1,073
Western pit			
Drilling	4,815	2,841	164
Blasting	4,099	2,132	123
Excavator ripping and loading trucks in pit	27,793	13,145	1,991
In pit haulage	190,838	49,510	5,363
Out of pit haulage to waste rock dump	49,477	12,836	1,271
Trucks unloading at waste rock dump	10,809	5,112	774
Dozers operating in pit/dump	205,242	49,598	21,550
Out of pit haulage - to low grade ore stockpile	10,178	2,641	286
Out of pit haulage - to high grade ore stockpile	0	0	0
Out of pit haulage - to ROM pad	39,581	10,269	1,112
Ore storage and processing			
Unload low grade ore to stockpile	1,544	730	111
Recover low grade ore from stockpile	3,088	1,461	221
Haulage of low grade ore to ROM	35,340	9,169	993
Unload high grade ore to stockpile	0	0	0
Recover high grade ore from stockpile	0	0	0
Haulage of high grade ore to ROM	0	0	0
Unload at ROM pad (low grade and high grade)	6,176	2,921	442
Load ore to hopper (FEL)	102,621	24,799	10,775
Ore preparation (sizing)	34,375	11,825	799
Limestone delivery - haulage to ROM pad	26,182	6,727	673
Limestone - unloading to ROM pad	5,868	2,775	420
Limestone - re-handle to process plant	5,868	2,775	420
Sulphur delivery - haulage to hopper	9,256	2,378	238
Unloading elemental sulphur to hopper	1,642	777	118
Conveyor transfer sulphur to process plant or stockpile	3,285	1,554	235
Loading sulphur stockpile	5,475	2,589	392
Product reclaim (FEL)	11,137	2,456	1,169
Loading trucks with product	150	71	11
Product haulage (back loaded to sulphur trucks)	0	0	0

Activity	TSP	PM_{10}	$PM_{2.5}$
Rejects			
Loading oversize ore to trucks	561	266	40
Haulage oversize to dump	6,359	6,359	6,359
Unload at dump	561	266	40
Wind erosion of exposed ground			
Scandium pits	8,245	4,123	618
Active pit - eastern	165,750	82,875	12,431
Active pit - western	26,138	13,069	1,960
Active dump - eastern	87,550	43,775	6,566
Inactive dump - eastern (initial rehab)	3,060	1,530	230
Active dump - western	18,870	9,435	1,415
Inactive dump - western (initial rehab	4,973	2,486	373
Low grade ore stockpile	171,484	85,742	12,861
High grade ore stockpile	0	0	0
ROM pad	1,431	715	107
TSF	203,490	101,745	15,262
Soil stockpiles - active	9,061	4,530	680
Soil stockpiles - inactive	12,718	6,359	954
Limestone stockpile	46	23	3
Product storage area	56	28	4
Miscellaneous			
Grading roads	11,132	3,889	345
Stacks	53,927	53,927	53,927
Total (kg/yr)	**2,149,657**	**797,210**	**197,330**

The mining activities described in the tables above can be categorised into three emission source types, as follows:

- Wind-insensitive sources (where the emission rate is independent of the wind speed).
- Wind-sensitive sources (where there is a relationship between the emission rate and wind speed).
- Wind erosion sources (where the emission is dependent on the wind speed).

The annual emissions for wind independent sources are evenly apportioned for each hour of the year (no adjustment applied). Hourly varying emissions for wind erosion sources are derived using equation 1, adjusted according to the cube of the hourly average wind speed and normalised so that the total emission over all hours in the year adds up to the estimated annual total emission. The emissions for wind-sensitive sources are converted to hourly emissions in a similar manner, however the wind speed adjustment is made based on equation 2.

Equation 1 (Skidmore, 1998)	**Equation 2** (US EPA, 1987)
$E_i = E_{annual} \times \frac{U_i^3}{\sum_{i=1}^{N} U_i^3}$	$E_i = E_{annual} \times \frac{\left(\frac{U_i}{2.2}\right)^{1.3}}{\sum_{i=1}^{N} \left(\frac{U}{2.2}\right)^{1.3}}$

Where:	$E_i = emissions\ for\ hour\ i$
	$E_{annual} = annual\ emissions$
	$U_i = wind\ speed\ for\ each\ hour\ i$
	$N = number\ of\ hours\ of\ wind\ speed$

APPENDIX 6
PARTICULATE MATTER DISPERSION MODELLING RESULTS

Table A6-1: Predicted Project-only and cumulative annual average PM_{10} concentration ($\mu g/m^3$)

ID	Description	Project-only annual average PM_{10} ($\mu g/m^3$)				Cumulative annual average PM_{10} ($\mu g/m^3$)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	0.5	0.4	0.5	0.5	13.9	13.9	14.0	13.9
M02	Victoria Park	0.8	0.7	0.8	0.7	14.2	14.1	14.3	14.2
M03	Ward 1	0.8	0.7	0.9	0.8	14.3	14.2	14.3	14.2
M04	Abandoned 2	0.8	0.8	1.0	0.9	14.3	14.3	14.5	14.4
M05	Berrilee	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
M06	Bon Accord	1.0	0.9	1.0	0.9	14.5	14.4	14.5	14.4
M07	Boxcowal	0.8	0.7	0.9	0.8	14.3	14.2	14.4	14.2
M08	Currajong Park 2	2.7	2.7	3.5	2.9	16.2	16.2	17.0	16.4
M09	Daisy Hill	1.0	0.9	1.2	1.0	14.5	14.4	14.7	14.4
M10	Glenburn	0.9	0.8	1.1	1.0	14.3	14.3	14.5	14.4
M12	Louisiana 1	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
M13	Louisiana 2	0.7	0.6	0.7	0.6	14.1	14.1	14.2	14.1
M14	Platina Farm	0.4	0.4	0.4	0.4	13.9	13.8	13.9	13.9
M16	Tarron Vale	0.9	0.8	0.9	0.8	14.4	14.2	14.4	14.3
M17	Jones 1	0.5	0.4	0.5	0.4	14.0	13.9	14.0	13.9
M18	Unnamed Dwelling 18	0.6	0.6	0.7	0.6	14.1	14.0	14.1	14.0
M19	Unnamed Dwelling 19	0.6	0.5	0.7	0.6	14.1	14.0	14.1	14.0
M20	Unnamed Dwelling 20	0.3	0.3	0.4	0.3	13.8	13.8	13.8	13.8
M21	Warra Wandi	0.9	0.8	1.0	0.8	14.3	14.3	14.5	14.3
M22	Brooklyn	2.0	2.0	2.9	2.2	15.5	15.4	16.4	15.7
M23	Currajong Park 1	2.7	2.7	3.5	2.8	16.2	16.1	16.9	16.3
M24	Flemington 1	1.3	1.2	1.4	1.3	14.8	14.6	14.9	14.7
M25	Flemington 2	1.3	1.1	1.4	1.2	14.8	14.6	14.8	14.7
M26	Kelvin Grove	1.2	1.2	1.6	1.3	14.7	14.7	15.1	14.8
M27	Milverton	1.2	1.2	1.6	1.3	14.7	14.7	15.1	14.8
M28	Rosehill	1.2	1.1	1.3	1.1	14.7	14.5	14.8	14.6
M29	Slapdown	2.0	1.5	2.0	1.6	15.5	15.0	15.4	15.1
M31	Wanda Bye	1.0	1.0	1.2	1.1	14.5	14.4	14.7	14.6
M32	Fifield Town Hall	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
M33	Fifield Fire Station	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
M34	Fifield Hotel	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
M35	St Dympna's Catholic Church	0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F01	Fifield Residences	0.8	0.7	0.8	0.7	14.3	14.1	14.3	14.2
F02		0.8	0.7	0.8	0.7	14.3	14.1	14.3	14.2
F03		0.7	0.6	0.8	0.6	14.2	14.1	14.2	14.1
F04		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F05		0.7	0.6	0.8	0.6	14.2	14.1	14.2	14.1
F06		0.8	0.7	0.9	0.7	14.3	14.2	14.3	14.2
F07		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F08		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F09		0.7	0.6	0.8	0.6	14.2	14.1	14.2	14.1
F10		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F11		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F12		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
F13		0.7	0.6	0.7	0.6	14.1	14.0	14.2	14.1
F14		0.7	0.6	0.7	0.6	14.1	14.0	14.2	14.1
F15		0.7	0.6	0.7	0.6	14.1	14.0	14.2	14.1

ID	Description	Project-only annual average PM_{10} (µg/m³)				Cumulative annual average PM_{10} (µg/m³)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
F16	Fifield Residences	0.7	0.6	0.7	0.6	14.1	14.0	14.2	14.1
F17		0.6	0.5	0.7	0.6	14.1	14.0	14.1	14.0
F18		0.7	0.6	0.8	0.7	14.2	14.1	14.3	14.1
F19		0.7	0.6	0.7	0.6	14.2	14.1	14.2	14.1
Mine-owned receptors									
M15	Sunrise	2.2	2.0	2.3	2.1	15.7	15.5	15.8	15.5

Table A6-2: Predicted Project-only and cumulative 24-hour average PM_{10} concentration (µg/m³)

