# VICKERY EXTENSION PROJECT

## ENVIRONMENTAL IMPACT STATEMENT

# APPENDIX E

## AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

WHITEHAVEN COAL

Intended for
**Whitehaven Coal Limited**

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# VICKERY EXTENSION PROJECT
# AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

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# 1. INTRODUCTION

The former Vickery Coal Mine and the former Canyon Coal Mine are located approximately 25 kilometres (km) north of Gunnedah, in New South Wales (NSW) (**Figure 1-1**). Open cut and underground mining activities were conducted at the former Vickery Coal Mine between 1986 and 1998. Open cut mining activities at the former Canyon Coal Mine ceased in 2009. The former Vickery and Canyon Coal Mines have been rehabilitated following closure.

The approved Vickery Coal Project (herein referred to as the Approved Mine) is an approved, but yet to be constructed, project involving the development of an open cut coal mine and associated infrastructure, and would facilitate a run-of-mine (ROM) coal production rate of up to approximately 4.5 million tonnes per annum (Mtpa) for a period of 30 years.

Whitehaven Coal Limited (Whitehaven) is seeking a new Development Consent for extension of open cut mining operations at the Approved Mine (herein referred to as the Vickery Extension Project [the Project]). This would include a physical extension to the Approved Mine footprint to gain access to additional ROM coal reserves, an increase in the footprint of waste rock emplacement areas, an increase in the approved ROM coal mining rate, construction and operation of the Project Coal Handling and Preparation Plant (CHPP), train load-out facility and rail spur. This infrastructure would be used for the handling, processing and transport of coal from the Project, as well as other Whitehaven mining operations.

This Air Quality and Greenhouse Gas Assessment forms part of an Environmental Impact Statement (EIS), which has been prepared to accompany a Development Application made for the Project in accordance with Part 4 of the *NSW Environmental Planning and Assessment Act, 1979*.

## 1.1 Study objectives and requirements

**Table 1-1** provides a summary of the Secretary's Environmental Assessment Requirements (SEARs) for air quality and where the requirement has been addressed in this report. Specific comments from the NSW Environment Protection Authority (EPA), Narrabri Shire Council and Gunnedah Shire Council are summarised in **Table 1-2**.

**Table 1-1: Summary of SEARs for air quality**

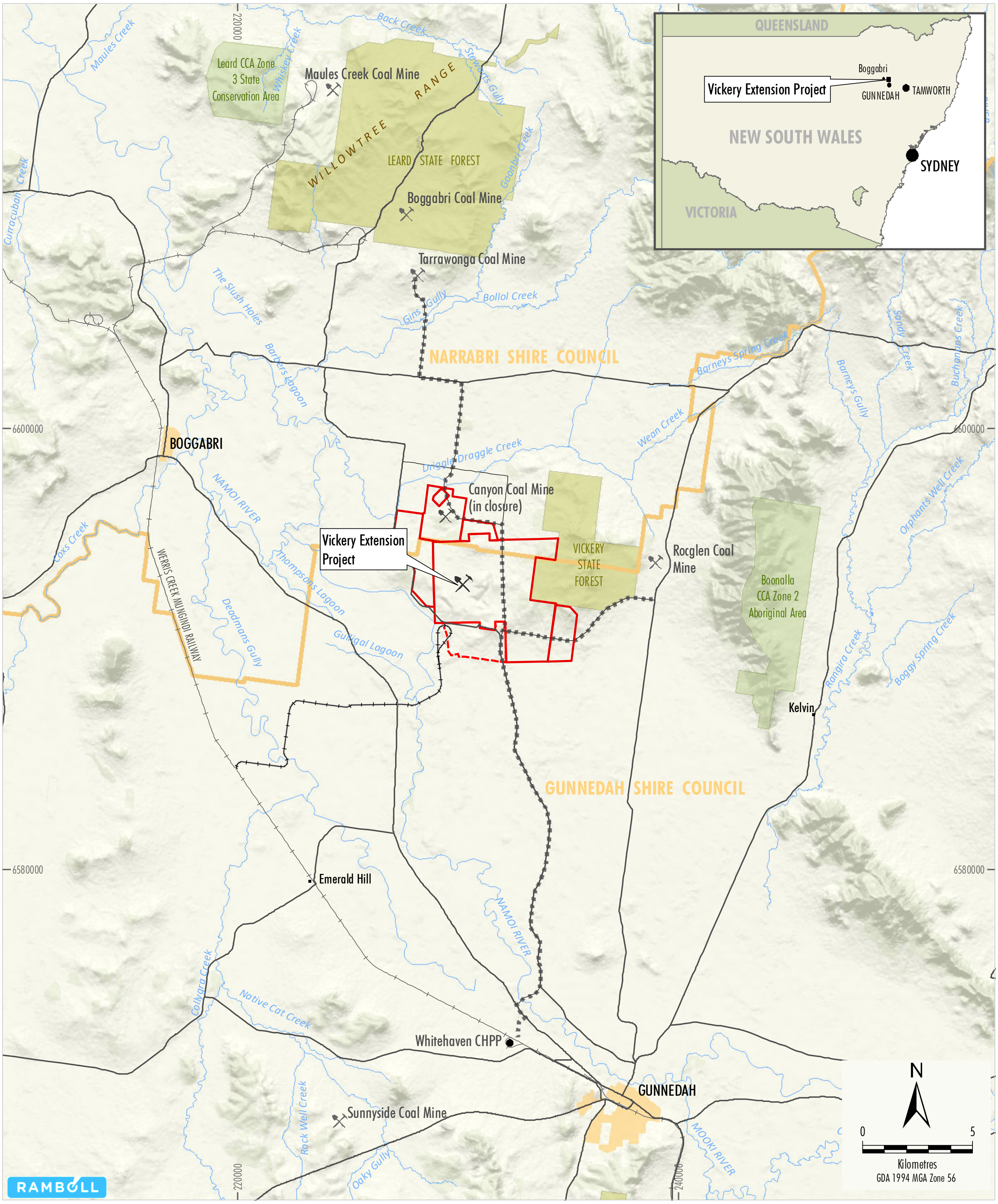
| Requirement | How requirement is addressed |
|---|---|
| Air, including:<br>• an assessment of the likely air quality impacts of the development in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*, having regard to EPA's requirements (see Attachment 2); and | Report prepared in accordance with the Approved Methods (refer **Section** 3). |
| • an assessment of the likely greenhouse gas impacts of the development; | Covered in **Section** 9. |

**Table 1-2: Summary of Agency comments for air quality**

| Requirement | How comment is addressed |
|---|---|
| **NSW EPA** | |
| Assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates to environmental harm, risk to human health and amenity. | Risk of the Project is assessed for all key pollutants. |
| Justify the level of assessment undertaken on the basis of risk factors, including but not limited to:<br>• proposal location;<br>• characteristics of the receiving environment; and<br>• type and quantity of pollutants emitted | Quantitative Level 2 air quality assessment is prepared in accordance with the Approved Methods. |
| Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to:<br>• meteorology and climate;<br>• topography;<br>• surrounding land-use;<br>• receptors<br>• ambient air quality. | Described in **Sections 4** and **5**. |
| Include a detailed description of the proposal. All processes that could result in air emissions must be identified and described in sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. | Detailed emission inventory described in **Section** 6. |
| Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits. Justification for the 'worst case' must also be included. | Worst case emission scenarios selected based on maximum production, exposed areas and distance to receptor locations. |
| Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment. This includes adjoining mining operations and general ambient rural dust levels. | Detailed cumulative assessment considered (refer to **Section 3.4** for description). |
| Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is sufficient uncertainty to warrant a rigorous numerical impact assessment. Air dispersion modelling must be conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005)[1].<br>http://www.epa.nsw.gov.au/resources/air/ammodelling05361.pdf | Quantitative Level 2 air quality assessment is prepared in accordance with the Approved Methods. |
| Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997)* and the *POEO (Clean Air) Regulation (2002)*. Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour". | Addressed in **Section 3.7** |
| Detail emission control techniques/practices that will be employed by the proposal. | Controls described in **Section** 6. |

| Requirement | How comment is addressed |
|---|---|
| Include an assessment of the air impacts from the movements of coal in uncovered wagons by rail. | Assessment considered in **Section** 8. |
| **Narrabri Shire Council** | |
| • Likely and potential impacts of the Project on neighbouring properties and the wider local government area as a result of the impact of dust from mining and related activities.<br>• Narrabri Shire Council requests that Whitehaven Coal implements appropriate dust mitigation procedures and provides continual local and regional dust monitoring and reporting. | Quantitative Level 2 air quality assessment is prepared in accordance with the Approved Methods, including detailed cumulative assessment.<br>Proposed monitoring described in **Section 10**. |
| **Gunnedah Shire Council** | |
| The impacts of the proposed development should address:<br>• Air Quality Monitoring and involvement in the Regional Quality Monitoring Network [sic]<br>• Cumulative Impacts | Proposed monitoring described in **Section 10**.<br>Detailed cumulative assessment considered (refer to **Section 3.4** for description). |

Note: [1] A 2016 update to the 'Approved Methods' was gazetted on 20 January 2017 and replaces the document dated August 2005.




LEGEND

- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Local Government Boundary
- State Forest
- State Conservation Area, Aboriginal Area
- Major Roads
- Railway
- Approved Road Transport Route
- Indicative Project Rail Spur

*Source: LPMA - Topographic Base (2010); NSW Department of Industry (2015)*

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

**Regional Location**

**Figure 1-1**

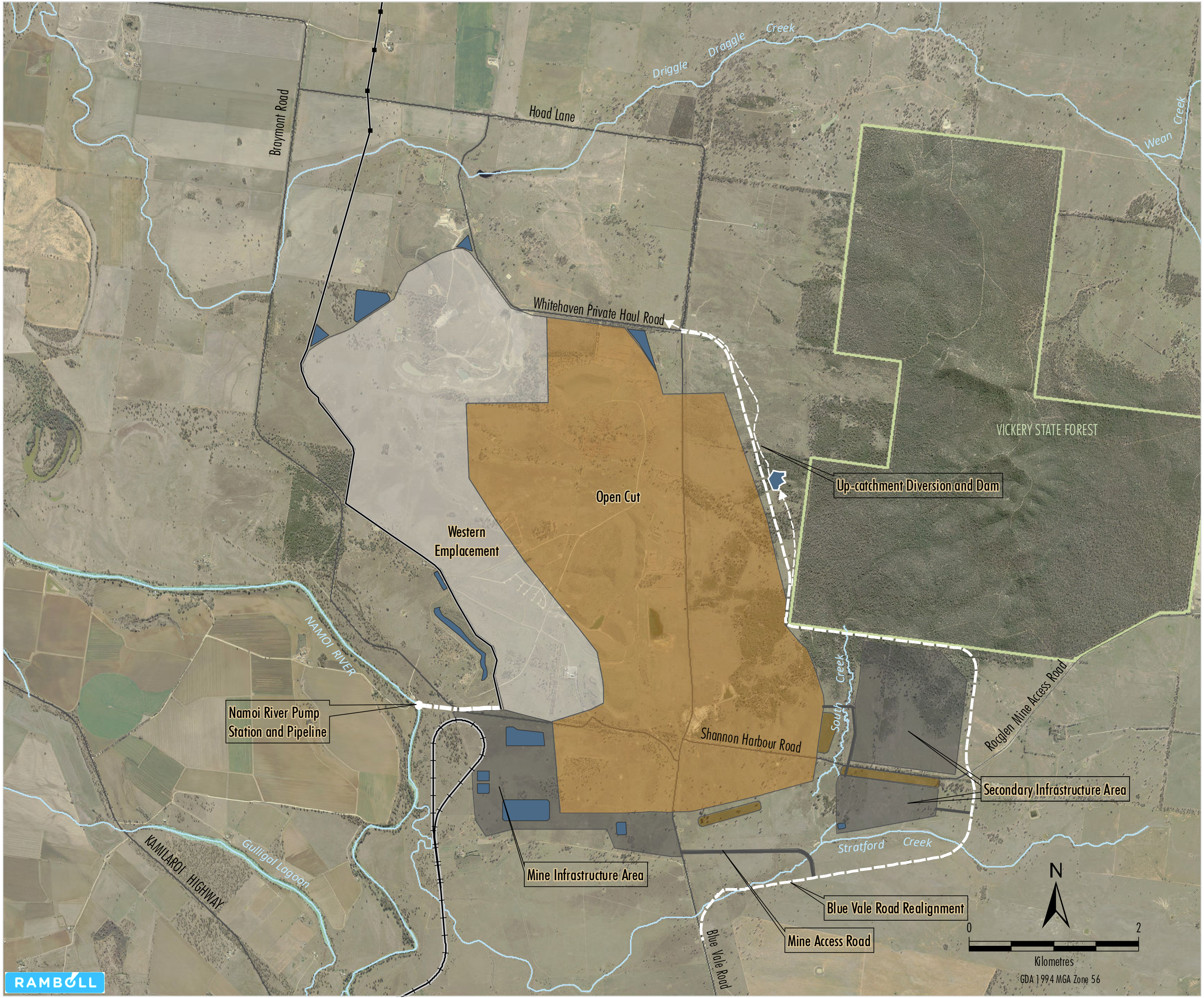
# 2. PROJECT OVERVIEW

The Project involves mining the coal reserves associated with the Approved Mine, as well as accessing additional coal reserves within the Project area. ROM coal would be mined by open cut methods at an average rate of 7.2 Mtpa over 25 years, with peak production of up to approximately 10 Mtpa.

As described in **Section 1**, the Project would include a physical extension to the Approved Mine footprint to gain access to additional ROM coal reserves, an increase in the footprint of waste rock emplacement areas, an increase in the approved ROM coal mining rate and construction and operation of the Project CHPP, train load-out facility and rail spur (**Figures 2-1** and **2-2**).

This infrastructure would be used for the handling, processing and transport of coal from the Project, as well as other Whitehaven mines.

**Figures 2-1** and **2-2** illustrate the general arrangement of the Project. A detailed description of the Project is provided in Section 2 in the Main Report of the EIS.




LEGEND

State Forest

Project Components

- Indicative Extent of Open Cut
- Indicative Extent of Out of Pit Waste Rock Emplacement
- Indicative Extent of Infrastructure Area
- Indicative Extent of Soil Stockpile
- Indicative Extent of Water Storage
- Indicative Mine Access Road Alignment
- Indicative Namoi River Pump Station and Pipeline
- Indicative Road Realignment
- Indicative Up-catchment Diversion and Dam Location
- Indicative Rail Spur Alignment
- Indicative Location of Groundwater Bores and Pipeline

*Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015); Essential Energy (2015)*

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

**Project General Arrangement - Project Mining Area**

**Figure 2-1**

RAMBOLL

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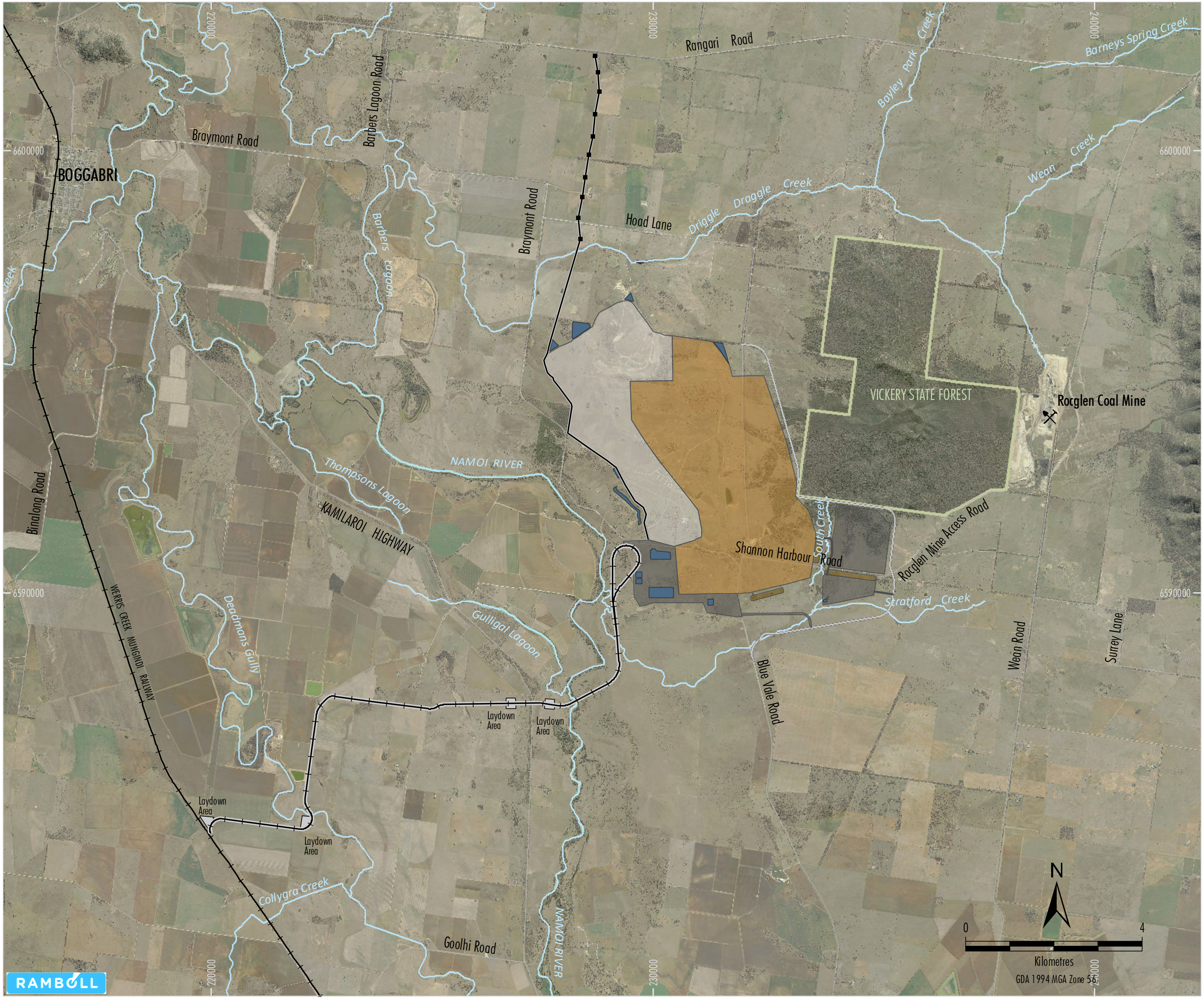


LEGEND

- State Forest
- Railway

Project Components

- Indicative Extent of Open Cut
- Indicative Extent of Out of Pit Waste Rock Emplacement
- Indicative Extent of Infrastructure Area
- Indicative Extent of Soil Stockpile
- Indicative Extent of Water Storage
- Indicative Mine Access Road Alignment
- Indicative Rail Spur Alignment
- Indicative Location of Groundwater Bores and Pipeline
- Indicative Road Realignment

*Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015)*

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

**Indicative Rail Spur Alignment**

**Figure 2-2**

RAMBOLL

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## 2.1 Production schedule

An indicative production schedule has been provided for the Project. The projected ROM coal (Mt[1]), waste rock (Mbcm[2]) and product coal (Mt) over the life of the Project is shown in **Table** 2-1.

The mine years chosen for assessment are highlighted in bold. The assessment also includes the handling, processing and transport of coal from other Whitehaven mines and the total product coal to rail column includes the coal from other Whitehaven mines, for the years when these mines would be operational.

**Table 2-1: Indicative production schedule**

| Project year | Waste (Mbcm) | Open Cut ROM Coal (Mt) | Total Product Coal (Mt) | Total Product Coal to Rail (Mtpa) – Vickery and other Whitehaven Mines |
|---|---|---|---|---|
| 2 | 12.2 | 1.0 | 0.9 | 3.1 |
| **3** | **34.0** | **2.7** | **2.4** | **5.7** |
| 4 | 54.0 | 4.3 | 3.9 | 6.9 |
| 5 | 74.0 | 5.5 | 4.9 | 7.6 |
| 6 | 89.0 | 7.2 | 6.5 | 9.2 |
| **7** | **89.0** | **8.4** | **7.6** | **10.2** |
| 8 | 89.0 | 8.5 | 7.6 | 10.3 |
| 9 | 89.0 | 9.8 | 8.9 | 11.5 |
| 10 | 89.0 | 9.3 | 8.4 | 11.1 |
| 11 | 89.0 | 8.8 | 7.9 | 10.6 |
| 12 | 91.9 | 8.6 | 7.6 | 10.3 |
| 13 | 95.0 | 8.6 | 7.5 | 7.5 |
| 14 | 95.0 | 8.3 | 7.4 | 7.4 |
| 15 | 95.0 | 9.1 | 8.1 | 8.1 |
| 16 | 95.0 | 9.9 | 8.9 | 8.9 |
| 17 | 95.0 | 9.6 | 8.5 | 8.5 |
| 18 | 95.0 | 9.7 | 8.6 | 8.6 |
| 19 | 95.0 | 9.5 | 8.5 | 8.5 |
| 20 | 90.0 | 8.9 | 7.8 | 7.8 |
| **21** | **95.0** | **9.9** | **8.8** | **8.8** |
| 22 | 70.0 | 7.8 | 6.9 | 6.9 |
| 23 | 55.0 | 6.5 | 5.6 | 5.6 |
| 24 | 35.0 | 4.0 | 3.4 | 3.4 |
| 25 | 15.0 | 2.1 | 1.9 | 1.9 |
| 26 | 5.4 | 1.1 | 0.9 | 0.9 |

[1] Mt = Million tonnes.

[2] Mbcm = Million bank cubic metres.

# 3. ASSESSMENT APPROACH

The Air Quality and Greenhouse Gas Assessment presents a quantitative assessment of potential air quality impacts, with an emphasis on emissions of particulate matter (PM), the key pollutants associated with mining operations.

The Air Quality and Greenhouse Gas Assessment has been prepared in general accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ("the Approved Methods") (NSW EPA, 2016).

## 3.1 Assessment approach

Local air quality impacts from the Project are assessed using a Level 2 assessment approach in general accordance with the Approved Methods. An overview of the approach to the assessment is as follows:

- The Project is reviewed for potential PM sources and mitigation measures are developed and reviewed by Whitehaven for confirmation of feasibility for incorporation as part of the Project.
- 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 for key pollutants from the Project, at surrounding sensitive receivers.
- Cumulative impacts are assessed, taking into account the combined effect of existing baseline air quality, other local sources of emissions, reasonably foreseeable future emissions and any indirect or induced effects.
- Estimates of the greenhouse gas emissions are presented and benchmarked against Greenhouse Gas accounts for NSW and Australia.

## 3.2 Assessment criteria

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 $PM_{2.5}$[3].

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 ground level concentrations (GLCs) are assessed against the NSW EPA's impact assessment criteria presented in **Table 3-1**.

The revised AAQ NEPM also establishes long-term goals for $PM_{2.5}$ to be achieved by 2025 (NEPC, 2015). It is noted that the purpose of the AAQ NEPM is to attain '*ambient air quality that allows for the adequate protection of human health and wellbeing*', and compliance with the AAQ NEPM is assessed through air quality monitoring data collected and reported by each state and territory. The long-term goals for $PM_{2.5}$ are therefore not applicable to the assessment of impacts of emissions sources on individual sensitive receptors, and are shown in **Table 3-1** for information only.

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[3] Particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively.

**Table 3-1: Impact assessment criteria and long term goals for PM**

| PM metric | Averaging period | Concentration (µg/m³) | Purpose of goal |
|---|---|---|---|
| TSP | Annual | 90 | Impact assessment criteria |
| $PM_{10}$ | 24 hour | 50 | |
| | Annual | 25 | |
| $PM_{2.5}$ | 24 hour | 25 | |
| | Annual | 8 | |
| | 24 hour | 20 | AAQ NEPM long-term goal for 2025 |
| | Annual | 7 | |

Note: µg/m³ = micrograms per cubic metre.

The Approved Methods specifies that the impact assessment criteria for 'criteria pollutants[4]' 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 3-2**, illustrating the maximum increase and total dust deposition rates which would be acceptable so that dust nuisance can be avoided.

**Table 3-2: Dust deposition criteria**

| Pollutant | Maximum Increase in Dust Deposition | Maximum Total Dust Deposition Level |
|---|---|---|
| Deposited dust (assessed as insoluble solids) | 2 g/m²/month | 4 g/m²/month |

Note: g/m² = grams per square metre.

### 3.2.1 Voluntary land acquisition and mitigation policy

In December 2014, the NSW Department of Planning and Environment (DP&E) released their Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (the VLAMP)[5]. 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 3-3** and voluntary acquisition rights apply when a development contributes to exceedances of the criteria set out in **Table 3-4**. 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.

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4 '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.

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

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.

**Table 3-3: 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 3-4: 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.

In November 2017 the DP&E released a draft review of the VLAMP, which included a revised annual average $PM_{10}$ criteria of 25 µg/m³ and introduced $PM_{2.5}$ criteria (8 µg/m³ annual average and 25µg/m³ 24-hour average). The criteria levels in the draft VLAMP are consistent with the impact assessment criteria in **Table 3-1**.

## 3.3 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). AERMOD is likely to be included as an approved regulatory model in the next update to the Approved Methods and has been applied and approved on a number of open cut mining operations in NSW (i.e. ENVIRON, 2012a; ENVIRON, 2015; NSW EPA (2015)[6]).

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.

One advantage of applying AERMOD for the Project is the ability to incorporate fine resolution mine plan terrain data, for each modelled mine plan, directly into the dispersion simulations. This allows, for example, sources within the open cut to be released at lower elevations, and sources at the waste rock emplacement to be released at higher elevations. This has an advantage over other models, such as CALPUFF, which incorporate terrain into the meteorological pre-processor and interpolate to the model grid resolution (effectively smoothing the mine terrain to grid resolution, typically 100 - 200 metres [m]). Further detail on model set up, in particular the process for preparation of meteorological data in the AERMET pre-processor, is provided in **Appendix 1**.

### 3.4 Cumulative impacts

Cumulative impacts are defined in the Cumulative Impacts Good Practice Guide for the Australian coal mining industry, as follows:

> *Cumulative impacts are the successive, incremental and combined impacts of one, or more activities on society, the economy and the environment. Cumulative impacts result from the aggregation and interaction of impacts on a receptor and may be the product of past, present or future activities.* (Franks et al, 2010).

Cumulative impacts are assessed by combining the contribution from the Project with the following sources:

- The existing ambient air quality environment, described based on baseline monitoring data established in the vicinity of the Project (described in **Section 5.2**).
- Other existing local sources (specifically, existing operations at the Maules Creek, Boggabri, Tarrawonga and Rocglen Coal Mines), are explicitly modelled for cumulative assessment (described in **Section 5.5**).
- Reasonably foreseeable future actions (which include the proposed future mining operations, including approved production increases).
- Indirect or induced effects (hauling of coal from Rocglen and Tarrawonga Coal Mines to the Project to represent haulage from other Whitehaven mines).