ID	Description	Project-only 24-hr average PM_{10} (µg/m³)				Cumulative 24-hr average PM_{10} (µg/m³)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	2.8	2.6	3.4	3.0	41.0	41.0	41.0	41.0
M02	Victoria Park	4.3	3.9	4.5	4.1	41.0	41.0	41.0	41.0
M03	Ward 1	6.2	4.5	5.5	4.7	41.0	41.0	41.0	41.0
M04	Abandoned 2	4.2	4.4	6.0	6.0	42.8	42.9	43.5	43.5
M05	Berrilee	5.7	4.8	5.8	5.2	41.0	41.0	41.0	41.0
M06	Bon Accord	8.1	5.6	6.8	6.2	41.0	41.0	41.0	41.0
M07	Boxcowal	4.1	3.5	4.7	3.7	41.2	41.3	41.2	41.2
M08	Currajong Park 2	13.8	10.1	12.3	11.3	46.1	43.6	43.7	43.6
M09	Daisy Hill	6.3	5.7	8.0	6.3	41.8	41.6	41.6	41.6
M10	Glenburn	5.6	4.4	6.5	5.8	42.9	42.9	43.7	43.7
M12	Louisiana 1	5.5	3.7	4.1	3.7	41.0	41.0	41.0	41.0
M13	Louisiana 2	5.2	3.6	4.0	3.6	41.0	41.0	41.0	41.0
M14	Platina Farm	2.7	2.3	2.7	2.3	41.1	41.0	41.2	41.1
M16	Tarron Vale	6.3	4.2	5.4	4.5	41.6	41.4	41.8	41.3
M17	Jones 1	3.7	2.9	3.4	2.9	41.0	41.0	41.0	41.0
M18	Unnamed Dwelling 18	3.7	3.0	4.5	3.6	41.2	41.2	41.3	41.3
M19	Unnamed Dwelling 19	4.0	3.2	4.7	3.7	41.2	41.2	41.3	41.3
M20	Unnamed Dwelling 20	2.6	2.1	2.6	2.3	41.0	41.0	41.1	41.1
M21	Warra Wandi	5.5	5.7	7.6	6.0	42.3	42.0	42.3	42.1
M22	Brooklyn	11.1	10.2	15.1	11.3	47.8	46.1	48.7	46.6
M23	Currajong Park 1	13.1	10.1	12.1	11.3	45.8	43.5	43.6	43.5
M24	Flemington 1	9.6	9.2	11.5	10.2	41.0	41.0	41.0	41.0
M25	Flemington 2	9.7	9.3	11.7	10.3	41.0	41.0	41.0	41.0
M26	Kelvin Grove	6.9	6.8	8.1	6.6	43.2	43.1	43.1	42.9
M27	Milverton	7.9	7.4	9.7	7.9	43.6	43.1	43.5	43.3
M28	Rosehill	9.2	5.8	6.7	6.1	41.1	41.1	41.1	41.1
M29	Slapdown	10.5	8.0	9.5	7.7	41.4	41.5	41.8	42.0
M31	Wanda Bye	5.7	5.1	6.4	7.0	42.9	44.0	44.1	45.2
M32	Fifield Town Hall	4.4	3.7	4.1	3.5	42.0	41.6	41.8	41.7
M33	Fifield Fire Station	4.4	3.6	4.1	3.5	42.0	41.6	41.8	41.7
M34	Fifield Hotel	4.5	3.7	4.2	3.5	42.0	41.6	41.8	41.7
M35	St Dympna's Catholic Church	4.6	3.7	4.2	3.5	42.1	41.7	42.0	41.7
F01	Fifield Residences	5.0	4.1	4.3	3.9	42.2	41.6	42.2	41.9
F02		5.2	4.2	4.2	3.9	42.0	41.5	41.9	41.8
F03		5.2	4.0	4.1	3.8	41.7	41.3	41.6	41.6
F04		5.3	4.0	4.3	3.9	41.6	41.2	41.5	41.5

ID	Description	Project-only 24-hr average PM_{10} (µg/m^3)				Cumulative 24-hr average PM_{10} (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
F05	Fifield Residences	4.8	4.3	4.6	4.3	42.5	42.1	42.2	42.1
F06		4.9	4.0	4.7	4.0	42.6	42.1	42.2	42.1
F07		4.6	3.7	4.2	3.6	42.1	41.7	42.0	41.7
F08		4.9	3.8	3.9	3.6	41.8	41.3	41.7	41.5
F09		5.0	3.9	3.9	3.7	41.8	41.3	41.7	41.6
F10		4.4	3.7	4.1	3.5	42.0	41.6	41.8	41.7
F11		4.4	3.7	4.1	3.5	42.0	41.6	41.8	41.7
F12		4.4	3.7	4.1	3.5	42.0	41.6	41.8	41.7
F13		4.5	3.6	4.0	3.4	41.9	41.5	41.7	41.6
F14		4.2	3.5	4.0	3.3	41.9	41.5	41.7	41.6
F15		4.5	3.5	3.8	3.3	41.7	41.4	41.6	41.5
F16		4.7	3.6	3.7	3.4	41.6	41.2	41.5	41.4
F17		4.0	3.4	3.9	3.2	41.8	41.5	41.6	41.5
F18		5.4	4.2	4.3	4.0	41.7	41.3	41.6	41.6
F19		4.5	3.6	4.2	3.5	42.1	41.7	41.9	41.7
Mine-owned receptors									
M15	Sunrise	14.7	15.6	17.8	16.3	41.1	41.2	41.3	41.3

Table A6-3: Predicted Project-only and cumulative annual average $PM_{2.5}$ concentration (µg/m^3) at private receptors

ID	Description	Project-only annual average $PM_{2.5}$ (µg/m^3)				Cumulative annual average $PM_{2.5}$ (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	0.1	0.1	0.2	0.2	6.2	6.2	6.3	6.3
M02	Victoria Park	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M03	Ward 1	0.2	0.2	0.3	0.3	6.3	6.3	6.4	6.4
M04	Abandoned 2	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M05	Berrilee	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M06	Bon Accord	0.3	0.3	0.3	0.3	6.4	6.4	6.4	6.4
M07	Boxcowal	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M08	Currajong Park 2	0.7	0.8	0.9	0.9	6.8	6.9	7.0	7.0
M09	Daisy Hill	0.3	0.3	0.3	0.3	6.4	6.4	6.4	6.4
M10	Glenburn	0.2	0.2	0.3	0.3	6.3	6.3	6.4	6.4
M12	Louisiana 1	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M13	Louisiana 2	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M14	Platina Farm	0.1	0.1	0.1	0.1	6.2	6.2	6.2	6.2
M16	Tarron Vale	0.3	0.3	0.3	0.3	6.4	6.4	6.4	6.4
M17	Jones 1	0.1	0.1	0.2	0.2	6.2	6.2	6.3	6.3
M18	Unnamed Dwelling 18	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M19	Unnamed Dwelling 19	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M20	Unnamed Dwelling 20	0.1	0.1	0.1	0.1	6.2	6.2	6.2	6.2
M21	Warra Wandi	0.3	0.2	0.3	0.3	6.4	6.3	6.4	6.4
M22	Brooklyn	0.6	0.6	0.8	0.7	6.7	6.7	6.9	6.8
M23	Currajong Park 1	0.7	0.8	0.9	0.8	6.8	6.9	7.0	6.9
M24	Flemington 1	0.4	0.4	0.4	0.4	6.5	6.5	6.5	6.5
M25	Flemington 2	0.3	0.4	0.4	0.4	6.4	6.5	6.5	6.5
M26	Kelvin Grove	0.4	0.4	0.4	0.4	6.5	6.5	6.5	6.5
M27	Milverton	0.4	0.4	0.4	0.4	6.5	6.5	6.5	6.5

ID	Description	Project-only annual average $PM_{2.5}$ (µg/m^3)				Cumulative annual average $PM_{2.5}$ (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
M28	Rosehill	0.3	0.3	0.4	0.4	6.4	6.4	6.5	6.5
M29	Slapdown	0.6	0.4	0.5	0.5	6.7	6.5	6.6	6.6
M31	Wanda Bye	0.3	0.3	0.3	0.3	6.4	6.4	6.4	6.4
M32	Fifield Town Hall	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M33	Fifield Fire Station	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M34	Fifield Hotel	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
M35	St Dympna's Catholic Church	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F01	Fifield Residences	0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F02		0.3	0.2	0.2	0.2	6.4	6.3	6.3	6.3
F03		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F04		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F05		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F06		0.3	0.2	0.2	0.2	6.4	6.3	6.3	6.3
F07		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F08		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F09		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F10		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F11		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F12		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F13		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F14		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F15		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F16		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F17		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F18		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
F19		0.2	0.2	0.2	0.2	6.3	6.3	6.3	6.3
Mine-owned receptors									
M15	Sunrise	0.6	0.6	0.6	0.6	6.7	6.7	6.7	6.7

Table A6-4: Predicted Project-only and cumulative 24-hour average $PM_{2.5}$ concentration (µg/m^3) at private receptors

ID	Description	Project-only 24-hr average $PM_{2.5}$ (µg/m^3)				Cumulative 24-hr average $PM_{2.5}$ (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	1.1	1.0	1.1	1.1	18.6	18.5	18.6	18.6
M02	Victoria Park	1.4	1.3	1.5	1.5	18.9	18.8	19.0	19.0
M03	Ward 1	1.6	1.3	1.5	1.5	19.1	18.8	19.0	19.0
M04	Abandoned 2	1.3	1.1	1.1	1.3	18.8	18.6	18.6	18.8
M05	Berrilee	1.5	1.5	1.7	1.7	19.0	19.0	19.2	19.2
M06	Bon Accord	2.0	1.8	1.9	1.9	19.5	19.3	19.4	19.4
M07	Boxcowal	1.3	1.0	1.1	1.2	18.8	18.5	18.6	18.7
M08	Currajong Park 2	3.5	3.3	3.7	3.3	21.0	20.8	21.2	20.8
M09	Daisy Hill	1.7	1.5	1.8	1.7	19.2	19.0	19.3	19.2
M10	Glenburn	1.6	1.1	1.2	1.2	19.1	18.6	18.7	18.7
M12	Louisiana 1	1.7	1.4	1.3	1.3	19.2	18.9	18.8	18.8
M13	Louisiana 2	1.6	1.4	1.3	1.3	19.1	18.9	18.8	18.8
M14	Platina Farm	0.8	0.8	0.8	0.9	18.3	18.3	18.3	18.4