Further discussion on the approach to cumulative assessment is provided in subsequent sections and an overview of the cumulative modelling for other mines is provided in **Appendix 1**.

### 3.5 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). Gaseous combustion emissions from mining equipment would not result in significant off-site concentrations and are unlikely to compromise ambient air quality goals. Therefore with the exception of PM, combustion emissions have not been quantitatively assessed.

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6 https://majorprojects.affinitylive.com/public/c254b6926cbde2e6358bdbc1aaaca9b4/Agency%20Submission_%20EPA.pdf

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). As noted in the DP&E's commissioned peer review of the air quality assessment for the Mount Owen Continued Operations Project, the US EPA AP-42 emission factors do include diesel particulate (TAS, 2015), therefore the emissions of $PM_{10}$ and $PM_{2.5}$ presented in **Section 6.2** are assumed to include the contribution from diesel combustion in mining equipment.

However, the emissions controls applied are often only relevant to the crustal fraction of total PM, for example the 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 6.2**. Greenhouse gas emissions from diesel combustion are considered in **Section** 9.

### 3.6 Blast fume

Blast fume is the result of a less than optimal chemical reaction of ammonium nitrate explosives during the open cut blasting process, resulting in the release of nitric oxide and $NO_2$. Fume generation can be the result of water and explosives mixing in the hole (geological and/or meteorological influences), the quality of explosive product supplied, and contamination of the explosive product during loading and/or on bench. Potential adverse impacts from blast fume can be effectively managed through good practice blast management.

Whitehaven should develop a Blast Management Plan for the Project, which will include blast fume prevention measures, developed in accordance with the *Code of Good Practice: Prevention and Management of Blast Generated $NO_x$ Gases in Surface Blasting* (Code of Practice) (Australian Explosives Industry and Safety Group Inc., 2011). The Blast Management Plan should outline the monitoring requirements for blast fume, including identification and rating of visual blast fume, as per Appendices 2 and 3 of the Code of Practice.

No additional assessment of blast fume is presented in this report as blast fume would be prevented during operations with the implementation of appropriate mitigation and management measures. It is noted that PM emissions from blasting are included in the emission inventories presented in **Section** 6.

### 3.7 POEO (Clean Air) Regulation

The statutory framework for managing air emissions in NSW is provided in the *Protection of the Environment Operations Act*[7] *1997* (POEO Act) and the primary regulations for air quality made under the POEO Act (POEO regulations) are:

- *Protection of the Environment Operations (Clean Air) Regulation 2010*[8].
- *Protection of the Environment Operations (General) Regulation 2009*[9].

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) and will comply with the associated 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 **Section 6.1**, having regard to all reasonable and feasible avoidance and mitigation measures.
- Whitehaven will manage odour through an Air Quality Management Plan, with reference to blast fume management and spontaneous combustion management, and in accordance with an EPL for the Project.
- No open burning will be performed on-site.

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7 http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N

8 http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N

9 http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

# 4. LOCAL SETTING AND RECEPTOR LOCATIONS

The majority of the Project area is located within previously cleared agricultural areas and rehabilitated open cut workings from historical mining activities. Dryland cropping and grazing of cattle is conducted to the north, west and south of the Project mining area on the flatter lands near the Namoi River and its tributaries. There are also some irrigated cropping enterprises in the vicinity of the Project, to the west of the Namoi River and to the north-west of the Project.

The elevation of the south-eastern part of the Project mining area ranges from approximately 330 m Australian Height Datum (AHD) near the boundary of the Vickery State Forest, to around 270 m AHD at the southern extent of the open cut. Elevation rises within the Vickery State Forest to a maximum elevation of 479 m AHD.

The existing Rocglen Coal Mine is located to the east, between the Vickery State Forest and Kelvin State Forest. To the north are the existing mining operations of Boggabri, Tarrawonga and Maules Creek Coal Mines.

The elevated ridgeline of Mount Kaputar to the north and north-east plays an important role in regional wind patterns (refer **Section** 5).

A three-dimensional representation of regional topography is presented in **Figure 4-1**, showing the Project and other local mining operations.

The local area contains a number of rural-residential properties situated at varying distances from the Project. The locations of the privately- and mine-owned receptor locations assessed in this report are shown in **Figure 4-2** (refer to **Appendix 2** for a tabulated list of receptors).

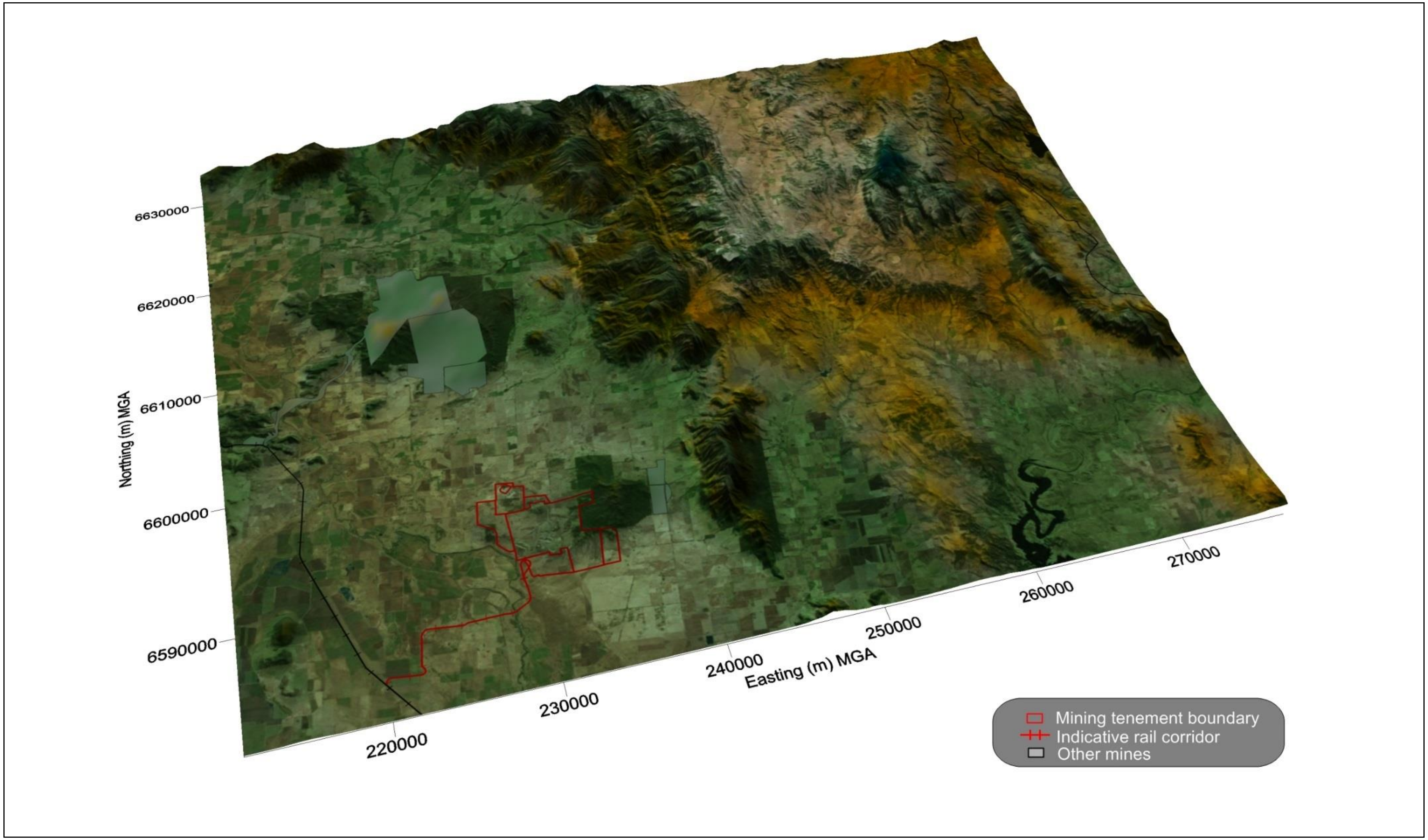



**Figure 4-1: Regional topography**

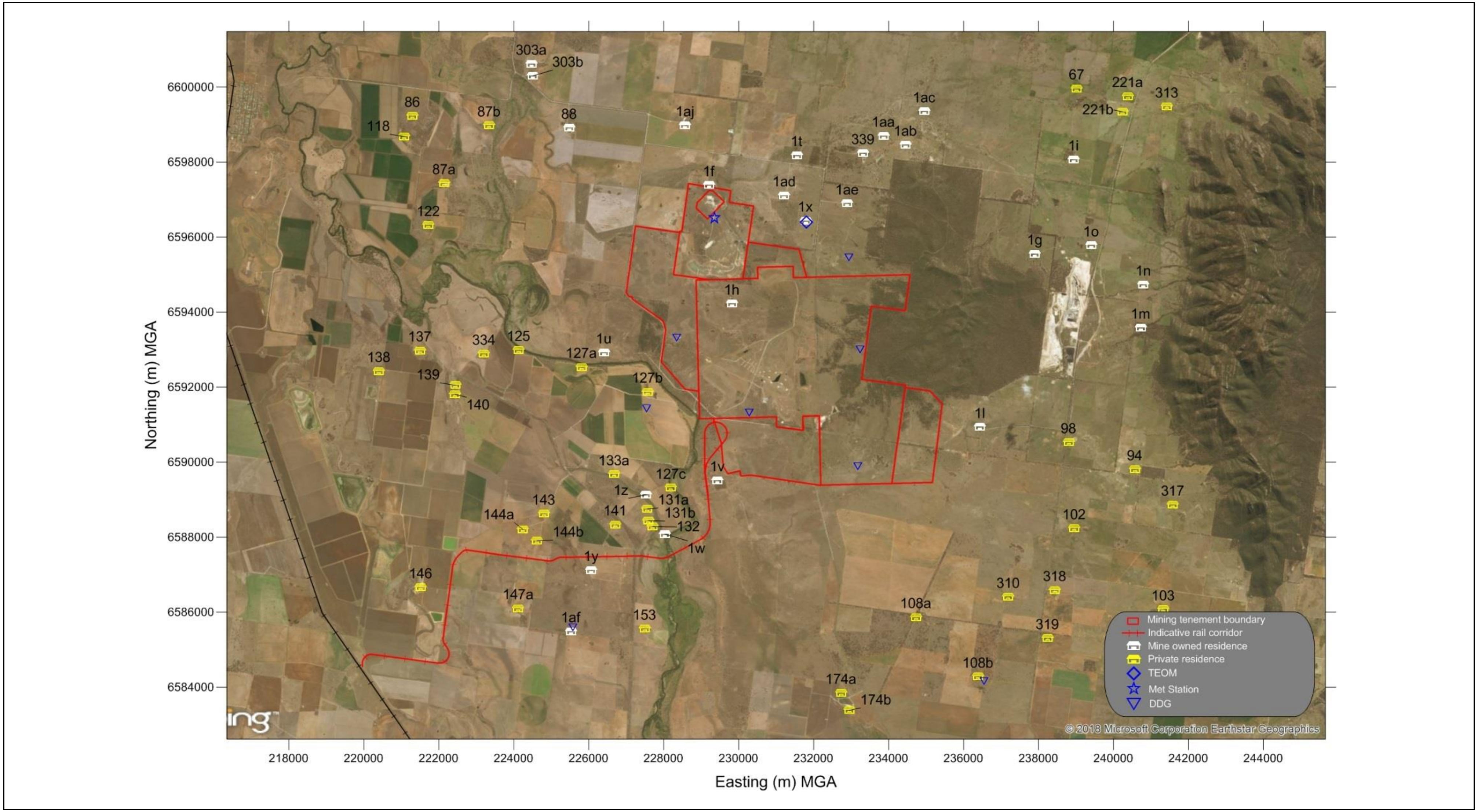



**Figure 4-2: Assessment locations surrounding the site**

# 5. EXISTING ENVIRONMENT

## 5.1 Meteorology

Whitehaven operates an on-site meteorological monitoring station at the Approved Mine that records 15 minute averages of wind speed and direction, temperature (at 2 m and 10 m), rainfall, relative humidity and solar radiation (labelled as 'Met Station' on **Figure 4-2**). A review of the previous four years of monitoring data indicates an excellent data capture rate and a high level of consistency in the measured data.

### 5.1.1 Prevailing winds

Annual wind roses for 2013 to 2016 are presented in **Figure 5-1**. There is a high degree of consistency in winds across the four years. Similar to regional wind patterns observed across the Namoi district (see **Appendix 3** for regional wind rose comparison) the wind direction is aligned along a north-west to south-east axis, with a dominant south-east component having the highest proportion of moderate wind speeds.

A consistent north-east component is also evident, with noticeably lighter wind speeds. Diurnal wind profiles in **Figure 5-2** show that this north-east component is most evident during winter, indicative of drainage flow (or katabatic winds) from the elevated ridgeline to the north and north-east which incorporates Mount Kaputar.

The wind roses show annual average wind speeds are approximately 3 metres per second (m/s) and the percentage occurrence of calm winds (<= 0.5 m/s) ranges from 3% to 4%. The high degree of consistency in winds across the four years indicates that each calendar year is suitable for modelling.

To align meteorology with cumulative modelling information for other coal mining sources to facilitate a detailed cumulative assessment with neighbouring mines, the period of January to December 2013 was selected for modelling (refer to discussion in **Section 5.5** and **Appendix 1**).

The calendar year 2013 is considered a suitable representative year based on the consistency in winds demonstrated in **Figure 5-1**.

Seasonal wind roses (shown in **Figure 5-2** and **Appendix 3**) demonstrate dominant south-east winds in summer, autumn and spring, with a west north-west component also occurring in spring. The north-east component (the drainage flow) is most prevalent in winter.

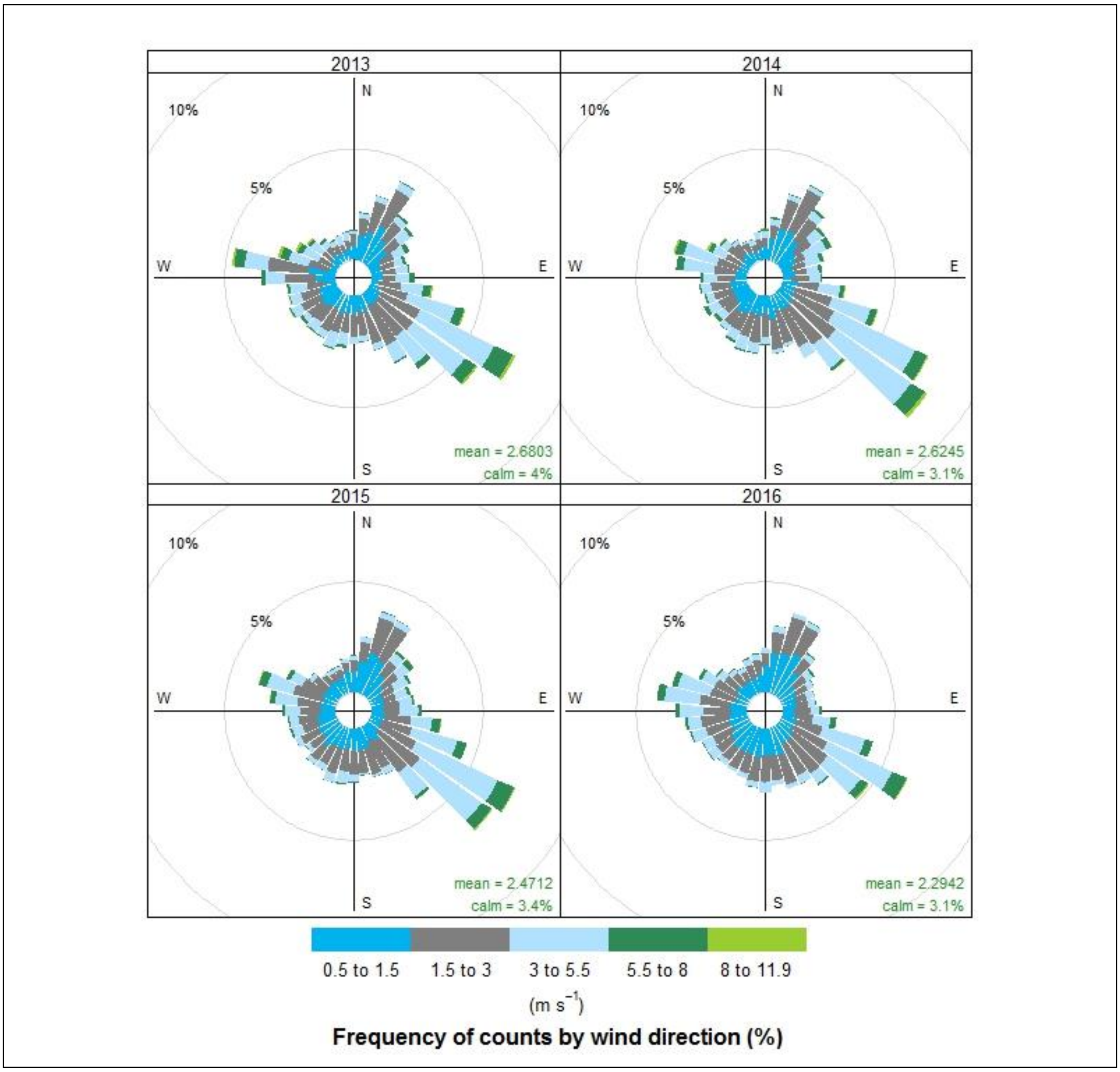



**Figure 5-1: Annual wind roses for the Project**

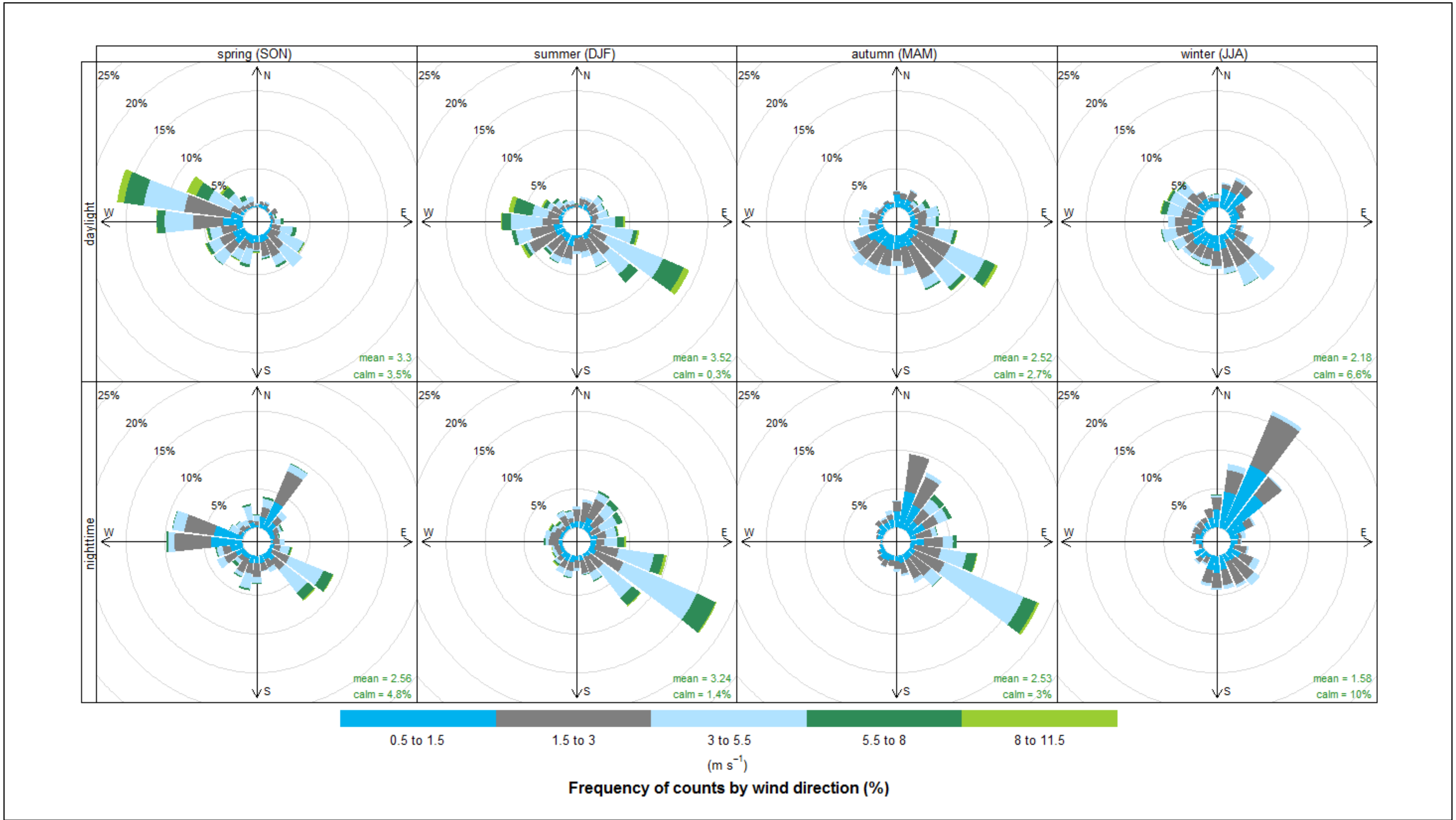
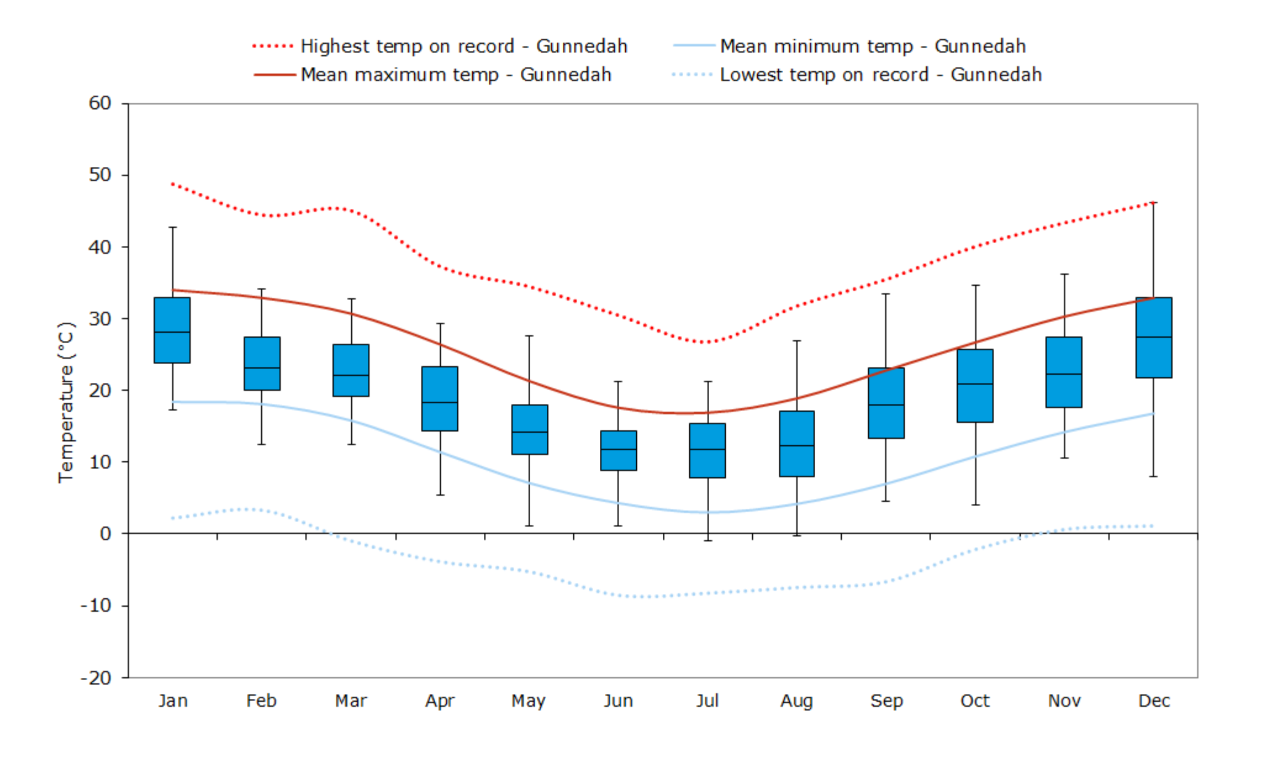



**Figure 5-2: Seasonal and diurnal wind roses for the Project**

### 5.1.2 Ambient temperature

The minimum, maximum, mean and upper and lower quartile temperatures for each month of the (2013) modelling period are presented as a box and whisker plot shown in **Figure 5-3**, and compared with long-term records at Gunnedah. The temperatures recorded during 2013 correlate well with the long-term historical trends.




2013 on-site 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 5-3: Comparison of long-term temperature records with modelling period**

### 5.1.3 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 years 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.

A comparison between long-term average monthly rainfall recorded at Gunnedah and the on-site data for the modelling period is presented in **Figure 5-4**. The on-site data for the modelling period recorded lower rainfall than the long-term average for nine months of the year.

Based on long-term records at Gunnedah, rainfall averages approximately 620 millimetres (mm) per year. During 2013, lower than average rainfall was recorded at Gunnedah (approximately 470 mm), while the on-site station recorded 508 mm. The lower than average rainfall for the modelling year does not affect the outcomes of this assessment, for the following reasons.

To provide a conservative (upper bound) estimate of the PM concentrations, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report. Sensitivity analysis completed for the Upper Hunter Particle Model (Kellaghan et al, 2014) indicates that the inclusion of wet deposition may reduce $PM_{10}$ concentrations by 20% to 50% during a period of rainfall, depending on distance from source to receptor.

The US EPA AP-42 emission factor documentation for unsealed roads (Chapter 13.2.2) describes a 'natural mitigation' factor, which can be applied for rainfall and other precipitation, based on the assumption that annual emissions are inversely proportional to the number of days with measureable rain, defined as the number of days with greater than 0.25 mm recorded. The emission inventories developed for this study have not applied this natural mitigation factor, and are therefore more conservative than if rainfall was incorporated.