ID	Description	Project-only 24-hr average $PM_{2.5}$ (µg/m^3)				Cumulative 24-hr average $PM_{2.5}$ (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
M16	Tarron Vale	1.6	1.5	1.5	1.5	19.1	19.0	19.0	19.0
M17	Jones 1	1.3	1.0	1.1	1.1	18.8	18.5	18.6	18.6
M18	Unnamed Dwelling 18	1.1	1.1	1.2	1.1	18.6	18.6	18.7	18.6
M19	Unnamed Dwelling 19	1.1	1.0	1.2	1.2	18.6	18.5	18.7	18.7
M20	Unnamed Dwelling 20	0.6	0.6	0.6	0.7	18.1	18.1	18.1	18.2
M21	Warra Wandi	1.4	1.6	1.8	1.7	18.9	19.1	19.3	19.2
M22	Brooklyn	3.6	3.0	3.8	3.5	21.1	20.5	21.3	21.0
M23	Currajong Park 1	4.5	3.6	3.5	3.2	22.0	21.1	21.0	20.7
M24	Flemington 1	2.7	3.4	4.0	3.9	20.2	20.9	21.5	21.4
M25	Flemington 2	2.7	3.4	3.9	3.8	20.2	20.9	21.4	21.3
M26	Kelvin Grove	1.7	1.9	2.2	2.1	19.2	19.4	19.7	19.6
M27	Milverton	2.4	2.2	2.5	2.5	19.9	19.7	20.0	20.0
M28	Rosehill	2.4	1.9	1.8	1.9	19.9	19.4	19.3	19.4
M29	Slapdown	3.4	2.3	2.3	2.2	20.9	19.8	19.8	19.7
M31	Wanda Bye	1.9	1.8	1.8	1.9	19.4	19.3	19.3	19.4
M32	Fifield Town Hall	1.6	1.2	1.2	1.2	19.1	18.7	18.7	18.7
M33	Fifield Fire Station	1.4	1.2	1.2	1.2	18.9	18.7	18.7	18.7
M34	Fifield Hotel	1.4	1.2	1.2	1.2	18.9	18.7	18.7	18.7
M35	St Dympna's Catholic Church	1.3	1.2	1.2	1.2	18.8	18.7	18.7	18.7
F01	Fifield Residences	1.5	1.3	1.3	1.3	19.0	18.8	18.8	18.8
F02		1.8	1.3	1.3	1.3	19.3	18.8	18.8	18.8
F03		1.3	1.2	1.2	1.2	18.8	18.7	18.7	18.7
F04		1.3	1.1	1.2	1.2	18.8	18.6	18.7	18.7
F05		1.3	1.3	1.3	1.3	18.8	18.8	18.8	18.8
F06		1.4	1.3	1.3	1.3	18.9	18.8	18.8	18.8
F07		1.3	1.2	1.2	1.2	18.8	18.7	18.7	18.7
F08		1.4	1.1	1.2	1.2	18.9	18.6	18.7	18.7
F09		1.3	1.2	1.2	1.2	18.8	18.7	18.7	18.7
F10		1.7	1.2	1.2	1.2	19.2	18.7	18.7	18.7
F11		1.6	1.2	1.2	1.2	19.1	18.7	18.7	18.7
F12		1.6	1.2	1.2	1.2	19.1	18.7	18.7	18.7
F13		1.6	1.1	1.2	1.2	19.1	18.6	18.7	18.7
F14		1.5	1.1	1.1	1.2	19.0	18.6	18.6	18.7
F15		1.3	1.1	1.1	1.1	18.8	18.6	18.6	18.6
F16		1.2	1.1	1.1	1.1	18.7	18.6	18.6	18.6
F17		1.4	1.1	1.1	1.1	18.9	18.6	18.6	18.6
F18		1.4	1.2	1.2	1.3	18.9	18.7	18.7	18.8
F19		1.3	1.2	1.2	1.2	18.8	18.7	18.7	18.7
Mine-owned receptors									
M15	Sunrise	4.5	4.9	5.2	5.2	22.0	22.4	22.7	22.7

Table A6-5: Predicted Project-only and cumulative annual average TSP (µg/m^3)

ID	Description	Project-only annual average TSP (µg/m^3)				Cumulative annual average TSP (µg/m^3)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	0.6	0.6	0.7	0.6	34.6	34.6	34.7	34.6
M02	Victoria Park	1.0	0.9	1.1	1.0	35.0	34.9	35.1	35.0
M03	Ward 1	1.1	1.0	1.2	1.0	35.1	35.0	35.2	35.0
M04	Abandoned 2	1.2	1.2	1.5	1.4	35.2	35.2	35.5	35.4
M05	Berrilee	0.9	0.8	1.0	0.9	34.9	34.8	35.0	34.9
M06	Bon Accord	1.4	1.2	1.4	1.3	35.4	35.2	35.4	35.3
M07	Boxcowal	1.1	1.0	1.3	1.1	35.1	35.0	35.3	35.1
M08	Currajong Park 2	4.3	4.2	5.6	4.5	38.3	38.2	39.6	38.5
M09	Daisy Hill	1.4	1.2	1.7	1.4	35.4	35.2	35.7	35.4
M10	Glenburn	1.3	1.3	1.6	1.5	35.3	35.3	35.6	35.5
M12	Louisiana 1	0.9	0.8	1.0	0.9	34.9	34.8	35.0	34.9
M13	Louisiana 2	0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
M14	Platina Farm	0.5	0.5	0.6	0.5	34.5	34.5	34.6	34.5
M16	Tarron Vale	1.2	1.0	1.2	1.0	35.2	35.0	35.2	35.0
M17	Jones 1	0.6	0.5	0.6	0.6	34.6	34.5	34.6	34.6
M18	Unnamed Dwelling 18	0.8	0.7	0.9	0.7	34.8	34.7	34.9	34.7
M19	Unnamed Dwelling 19	0.8	0.7	0.8	0.7	34.8	34.7	34.8	34.7
M20	Unnamed Dwelling 20	0.4	0.4	0.5	0.4	34.4	34.4	34.5	34.4
M21	Warra Wandi	1.2	1.1	1.5	1.2	35.2	35.1	35.5	35.2
M22	Brooklyn	3.2	3.0	4.6	3.5	37.2	37.0	38.6	37.5
M23	Currajong Park 1	4.2	4.1	5.5	4.4	38.2	38.1	39.5	38.4
M24	Flemington 1	1.9	1.6	2.0	1.8	35.9	35.6	36.0	35.8
M25	Flemington 2	1.8	1.6	1.9	1.7	35.8	35.6	35.9	35.7
M26	Kelvin Grove	1.8	1.8	2.4	2.0	35.8	35.8	36.4	36.0
M27	Milverton	1.9	1.8	2.5	2.0	35.9	35.8	36.5	36.0
M28	Rosehill	1.8	1.5	1.9	1.6	35.8	35.5	35.9	35.6
M29	Slapdown	2.8	2.1	2.8	2.3	36.8	36.1	36.8	36.3
M31	Wanda Bye	1.5	1.4	1.8	1.7	35.5	35.4	35.8	35.7
M32	Fifield Town Hall	0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
M33	Fifield Fire Station	0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
M34	Fifield Hotel	0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
M35	St Dympna's Catholic Church	0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F01	Fifield Residences	1.1	0.9	1.1	0.9	35.1	34.9	35.1	34.9
F02		1.1	0.9	1.1	0.9	35.1	34.9	35.1	34.9
F03		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F04		0.9	0.8	0.9	0.8	34.9	34.8	34.9	34.8
F05		1.0	0.8	1.0	0.9	35.0	34.8	35.0	34.9
F06		1.1	0.9	1.2	1.0	35.1	34.9	35.2	35.0
F07		0.9	0.8	1.0	0.9	34.9	34.8	35.0	34.9
F08		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F09		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F10		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F11		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F12		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
F13		0.9	0.7	0.9	0.8	34.9	34.7	34.9	34.8
F14		0.9	0.7	0.9	0.8	34.9	34.7	34.9	34.8

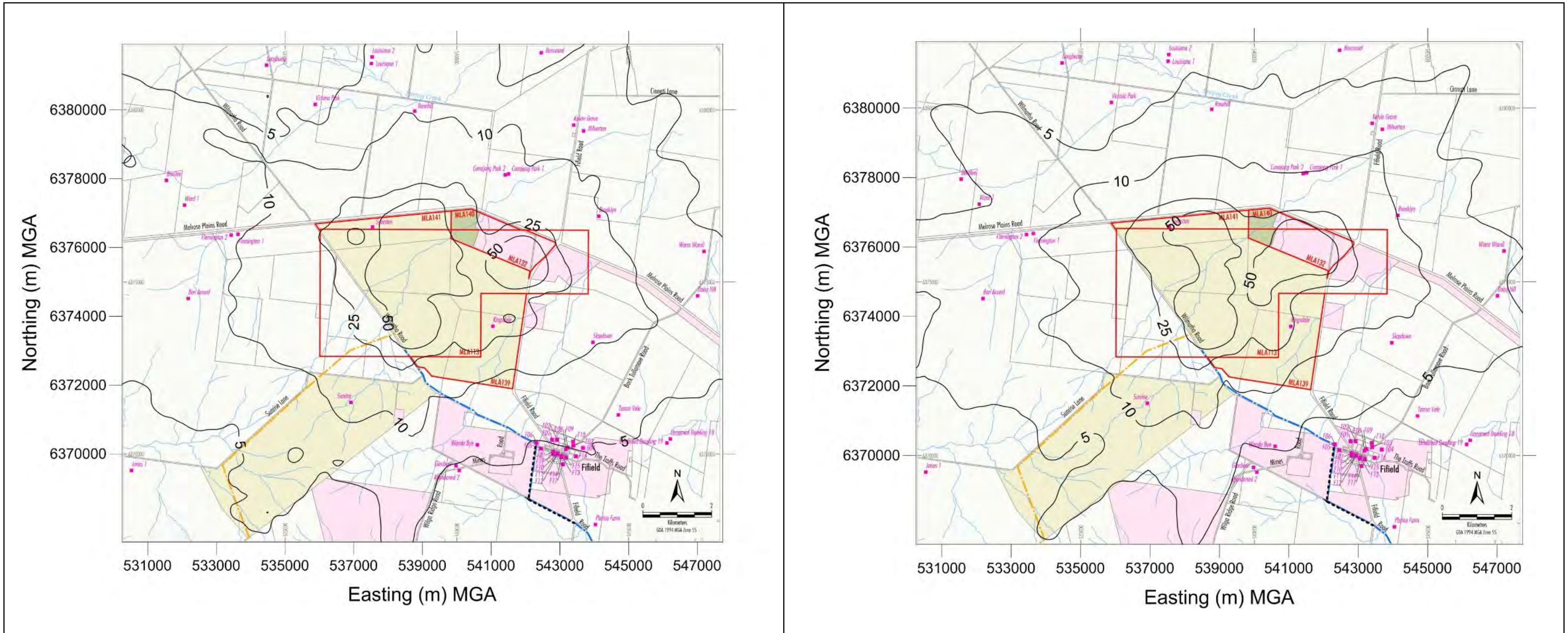
ID	Description	Project-only annual average TSP (µg/m³)				Cumulative annual average TSP (µg/m³)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
F15	Fifield Residences	0.9	0.7	0.9	0.8	34.9	34.7	34.9	34.8
F16		0.8	0.7	0.9	0.8	34.8	34.7	34.9	34.8
F17		0.8	0.7	0.9	0.7	34.8	34.7	34.9	34.7
F18		1.0	0.8	1.0	0.9	35.0	34.8	35.0	34.9
F19		0.9	0.8	1.0	0.8	34.9	34.8	35.0	34.8
Mine-owned receptors									
M15	Sunrise	3.4	3.1	3.6	3.1	37.4	37.1	37.6	37.1