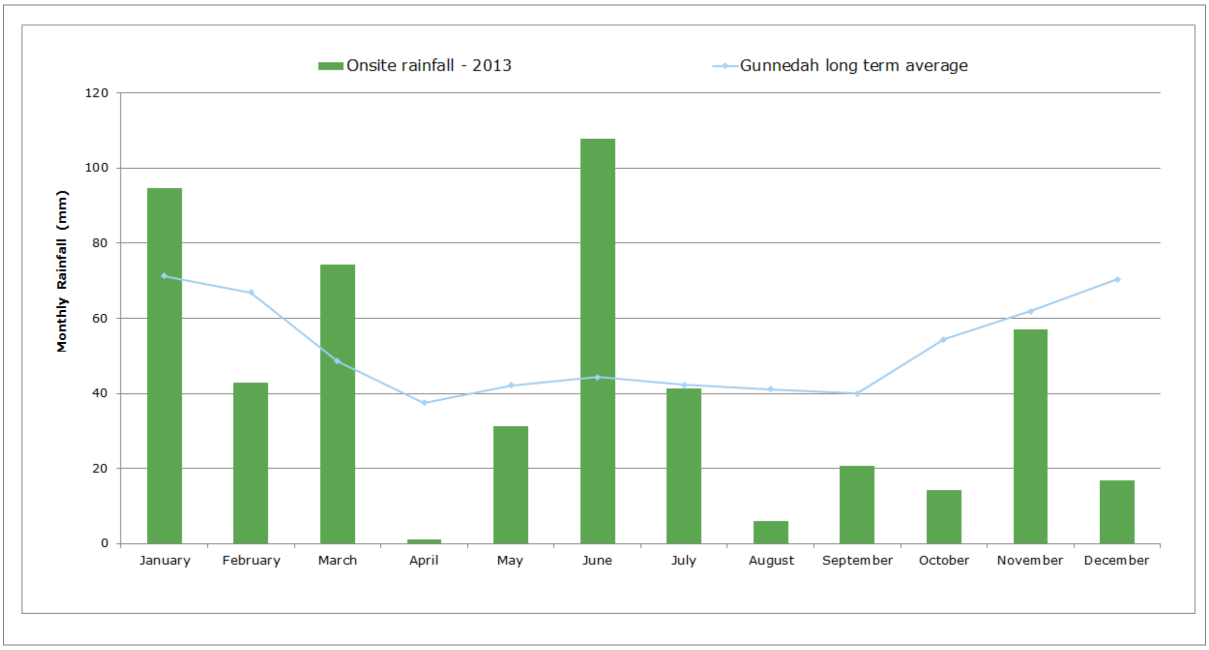



**Figure 5-4: Rainfall comparison**

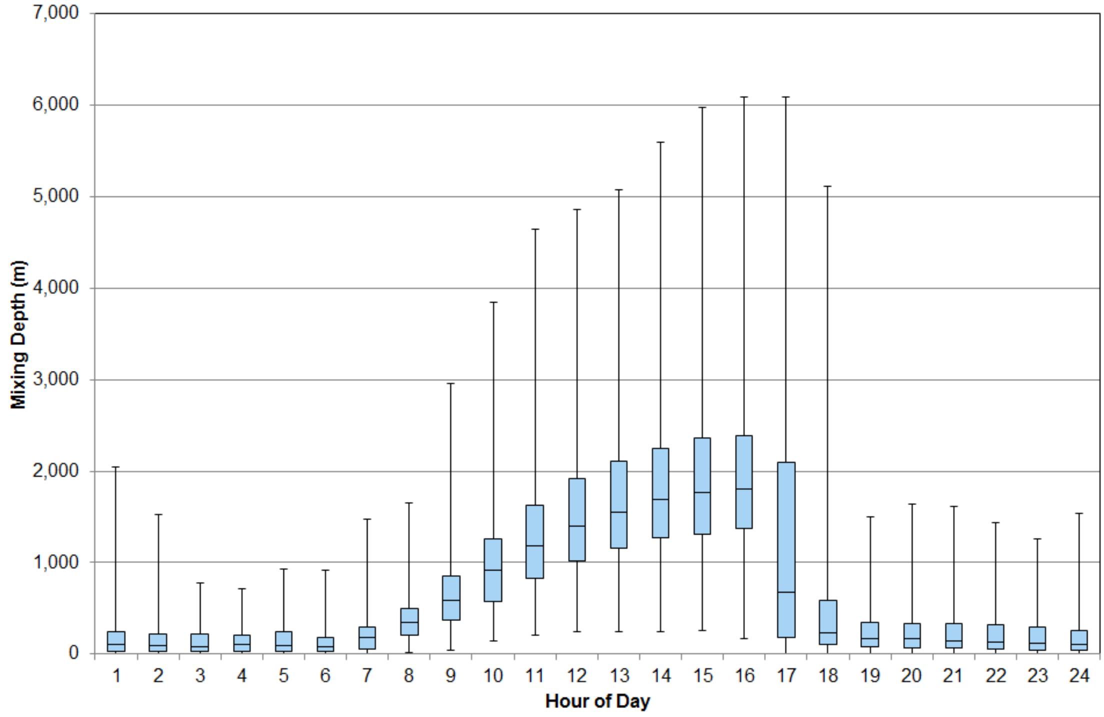
### 5.1.4 Atmospheric stability and boundary layer heights

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 on-site weather station, sunrise and sunset times and adjusted TAPM-predicted upper air temperature profile (further discussion provided in **Appendix 1**).

The variation in average boundary layer heights by hour of the day is illustrated in **Figure 5-5**. It can be seen that greater boundary layer heights are experienced during the daytime hours, peaking in the mid to late afternoon. Higher daytime wind velocities and the onset of incoming solar radiation increase 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.




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 5-5: AERMET-generated diurnal variations in average boundary layer depth**

Atmospheric stability refers to the degree of turbulence or mixing that occurs in 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 5-6** 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 daytime hours and lowest during evening through to early morning hours.

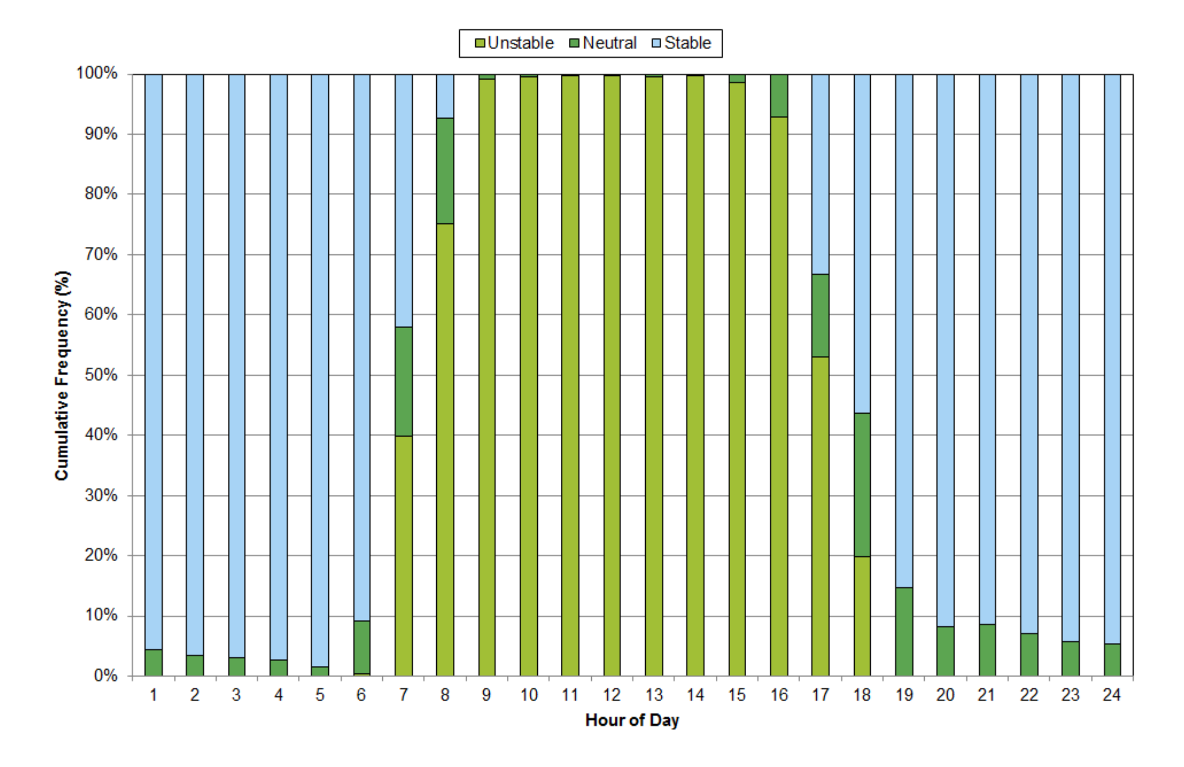



**Figure 5-6: Diurnal variations in AERMET-generated atmospheric stability**

## 5.2 Baseline ambient air quality

Whitehaven has operated a TEOM-DF[10] at the Wil-gai property since early 2012 (location shown on **Figure 4-2**). Monitoring data collected between 2012 and 2016 have been analysed and used to describe baseline concentrations of $PM_{10}$ and $PM_{2.5}$ for use in the cumulative assessment[11].

The NSW EPA has recently released the Namoi district air quality monitoring portal, providing access to industry monitoring data across the region. The data portal includes the Wil-gai TEOM, which is described by the EPA as being representative of ambient air quality conditions at the town of Boggabri and rural residences in the area. The site is therefore considered suitable to describe the baseline ambient air quality for the Project[12].

The 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations measured at Wil-gai are presented in **Figure 5-7**. With the exception of one day in late 2014, 24-hour $PM_{10}$ concentrations were below the impact assessment criteria for the entire period 2013 - 2016. There were no days when the 24-hour $PM_{2.5}$ concentration was above the impact assessment criteria. There are fewer elevated $PM_{10}$ concentrations in 2013 and 2015, compared to 2014 and 2016. Conversely, there are more elevated $PM_{2.5}$ concentrations in 2013 and 2016, compared to 2014 and 2015.

[10] TEOM = Tapered Element Oscillating Microbalance, used to measure PM. The TEOM-DF refers to a dichotomous model which measures both $PM_{10}$ and $PM_{2.5}$.

[11] In presenting TEOM monitoring data, validation has been performed on the 1-hour data. As a first step, 1-hour average data below negative 10 were removed. A single data outlier on the 7/8/2013 was also removed ($PM_{2.5}$ - 102.7 µg/m$^3$ and $PM_{10}$ - 851.9 µg/m$^3$). A 24-hour average concentration was calculated where the data recovery is greater than 75% for that day (i.e. more than 18 hourly data points). On completion of this analysis negative values remained in the 24-hour averages. The analysis was therefore repeated to remove all 1-hour data less than or equal to zero. Upon completion of this process data completeness was 91%.

[12] It is noted that the data accessible via the portal is essentially raw data (some data points are invalidated) and therefore may vary slightly to the data reported in this report.

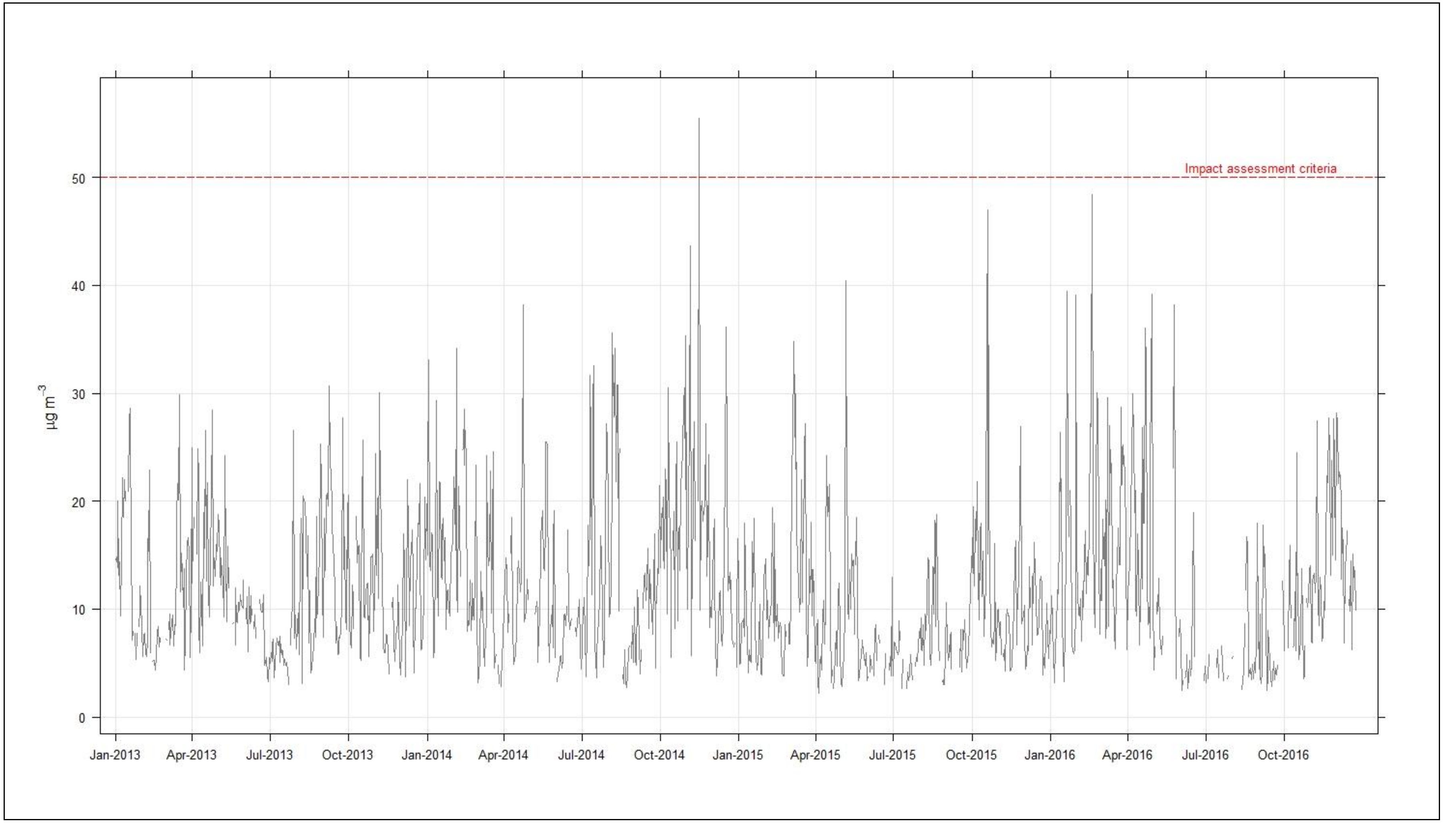



**Figure 5-7: 24-hr average $PM_{10}$ concentration - January 2013 to December 2016[13]**

[13] Gaps in the dataset are filled using a simple linear regression analysis. All available $PM_{10}$ and $PM_{2.5}$ data (i.e. from 2013 to 2016) are plotted and the linear relationship between $PM_{10}$ and $PM_{2.5}$ is derived. Where $PM_{10}$ data are missing and $PM_{2.5}$ data are available, this linear relationship is used to 'fill' the missing $PM_{10}$ data.

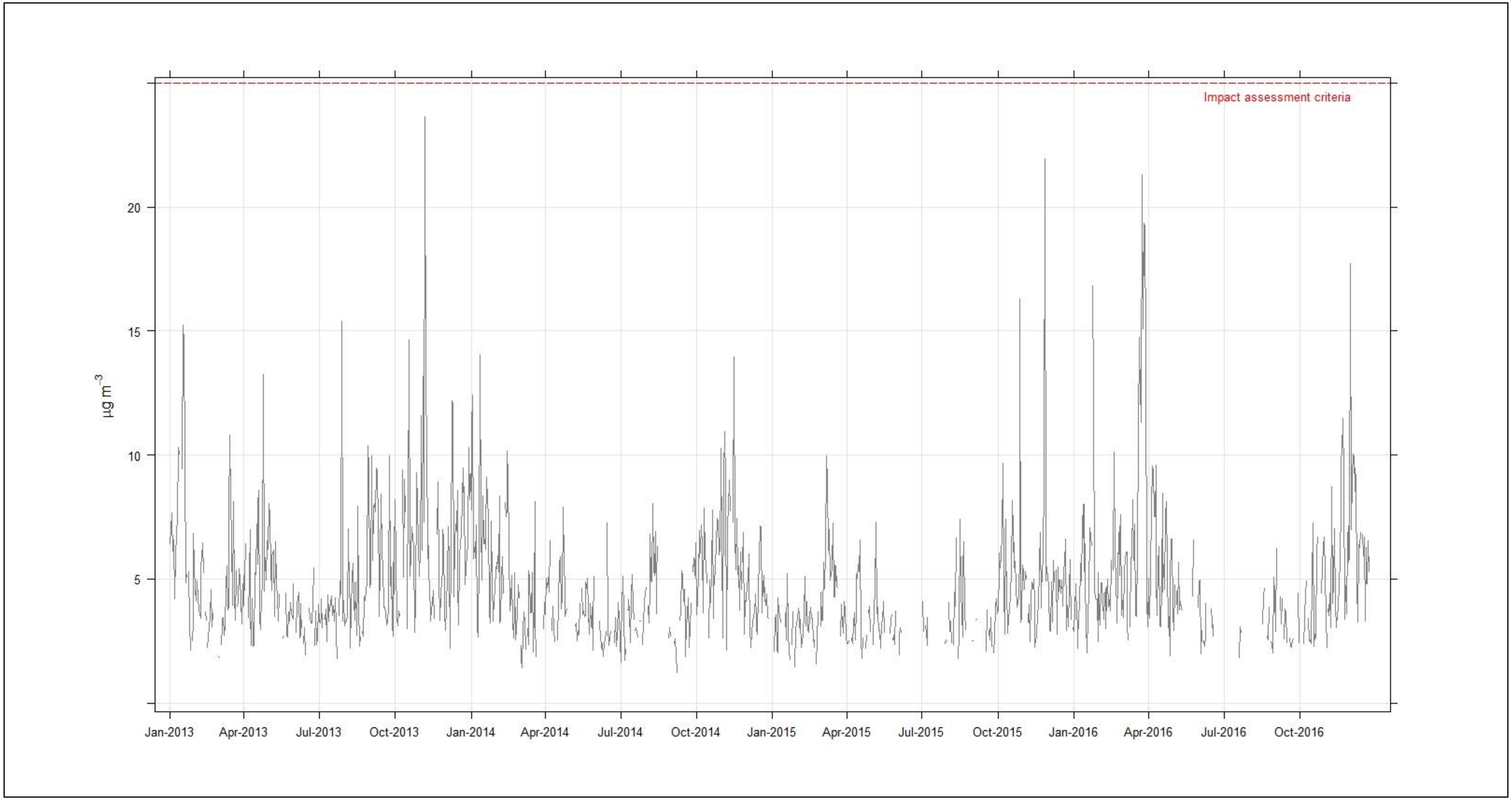



**Figure 5-8: 24-hr average $PM_{2.5}$ concentration - January 2013 to December 2016**[14]

[14] Gaps in the dataset are filled using a simple linear regression analysis. All available $PM_{10}$ and $PM_{2.5}$ data (i.e. from 2013 to 2016) are plotted and the linear relationship between $PM_{10}$ and $PM_{2.5}$ is derived. Where $PM_{2.5}$ data are missing and $PM_{10}$ data are available, this linear relationship is used to 'fill' the missing $PM_{2.5}$ data.

Annual average $PM_{10}$ and $PM_{2.5}$ concentrations for the Wil-gai TEOM are presented in **Table 5-1**. The existing baseline annual average $PM_{10}$ concentrations are approximately 50% of the impact assessment criteria, while the existing baseline annual average $PM_{2.5}$ concentrations are approximately 60% of the impact assessment criteria.

The annual average $PM_{10}$ and $PM_{2.5}$ concentrations for 2013 (the modelled year) were assessed to determine if they could be considered representative of the site. The annual average $PM_{10}$ concentration for 2013 is consistent with the average $PM_{10}$ concentration across all four years and is therefore considered appropriate to describe the background for the site. The $PM_{2.5}$ concentration for 2013 is higher than the average concentration across all four years, and consistent with the maximum concentration for the four years, and can therefore be considered a conservative background level. The annual average $PM_{10}$ and $PM_{2.5}$ concentrations for 2013 were therefore adopted as background for this assessment.

**Table 5-1: Annual average $PM_{10}$ and $PM_{2.5}$**

| Pollutant | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| $PM_{10}$ concentration (µg/m$^3$) | 12.0 | 13.8 | 9.6 | 12.5 |
| $PM_{2.5}$ concentration (µg/m$^3$) | 5.3 | 4.6 | 4.1 | 5.3 |

The sensitivity of ambient $PM_{10}$ concentrations to wet and dry years is investigated by looking at the long-term trends in $PM_{10}$ concentrations at Tamworth over a period of 14 years. **Figure 5-9** presents the trend (and 95% confidence intervals) in monthly median $PM_{10}$ concentrations, plotted using the smooth trend function in Openair (Carslaw, 2015; Carslaw and Ropkins, 2012). The plot shows a cyclical pattern in monthly $PM_{10}$ which correlates with the Southern Oscillation Index and El Niño Southern Oscillation.

For example, between 2010 and 2012, a dip in $PM_{10}$ concentrations is evident, corresponding to development of La Nina conditions and above average-rainfall in 2010 and 2011. In 2013 (the assessment year) $PM_{10}$ concentrations increased, corresponding to a period of low rainfall and the warmest year on record for NSW.

There are some years where baseline PM concentrations may be higher than 2013 and some years where baseline PM concentrations may be lower. The average $PM_{10}$ concentration across all four years of Wil-gai data is 12.0 µg/m$^3$ (i.e. equivalent to the annual average for 2013 chosen for the assessment).

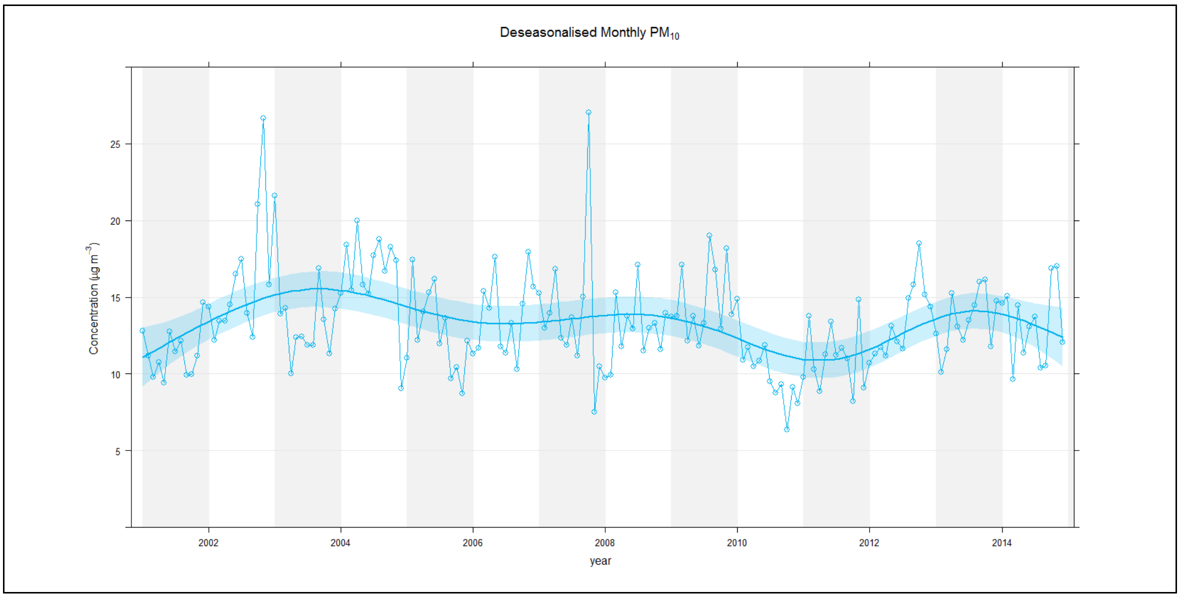



**Figure 5-9: Monthly median $PM_{10}$ concentrations for Tamworth - 2001 to 2014**

The approach to cumulative assessment, described in **Section 3.4**, includes explicit modelling of local mining operations, therefore the potential for double counting of existing mining operations was considered. Visual analysis of hourly $PM_{10}$ and $PM_{2.5}$ concentrations are plotted against wind speed and direction and presented in **Appendix 4**. When plotted against wind speed and direction, Wil-gai $PM_{10}$ and $PM_{2.5}$ concentrations in 2013 do not have a significant signal from existing mining operations. The highest mean hourly $PM_{10}$ and $PM_{2.5}$ concentrations occur when strong winds blow from the north-west, indicative of a distant source located to the north-west.

### 5.2.1 TSP concentration

TSP concentrations are not measured in the vicinity of the Project, however annual average TSP concentrations can be derived based on typical ratios of $PM_{10}$/TSP. A $PM_{10}$/TSP ratio of 0.5 has been applied, consistent with the ratio applied for other Whitehaven mines in the region. This ratio has been applied to the annual average $PM_{10}$ concentrations to derive a representative TSP background concentration ranging from 19.2 µg/m³ to 27.7 µg/m³.

### 5.2.2 Dust deposition

Whitehaven have been collecting dust deposition monitoring data in the vicinity of the Project since late 2011 (locations shown on **Figure 4-2**). Annual average dust deposition levels are presented in **Table 5-2**. The annual average dust deposition levels across the monitoring network range from 2.0 to 3.7 g/m²/month. The average across all sites and years is 2.8 g/m²/month, which is generally consistent with levels recorded in rural areas of NSW.

**Table 5-2: Annual average dust deposition**

| Site | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| DDG1 | 1.0 | 0.9 | 1.8 | 2.5 | 2.3 |
| DDG2 | 9.7 | 7.0 | 17.5 | 8.2 | 1.2 |
| DDG3 | 1.7 | 1.7 | 1.8 | 1.2 | 0.8 |
| V1 | 1.2 | 1.2 | 2.9 | 2.8 | 4.0 |
| V2 | 0.6 | 0.8 | 1.2 | 1.0 | 0.6 |
| V3 | 3.4 | 2.5 | 1.8 | 8.6 | 4.0 |
| V4 | 1.7 | 2.1 | 0.9 | 4.3 | 2.1 |
| V5 | 0.7 | 0.9 | 1.7 | 1.4 | 0.8 |
| **Average** | **2.5** | **2.1** | **3.7** | **3.7** | **2.0** |

### 5.2.3 Adopted background for cumulative assessment

The following background values are adopted for cumulative assessment:

- 24-hour $PM_{10}$ concentration – daily varying.
- Annual average $PM_{10}$ concentration – 12 µg/m³.
- 24-hour $PM_{2.5}$ concentration – daily varying.
- Annual average $PM_{2.5}$ concentration – 5.3 µg/m³.
- Annual average TSP concentration – 23.9 µg/m³.
- Annual average dust deposition – 2.8 g/m²/month.

# 6. EMISSION INVENTORY

Emissions inventories have been developed for three representative years of mining operations, selected to assess the air quality impacts of worst-case operations, for example where material movement is high and where extraction or wind erosion areas are largest, or where operations are located closest to receivers (refer to **Table 2-1** for the indicative Project production schedule, and **Appendix 1** for the progression of the mine throughout the Project).

The operational scenarios of the Project assessed for air quality are:

- Year 3 – representative of initial development of the open cut in the eastern area of the mining lease plus processing of coal from other Whitehaven mines at maximum approved production.
- Year 7 – representative of continued development of the open cut in the eastern area of the mining lease plus processing of coal from other Whitehaven mines at maximum approved production; and
- Year 21 – representative of ongoing operations in the southern extremity of the pit, with maximum overburden and ROM coal production.