Table A6-6: Predicted Project-only and cumulative dust deposition (g/m²/month)

ID	Description	Project-only annual average dust deposition (g/m²/month)				Cumulative annual average dust deposition (g/m²/month)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
Private receptors									
M01	Longburra	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M02	Victoria Park	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M03	Ward 1	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M04	Abandoned 2	0.2	0.1	0.1	0.1	2.9	2.8	2.8	2.8
M05	Berrilee	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M06	Bon Accord	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M07	Boxcowal	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M08	Currajong Park 2	0.2	0.2	0.2	0.2	2.9	2.9	2.9	2.9
M09	Daisy Hill	0.1	0.0	0.1	0.0	2.8	2.7	2.8	2.7
M10	Glenburn	0.2	0.1	0.1	0.1	2.9	2.8	2.8	2.8
M12	Louisiana 1	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M13	Louisiana 2	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M14	Platina Farm	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M16	Tarron Vale	0.1	0.0	0.0	0.0	2.8	2.7	2.7	2.7
M17	Jones 1	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M18	Unnamed Dwelling 18	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M19	Unnamed Dwelling 19	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M20	Unnamed Dwelling 20	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M21	Warra Wandi	0.1	0.0	0.1	0.0	2.8	2.7	2.8	2.7
M22	Brooklyn	0.2	0.1	0.2	0.2	2.9	2.8	2.9	2.9
M23	Currajong Park 1	0.2	0.2	0.2	0.2	2.9	2.9	2.9	2.9
M24	Flemington 1	0.1	0.0	0.0	0.0	2.8	2.7	2.7	2.7
M25	Flemington 2	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M26	Kelvin Grove	0.1	0.1	0.1	0.1	2.8	2.8	2.8	2.8
M27	Milverton	0.1	0.1	0.1	0.1	2.8	2.8	2.8	2.8
M28	Rosehill	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M29	Slapdown	0.1	0.1	0.1	0.1	2.8	2.8	2.8	2.8
M31	Wanda Bye	0.2	0.1	0.1	0.1	2.9	2.8	2.8	2.8
M32	Fifield Town Hall	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M33	Fifield Fire Station	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M34	Fifield Hotel	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
M35	St Dympna's Catholic Church	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F01	Fifield Residences	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F02		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7

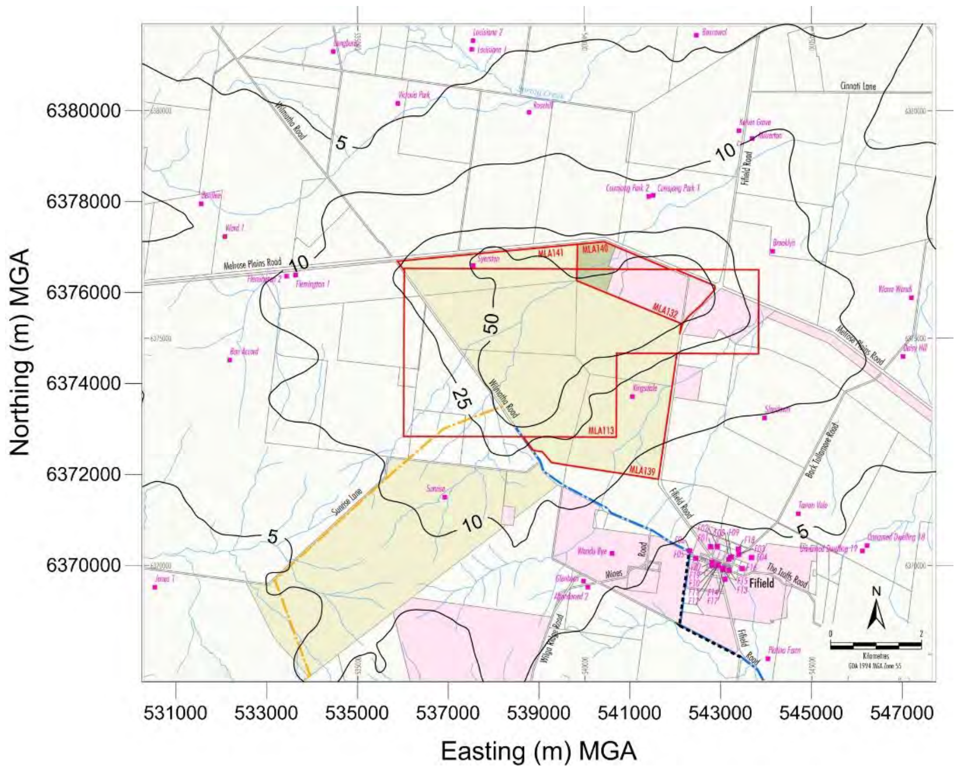
ID	Description	Project-only annual average dust deposition ($g/m^2/month$)				Cumulative annual average dust deposition ($g/m^2/month$)			
		Year 1	Year 6	Year 11	Year 21	Year 1	Year 6	Year 11	Year 21
F03	Fifield Residences	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F04		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F05		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F06		0.1	0.0	0.0	0.0	2.8	2.7	2.7	2.7
F07		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F08		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F09		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F10		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F11		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F12		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F13		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F14		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F15		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F16		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F17		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F18		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
F19		0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7
Mine-owned receptors									
M15	Sunrise	0.2	0.1	0.2	0.1	2.9	2.8	2.9	2.8

APPENDIX 7
CONTOUR PLOTS

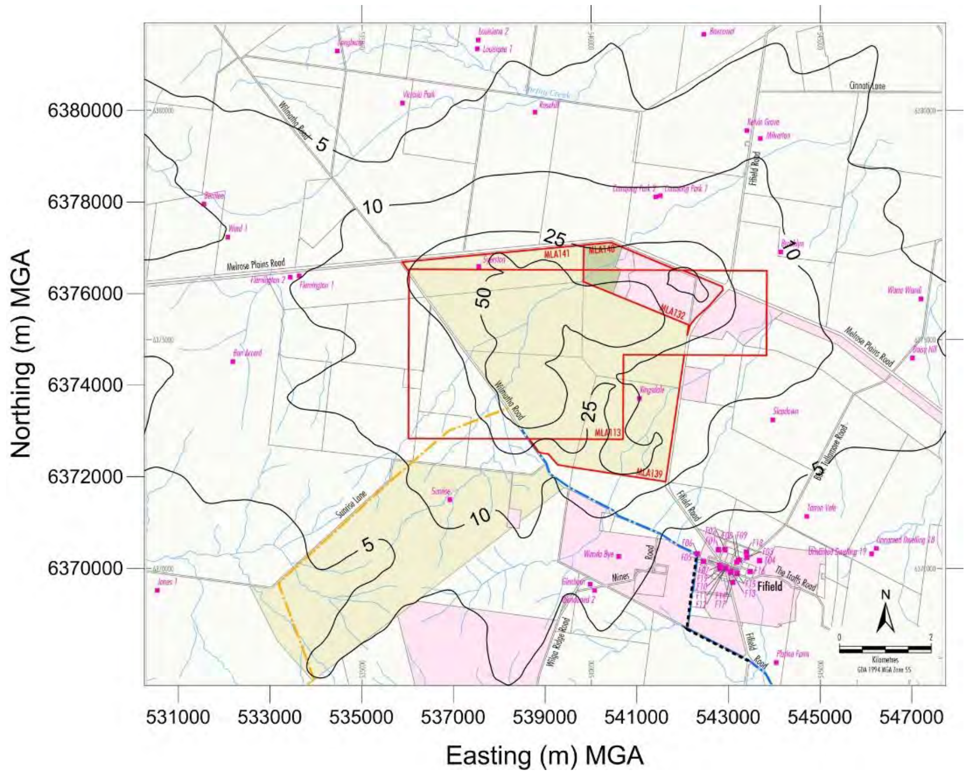


Year 1	Year 6

Figure A7-1: Predicted Project-only 24-hour average PM_{10} - Year 1 and Year 6

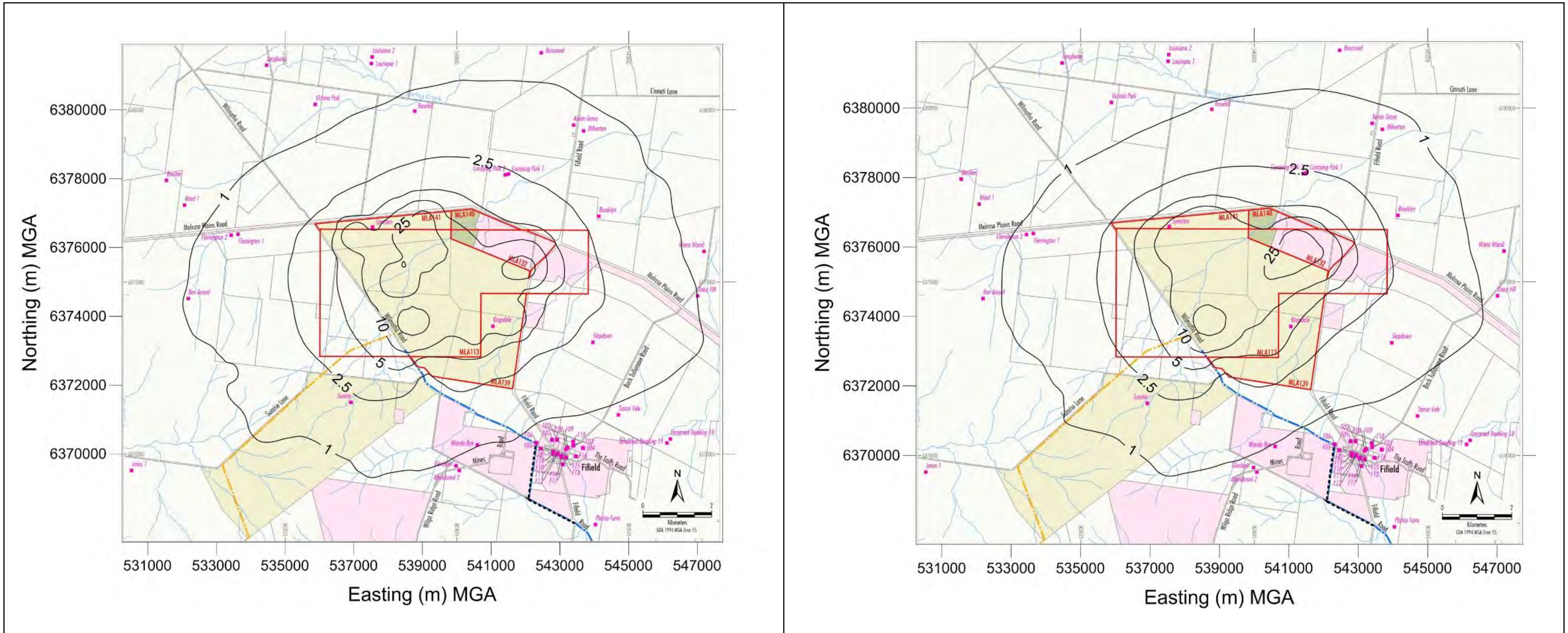


Year 11



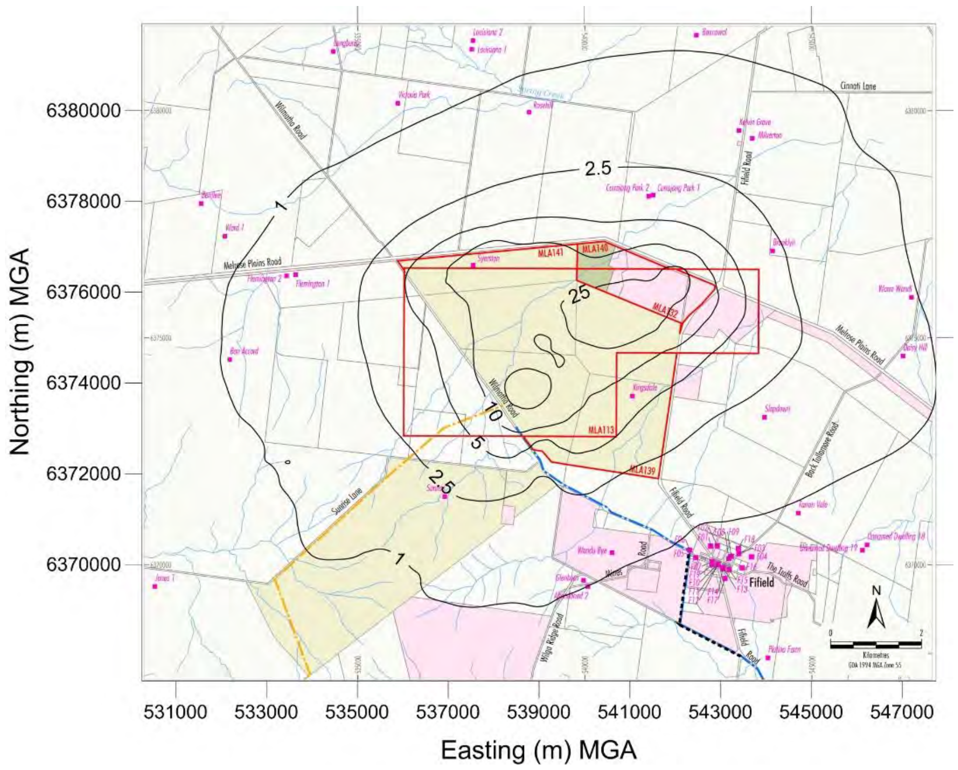
Year 21

Figure A7-2: Predicted Project-only 24-hour average PM_{10} - Year 11 and Year 21