The three operational scenarios were selected in consideration of maximum potential dust emissions, based on highest ROM production rate, highest waste rock extraction rate, maximum active disturbance areas and proximity of disturbed areas to resident locations, such that the potential impacts at the nearest privately-owned receivers are assessed over the life of the Project.

Consistent with the Approved Methods, emission factors developed by the US EPA[15], have been applied to estimate the amount of dust produced by each activity (soil stripping, waste rock [overburden] removal, coal removal and processing, wind erosion and hauling).

## 6.1 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). Following on from the Benchmarking Study, the EPA developed a series of PRPs for coal mines, referred to as the "Dust Stop" PRPs and issued guidelines for BMP determinations for operating coal mines. Each operating coal mine in NSW had to identify the top four mining activities that contribute to the emissions of TSP, $PM_{10}$ and $PM_{2.5}$. For each of the top four activities, a BMP determination was required, taking into account the practicability of implementation, costs, regulatory requirements, environmental impacts, safety implications and compatibility with operations.

The top four contributors to annual emissions of $PM_{10}$ and $PM_{2.5}$ for the Project are presented in **Figure 6-1** and **Figure 6-2**[16]. The top four contributors to annual emissions are, in order: hauling, wind erosion (WE) of exposed areas, overburden (OB) handling and coal handling.

An overview of the BMP determination for the Project and the emission reductions applied, is presented in **Table 6-1**. Control measures are applied to the most significant emissions sources for the Project, consistent with best practice emissions controls (Katestone, 2011).

Other control measures, while not explicitly applied as a reduction factor, are accounted for in the emission inventory on the basis of the mine plan, including:

- Direct placement of overburden where possible, reducing the double handling of material, potential for wind erosion and haulage distances.
- Site-wide vehicle speed limits.

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

[16] The analysis is presented for Year 7 emissions only, noting that the relative source contribution do not change significantly across each year based on the emission estimates.

- Progressive rehabilitation of disturbed areas.
- Minimising the double handling of material, wherever practicable (i.e. direct dump to ROM hopper).
- Avoiding disturbance, or temporary rehabilitation of long-term soil stockpiles and waste rock emplacements.
- Proactive, reactive or corrective measures where watering is not sufficient (for example, as determined through monitoring and/or visual inspection), certain activities may be ceased or relocated to more sheltered areas.

Whitehaven reserves the right to achieve best management practice through alternative methods so as to allow for technological advances and economic comparative analysis of options.

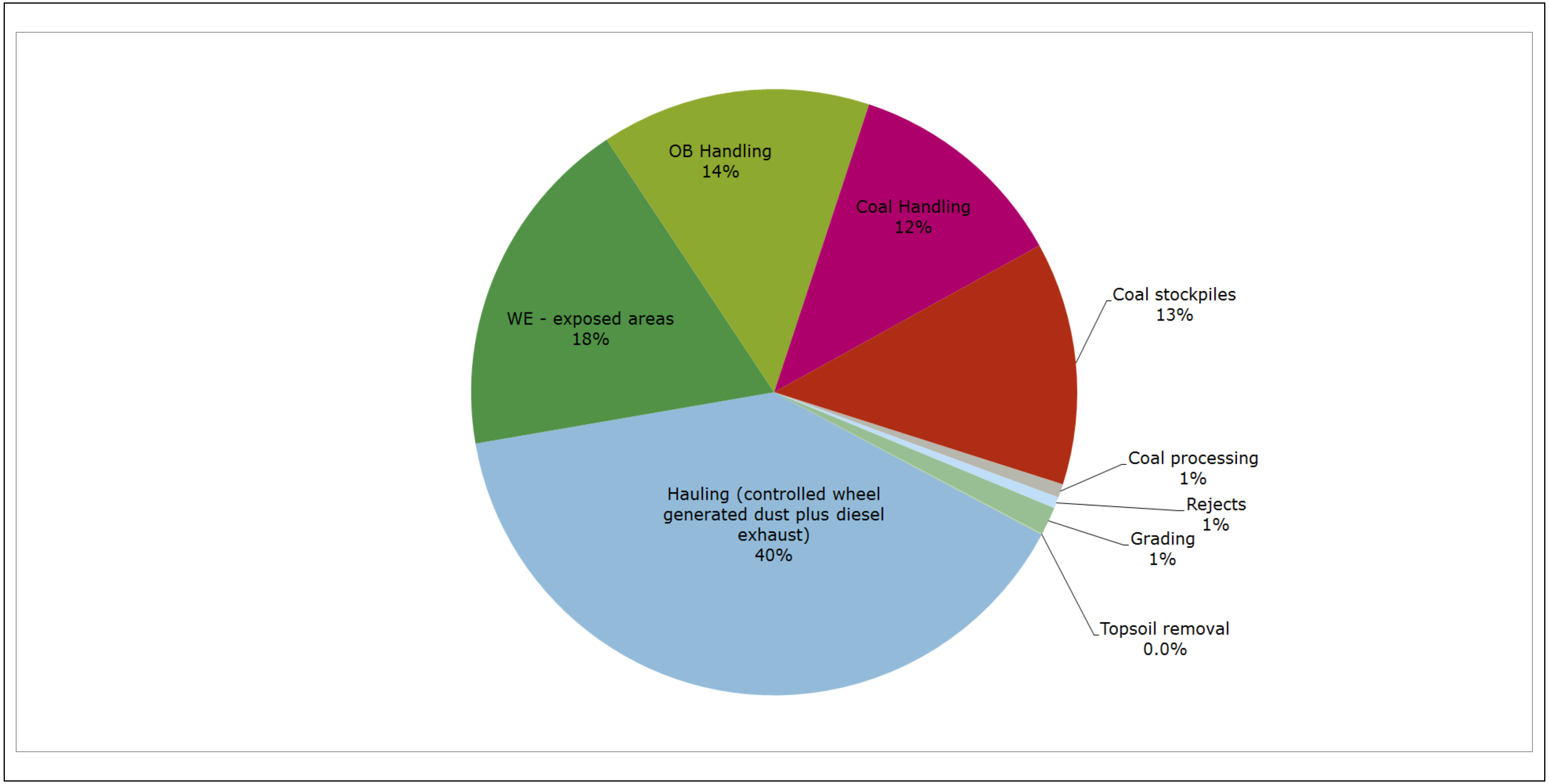


**Figure 6-1: Emissions by source category for $PM_{10}$ (Year 7)**

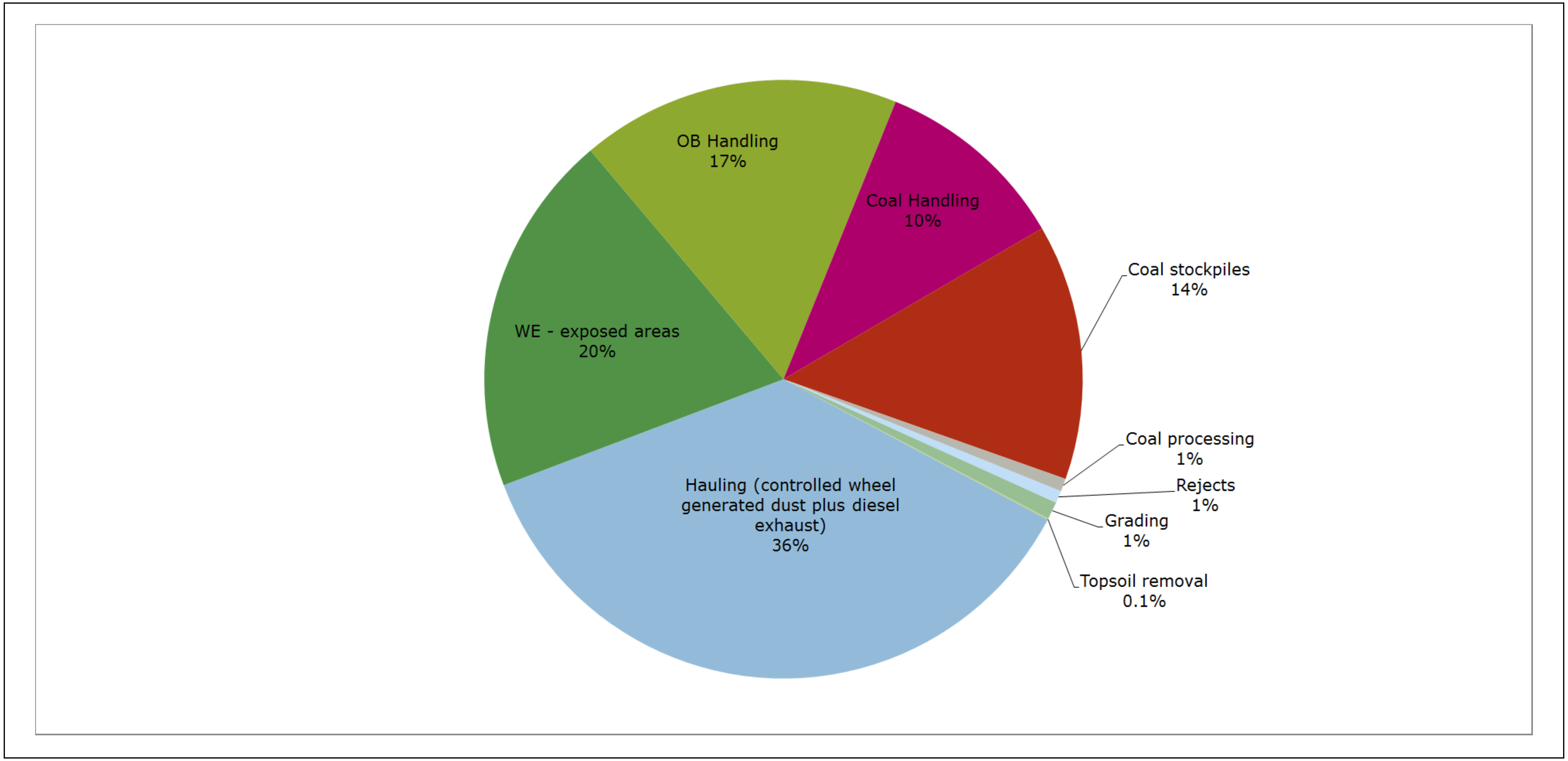


**Figure 6-2: Emissions by source category for $PM_{2.5}$ (Year 7)**

**Table 6-1: 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 proposed for the Project. |
| | Surface treatments | Yes | 90% | 90% control is assumed for watering, with no additional surface treatments planned. Australian Coal Association Research Program (ACARP) project C20023 (Cox & Laing, 2014) demonstrated that watering alone can achieve 85% to 95% control efficiency for unsealed roads. Tarrawonga Coal Mine, operated by Whitehaven, was one of the sites included in the study and recorded an average control efficiency of 91%. |
| | Use of larger trucks | Yes | N/A | Use of larger trucks for waste hauling (assists to reduce wheel-generated emissions). |
| | Conveyors | No | N/A | Use of conveyors to move ROM coal from the open cut to the CHPP is not proposed for the 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 emplacement areas (85% for depletion in active areas), rehabilitation areas (95% for seeding) and soil stockpiles (65% for crusting). Controls are based on ACARP project C22027 (Roddis et al., 2015). |
| | Wind speed reduction | Yes | N/A | Achieved through emplacement within the footprint of the open cut void where possible and vegetative cover for rehabilitation areas. |
| OB handling | Avoidance | Yes | N/A | Achieved through emplacement within the footprint of the open cut void where possible. |
| | 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 rock emplacement is not proposed for the 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 dozer travel routes moist | No | N/A | Not proposed for the Project. |
| Coal handling | Avoidance | Yes | N/A | Achieved through bypassing the ROM pad where possible and direct dump to hopper. |
| | Minimising drop heights | Yes | 30% | Would apply for the Project and implemented through driver training. |
| | Enclosure of dump hopper | Yes | 70% | Enclosure on 3 sides. |
| | Water application | No | N/A | No control applied, however ROM hopper dust suppression is proposed for the Project. |
| | Dust extraction | No | N/A | Not proposed for the Project. |
| Coal Stockpiles | Water sprays | Yes | 50% | Water sprays on coal stockpiles. |
| Coal processing | Wet suppression | Yes | N/A | Controlled emissions factors used for crushing and screening. |
| | Wind shielding | Yes | 70% | Wind shielding (40%) and watering (50%). |

## 6.2 Diesel emissions

As discussed previously, 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 NSW EPA recently completed a benchmarking study to evaluate a number of options for reducing diesel emissions for all 64 coal mines in NSW (NSW EPA, 2014). The NSW EPA surveyed each coal mine in NSW to collect the technical details needed for a cost benefit analysis. Total $PM_{2.5}$ emissions (1,298 tonnes per annum [tpa]) and diesel combustion (936,440 kilolitres [kL]) were reported in NSW EPA (2014) and used to derive a NSW fleet average emission factor of 1.39 kilograms (kg) $PM_{2.5}$/kL diesel.

The estimated emissions of $PM_{10}$ and $PM_{2.5}$ from diesel combustion for the Project are presented in **Table 6-2**. Emissions are estimated based on the assumption that mining equipment for the Project would have emission performance approximately 50% lower than the NSW fleet average emission factor for $PM_{2.5}$. Annual $PM_{10}$ emissions are estimated based on the assumption that $PM_{2.5}$ emissions are 97% of $PM_{10}$ emissions (NSW EPA, 2012).

Emissions from diesel combustion represent a small proportion of total $PM_{10}$ emissions but are a significant component of $PM_{2.5}$ emissions.