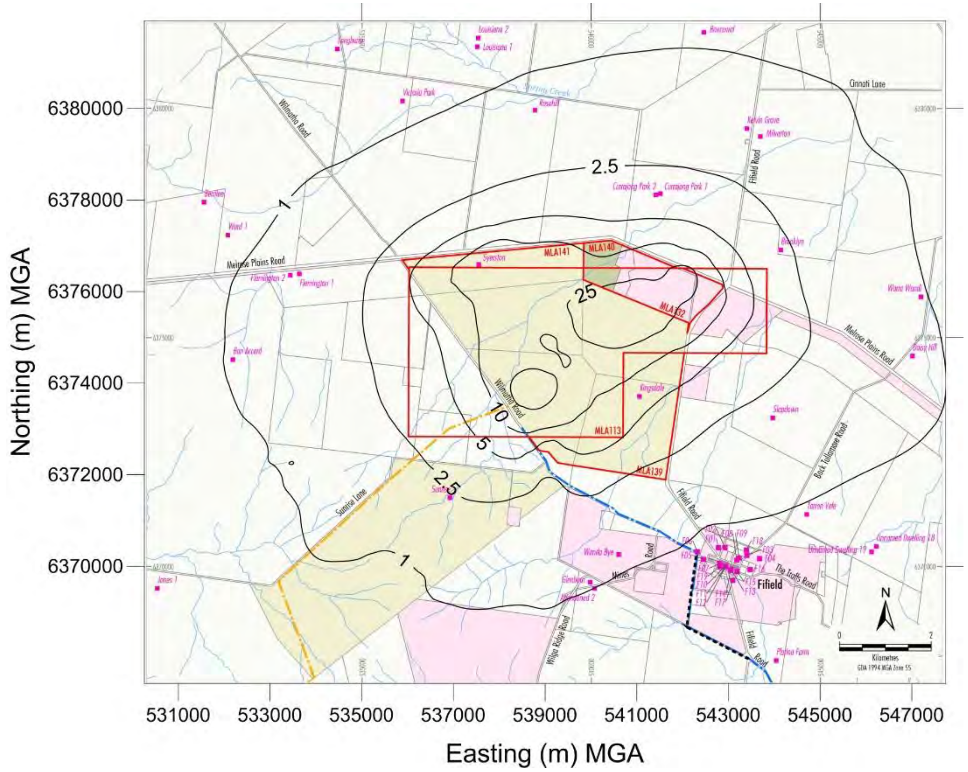


Year 1	Year 6

Figure A7-3: Predicted Project-only annual average PM_{10} - Year 1 and Year 6



Year 11



Year 21

Figure A7-4: Predicted Project-only annual average PM_{10} - Year 11 and Year 21

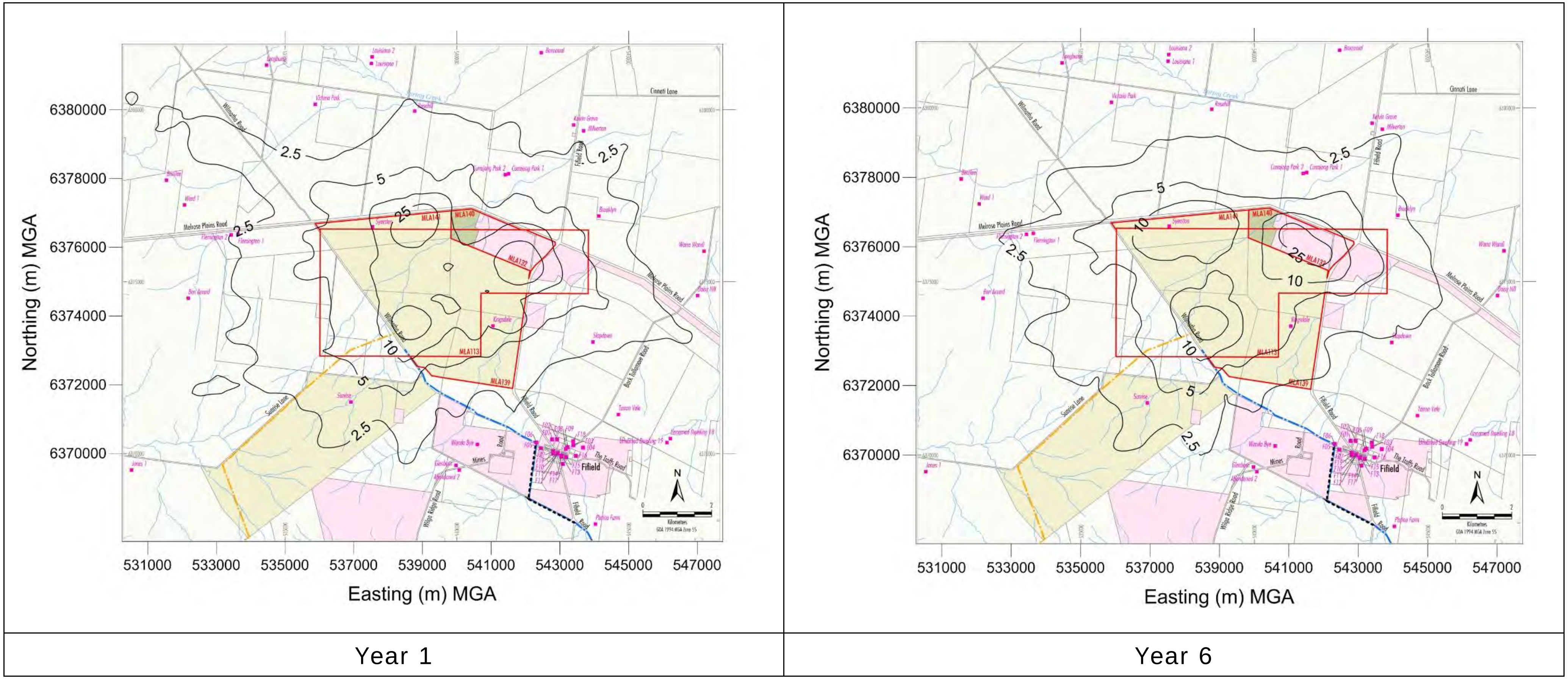
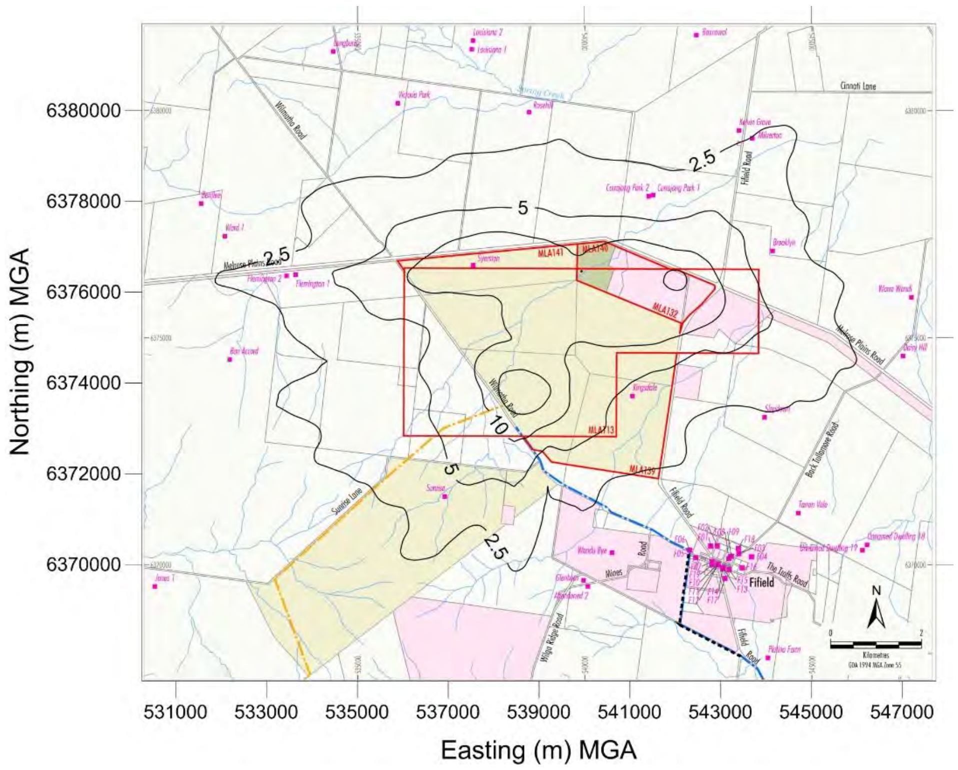
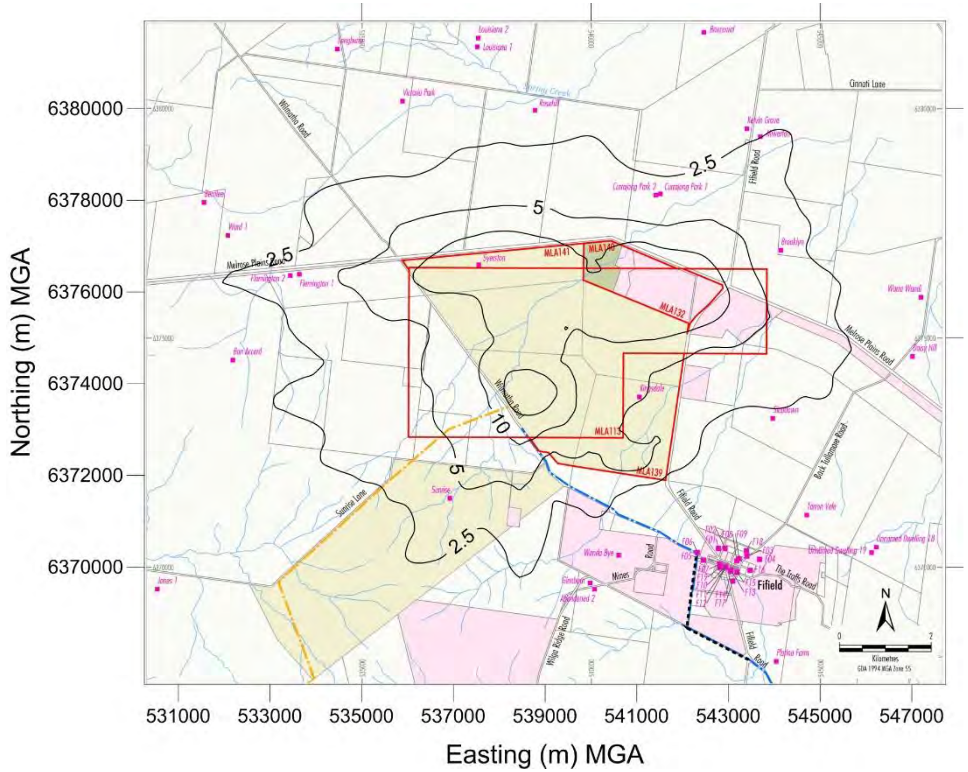


Figure A7-5: Predicted Project-only 24-hour average $PM_{2.5}$ - Year 1 and Year 6



Year 11



Year 21

Figure A7-6: Predicted Project-only 24-hour average $PM_{2.5}$ - Year 11 and Year 21

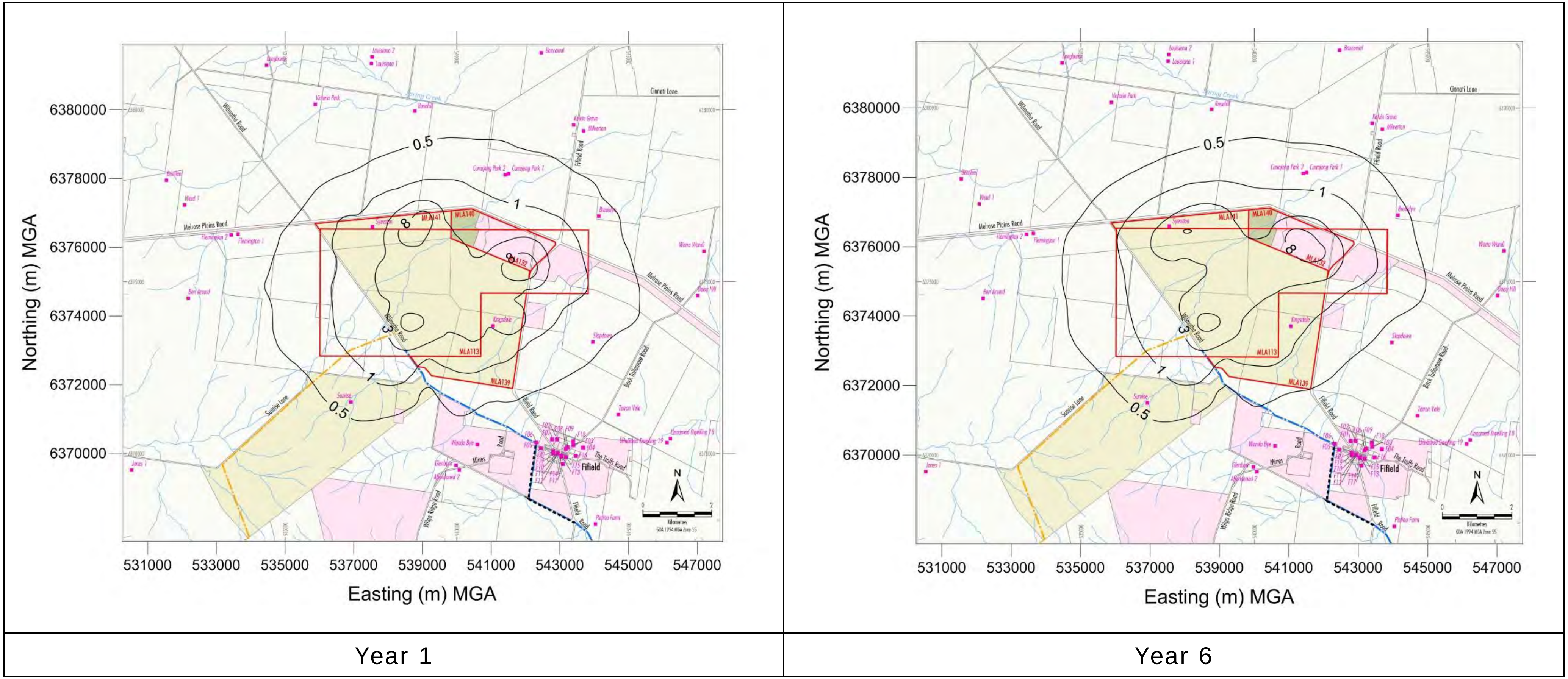
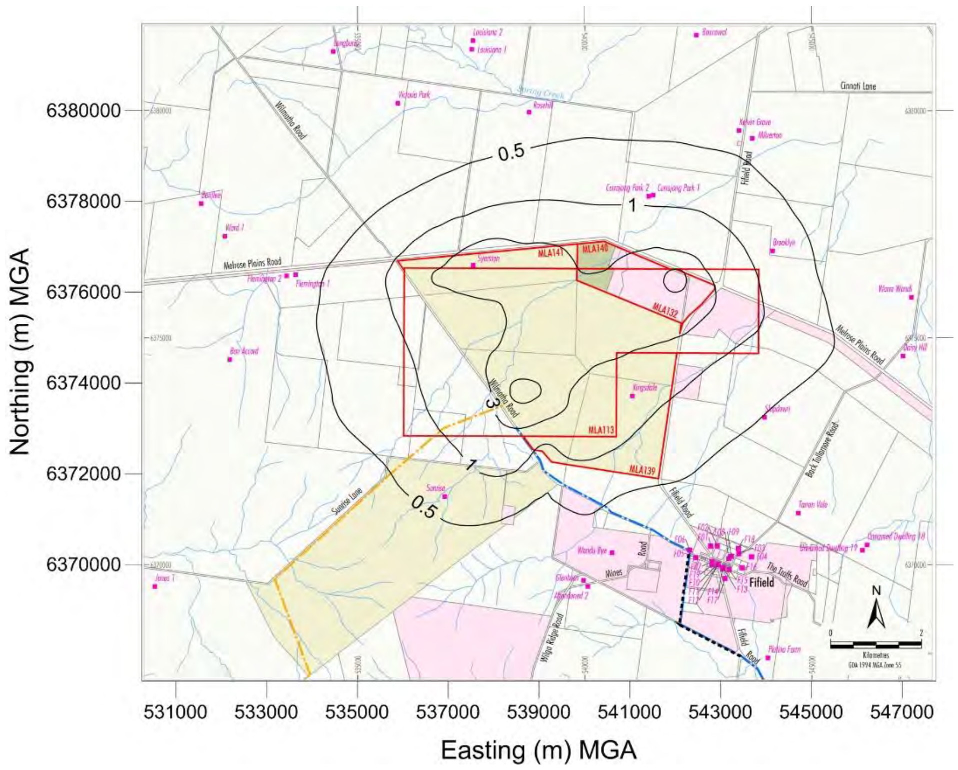
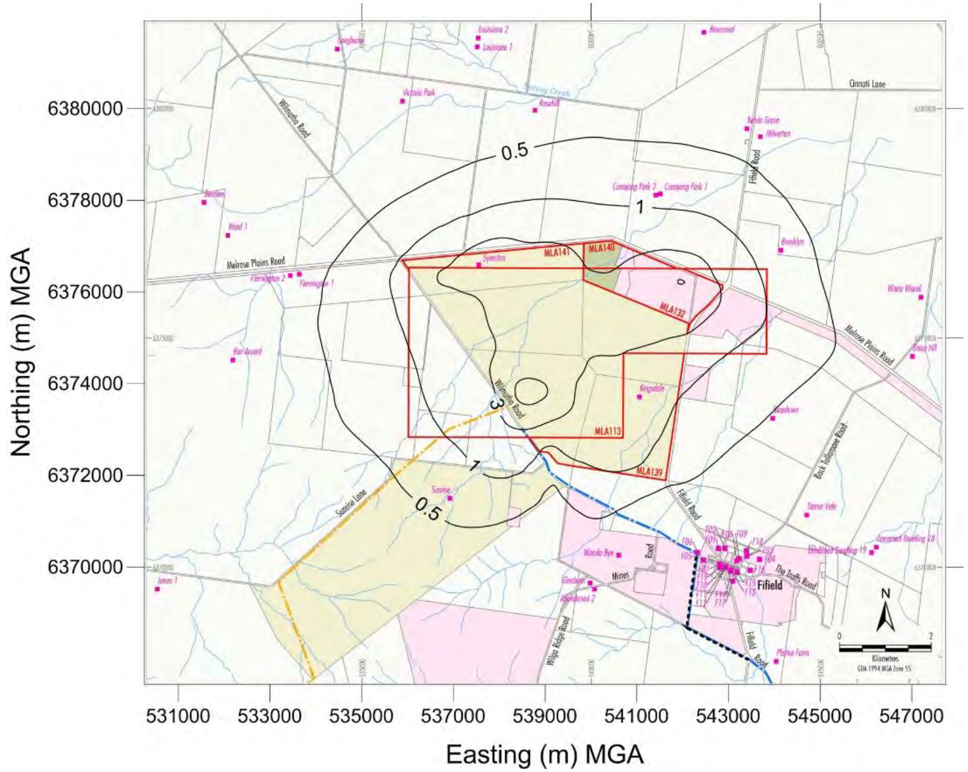


Figure A7-7: Predicted Project-only annual average $PM_{2.5}$ - Year 1 and Year 6



Year 11



Year 21

Figure A7-8: Predicted Project-only annual average $PM_{2.5}$ - Year 11 and Year 21

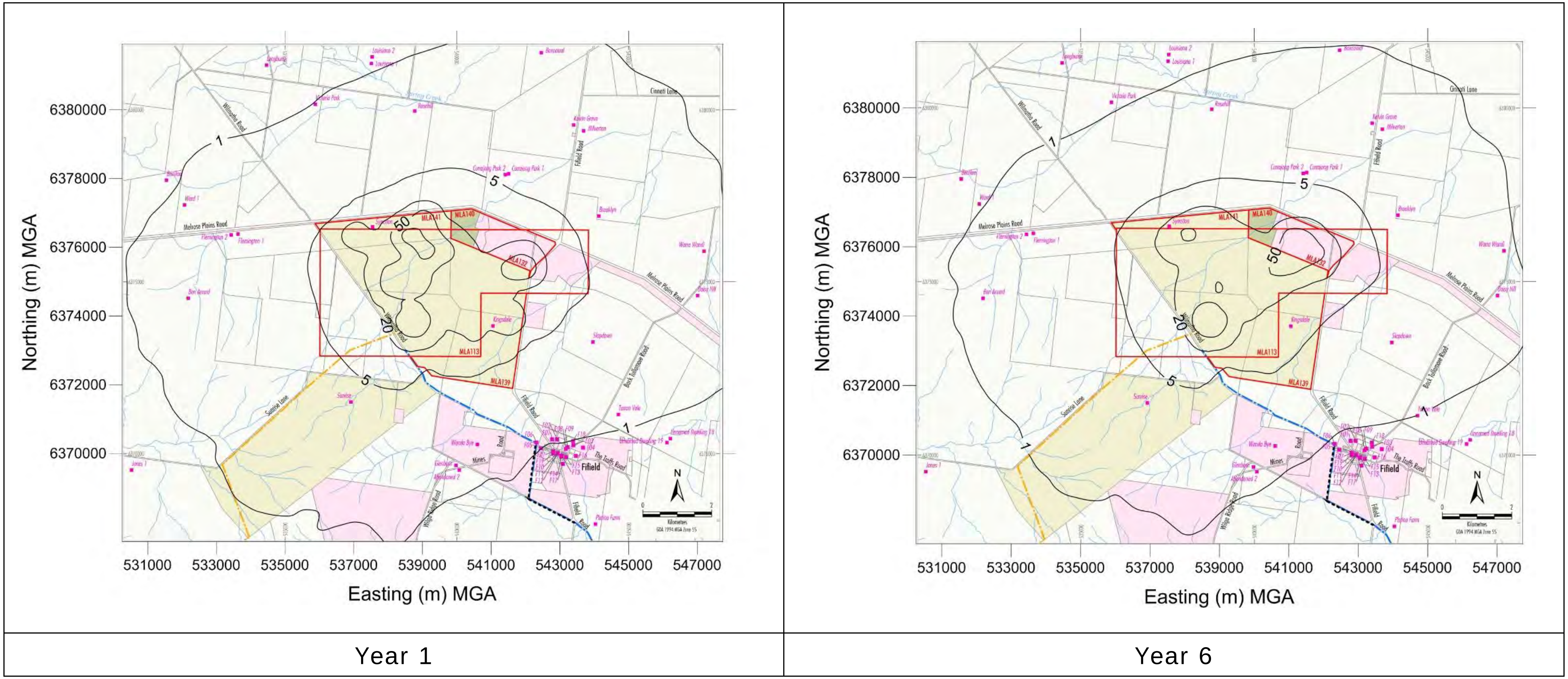
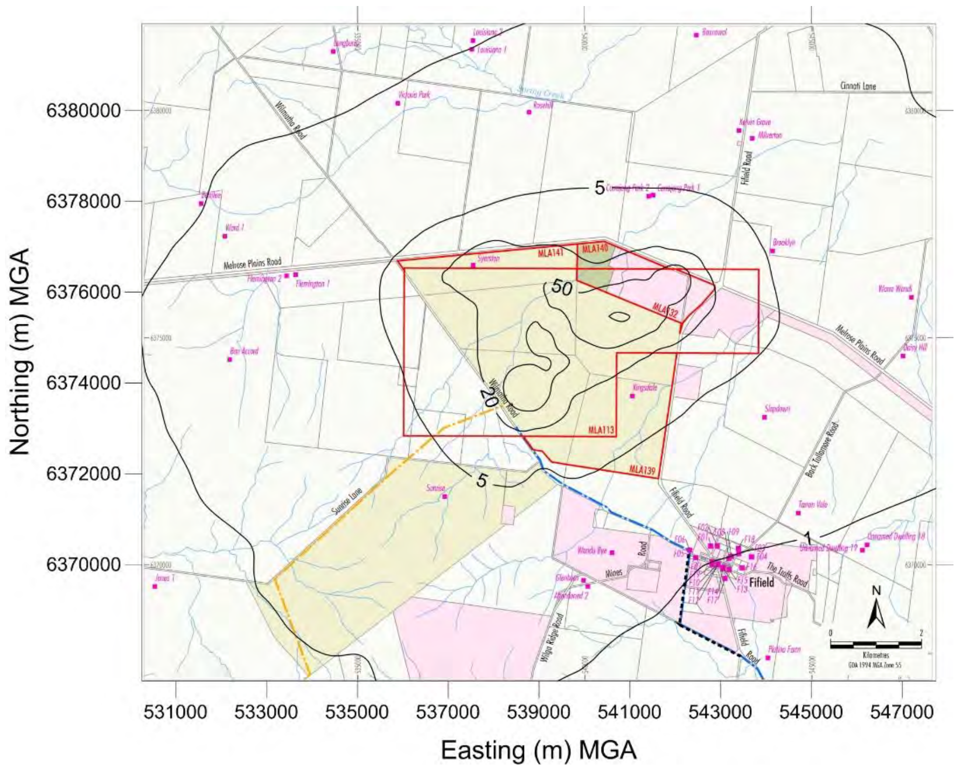
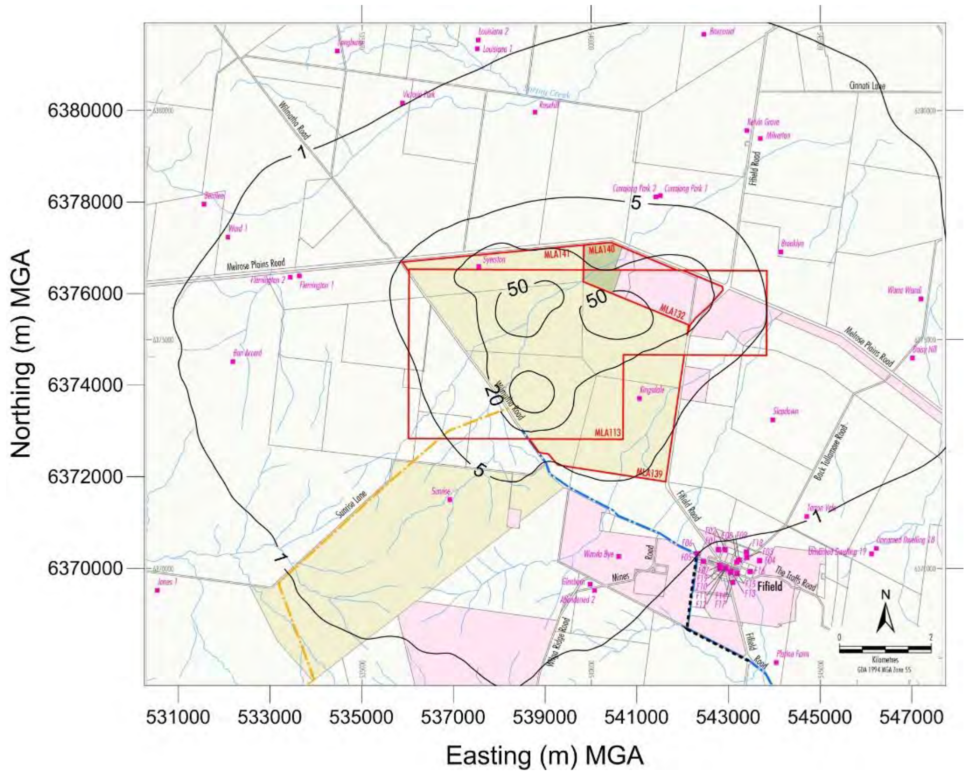


Figure A7-9: Predicted Project-only annual average TSP - Year 1 and Year 6

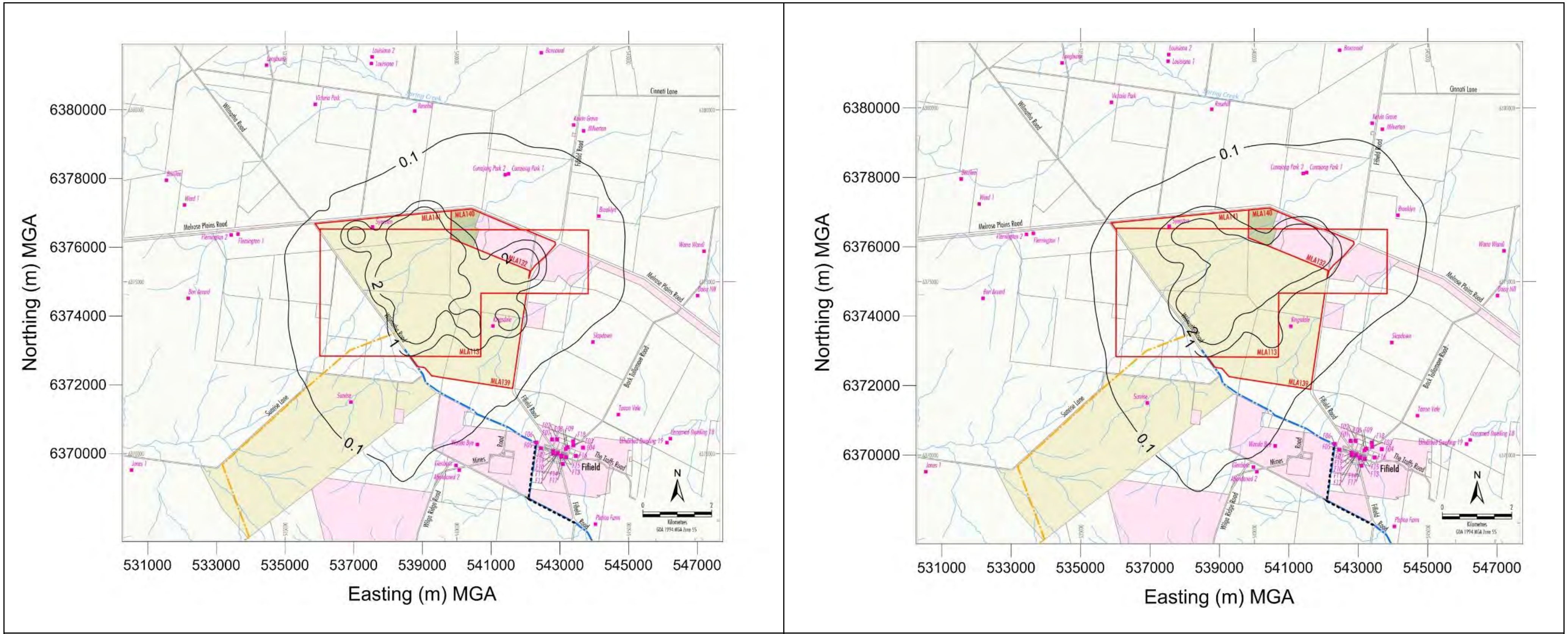


Year 11



Year 21

Figure A7-10: Predicted Project-only annual average TSP - Year 11 and Year 21



Year 1	Year 6

Figure A7-11: Predicted Project-only annual average dust deposition - Year 1 and Year 6

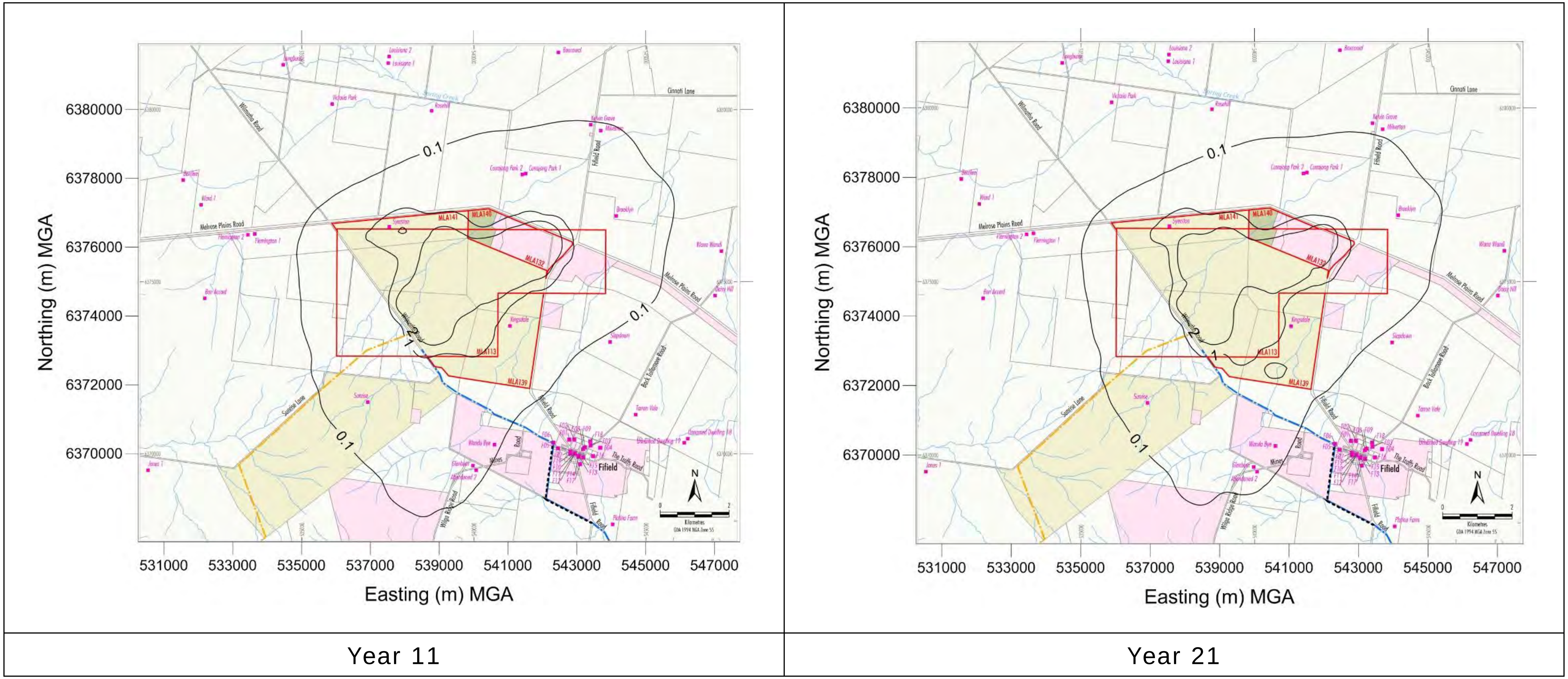


Figure A7-12: Predicted Project-only annual average dust deposition - Year 11 and Year 21