**Table 6-2: Annual $PM_{10}$ and $PM_{2.5}$ emissions from diesel combustion (kg/annum)**

| Year | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|
| Year 3 | 10,766 | 10,433 |
| Year 7 | 33,951 | 32,933 |
| Year 21 | 39,991 | 38,791 |

The majority of mine site diesel (97%) is consumed in haul trucks (62%), excavators (19%) and dozers/loaders (15%) (NSW EPA, 2014). The emissions inventory applies no controls for dozers/loaders and excavators, therefore the adjustments for diesel emissions are only needed for haul road controls. The estimated diesel emission 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.

It is assumed that 62% of the total site diesel consumption is used for hauling and the total emissions are allocated to each haul road (waste, coal, rejects, etc.) pro-rata, based on the total tonnage hauled along each route.

## 6.3 Summary of estimated emissions

$PM_{10}$ and $PM_{2.5}$ emissions inventories are summarised in **Table 6-3** and **Table 6-4**. Full details on the emission inventory development, including the assumptions, input data and emission factors used, are provided in **Appendix 5**. Annual emission inventories for TSP are also shown in **Appendix 5**.

**Table 6-3: Annual $PM_{10}$ emissions (kg/annum)**

| Pit | Activity | $PM_{10}$ | | |
|---|---|---|---|---|
| | | Year 3 | Year 7 | Year 21 |
| **Soil Stripping** | | | | |
| Open Cut | Stripping | 1,107 | 718 | 3,197 |
| | Ex/FEL loading trucks | 9 | 6 | 27 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 207 | 459 | 1,019 |
| | Unloading trucks | 9 | 6 | 27 |
| **Overburden removal and dumping** | | | | |
| Open Cut | Drilling | 11,152 | 29,193 | 31,161 |
| | Blasting | 8,984 | 23,517 | 25,103 |
| | Ex/FEL loading trucks | 41,840 | 109,523 | 116,906 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 120,271 | 586,966 | 509,274 |
| | Unloading trucks | 20,920 | 54,761 | 58,453 |
| | Dozers - Pit | 10,665 | 14,219 | 14,219 |
| | Dozers - Dump | 3,555 | 5,332 | 5,332 |
| **Coal removal** | | | | |
| Open Cut | Dozer ripping | 63,985 | 76,783 | 76,783 |
| | Ex/FEL loading trucks | 29,459 | 92,897 | 109,423 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 21,491 | 52,836 | 35,157 |
| **Coal processing** | | | | |
| Vickery Coal Mine | Unload to hopper / ROM pad | 410 | 1,294 | 1,524 |
| | Rehandle - ROM to hopper | 2,310 | 2,310 | 2,310 |
| | Crushing | 716 | 2,259 | 2,661 |
| | Screening | 982 | 3,096 | 3,647 |
| | Transfer 55% to processing plant (CHPP) | 967 | 3,051 | 3,593 |
| | Transfer 45% to Bypass circuit | 79 | 250 | 294 |
| | Loading product stockpile from CHPP | 154 | 481 | 552 |
| | Loading product stockpile from Bypass | 264 | 832 | 980 |
| | Product coal transfer station | 305 | 957 | 1,113 |
| | Loading trains | 305 | 957 | 1,113 |
| Tarrawonga Coal Mine | Unload to hopper / ROM pad | 464 | 464 | 0 |
| | Crushing | 810 | 810 | 0 |
| | Screening | 1,110 | 1,110 | 0 |
| | Transfer 55% to processing plant (CHPP) | 1,094 | 1,094 | 0 |
| | Transfer 45% to Bypass circuit | 89 | 89 | 0 |
| | Loading product stockpile from CHPP | 168 | 168 | 0 |
| | Loading product stockpile from Bypass | 298 | 298 | 0 |
| | Product coal transfer station | 338 | 338 | 0 |
| | Loading trains | 338 | 338 | 0 |
| Rocglen Coal Mine | Unload to hopper / ROM pad | 101 | 0 | 0 |
| | Crushing | 176 | 0 | 0 |
| | Screening | 241 | 0 | 0 |
| | Transfer 55% to processing plant (CHPP) | 237 | 0 | 0 |
| | Transfer 45% to Bypass circuit | 19 | 0 | 0 |
| | Loading product stockpile from CHPP | 36 | 0 | 0 |
| | Loading product stockpile from Bypass | 65 | 0 | 0 |
| | Product coal transfer station | 73 | 0 | 0 |
| | Loading trains | 73 | 0 | 0 |
| All coal | Product stockpile reclaim (dozers) | 21,980 | 21,980 | 21,980 |
| **Coarse rejects** | | | | |
| Coarse rejects | Ex/FEL loading trucks | 2,710 | 9,722 | 11,761 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 1,977 | 5,530 | 3,779 |
| | Unload to dump | 54 | 193 | 234 |
| **Wind erosion of exposed ground** | | | | |
| Open Cut | Pre-strip | 4,701 | 3,052 | 13,583 |
| | Active pit | 20,912 | 72,460 | 84,484 |
| | Active dump | 146,254 | 183,504 | 164,805 |
| | Inactive dump | 0 | 41,288 | 37,081 |
| | Active rehabilitation | 0 | 528 | 2,992 |
| | Soil stockpiles | 916 | 1,200 | 1,200 |
| **Wind erosion and maintenance of stockpiles and ROM pads** | | | | |
| | ROM pads | 127,721 | 127,721 | 127,721 |
| | Product stockpiles | 85,147 | 85,147 | 85,147 |
| **Miscellaneous** | | | | |
| | Grading roads | 20,412 | 24,494 | 24,494 |
| | | | | |
| | **Total (kg/annum)** | **778,661** | **1,644,234** | **1,583,130** |

Note: FEL = Front End Loader

**Table 6-4: Annual $PM_{2.5}$ emissions (kg/annum)**

| Pit | Activity | $PM_{2.5}$ | | |
|---|---|---|---|---|
| | | Year 3 | Year 7 | Year 21 |
| **Soil Stripping** | | | | |
| Open Cut | Stripping | 232 | 151 | 671 |
| | Ex/FEL loading trucks | 1 | 1 | 4 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 25 | 50 | 121 |
| | Unloading trucks | 1 | 1 | 4 |
| **Overburden removal and dumping** | | | | |
| Open Cut | Drilling | 643 | 1,684 | 1,798 |
| | Blasting | 518 | 1,357 | 1,448 |
| | Ex/FEL loading trucks | 6,336 | 16,585 | 17,703 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 17,062 | 74,463 | 69,400 |
| | Unloading trucks | 3,168 | 8,292 | 8,851 |
| | Dozers – Pit | 6,554 | 8,738 | 8,738 |
| | Dozers – Dump | 2,185 | 3,277 | 3,277 |
| **Coal removal** | | | | |
| Open Cut | Dozer ripping | 6,088 | 7,306 | 7,306 |
| | Ex/FEL loading trucks | 4,565 | 14,396 | 16,957 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 2,320 | 5,928 | 4,349 |
| **Coal processing** | | | | |
| Vickery Coal Mine | Unload to hopper / ROM pad | 62 | 196 | 231 |
| | Rehandle - ROM to hopper | 220 | 220 | 220 |
| | Crushing | 133 | 418 | 493 |
| | Screening | 66 | 209 | 246 |
| | Transfer 55% to processing plant (CHPP) | 146 | 462 | 544 |
| | Transfer 45% to Bypass circuit | 12 | 38 | 45 |
| | Loading product stockpile from CHPP | 23 | 73 | 84 |
| | Loading product stockpile from Bypass | 40 | 126 | 148 |
| | Product coal transfer station | 46 | 145 | 169 |
| | Loading trains | 46 | 145 | 169 |
| Tarrawonga Coal Mine | Unload to hopper / ROM pad | 70 | 70 | 0 |
| | Crushing | 150 | 150 | 0 |
| | Screening | 75 | 75 | 0 |
| | Transfer 55% to processing plant (CHPP) | 166 | 166 | 0 |
| | Transfer 45% to Bypass circuit | 14 | 14 | 0 |
| | Loading product stockpile from CHPP | 25 | 25 | 0 |
| | Loading product stockpile from Bypass | 45 | 45 | 0 |
| | Product coal transfer station | 51 | 51 | 0 |
| | Loading trains | 51 | 51 | 0 |
| Rocglen Coal Mine | Unload to hopper / ROM pad | 15 | 0 | 0 |
| | Crushing | 33 | 0 | 0 |
| | Screening | 16 | 0 | 0 |
| | Transfer 55% to processing plant (CHPP) | 36 | 0 | 0 |
| | Transfer 45% to Bypass circuit | 3 | 0 | 0 |
| | Loading product stockpile from CHPP | 5 | 0 | 0 |
| | Loading product stockpile from Bypass | 10 | 0 | 0 |
| | Product coal transfer station | 11 | 0 | 0 |
| | Loading trains | 11 | 0 | 0 |
| All coal | Product stockpile reclaim (dozers) | 2,091 | 2,091 | 2,091 |
| **Coarse rejects** | | | | |
| Coarse rejects | Ex/FEL loading trucks | 420 | 1,507 | 1,823 |
| | Hauling (controlled wheel-generated emissions plus diesel exhaust) | 213 | 620 | 467 |
| | Unload to dump | 8 | 29 | 35 |
| **Wind erosion of exposed ground** | | | | |
| Open Cut | Pre-strip | 705 | 458 | 2,037 |
| | Active pit | 3,137 | 10,869 | 12,673 |
| | Active dump | 21,938 | 27,526 | 24,721 |
| | Inactive dump | 0 | 6,193 | 5,562 |
| | Active rehabilitation | 0 | 79 | 449 |
| | Soil stockpiles | 137 | 180 | 180 |
| **Wind erosion and maintenance of stockpiles and ROM pads** | | | | |
| | ROM pads | 19,158 | 19,158 | 19,158 |
| | Product stockpiles | 12,772 | 12,772 | 12,772 |
| **Miscellaneous** | | | | |
| | Grading roads | 1,811 | 2,173 | 2,173 |
| | | | | |
| | **Total (kg/annum)** | **113,675** | **228,564** | **227,117** |

Note: FEL = Front End Loader.

## 6.4 Hourly varying emissions

The annual emissions presented in **Table 6-3** and **Table 6-4** 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-insensitive 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: | |
|---|---|
| | $E_i = emissions\ for\ hour\ i$ |
| | $E_{annual} = annual\ emissions$ |
| | $U_i = wind\ speed\ for\ each\ hour\ i$ |
| | $N = number\ of\ hours\ of\ wind\ speed$ |

An example of the resultant hourly varying emissions profile is presented in **Figure 6-3**. The plot shows a constant emission rate for wind-insensitive sources (evenly apportioned across the year) compared with a diurnal and seasonal profile for wind erosion, with higher emissions occurring in October through March (the warmer months) and peaking each afternoon, when higher wind speeds are recorded.

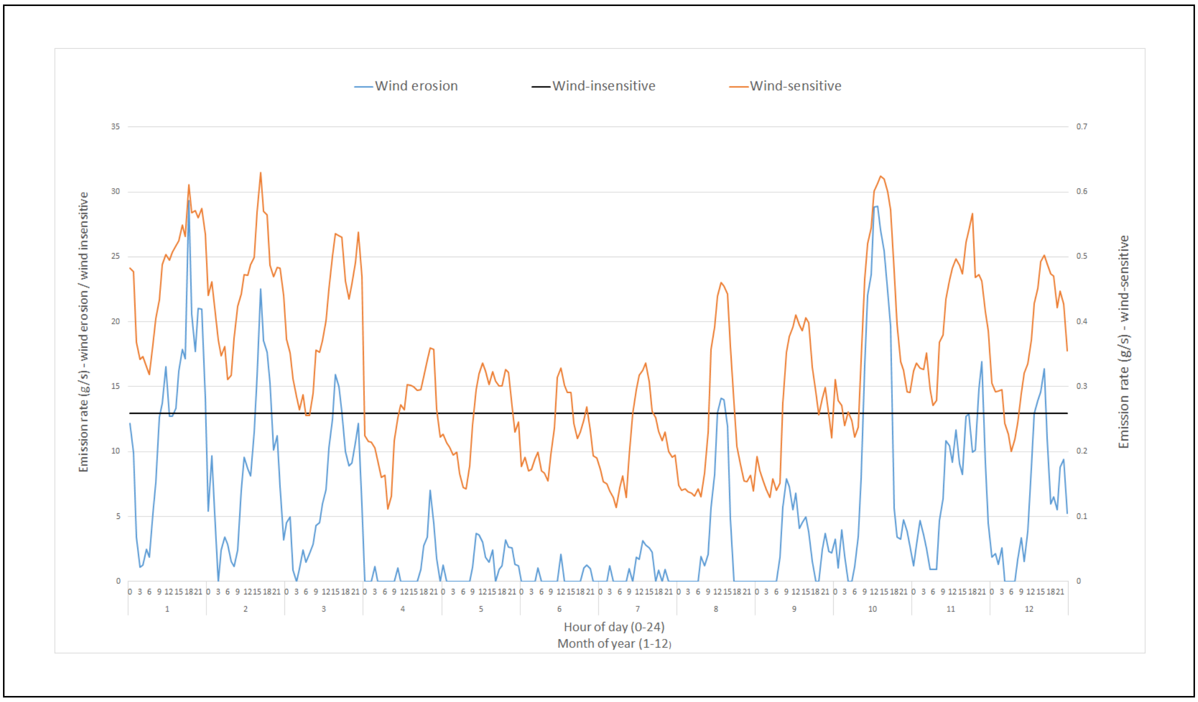


**Figure 6-3: Example of an hourly varying emissions profile (Year 7 $PM_{10}$)**

## 6.5 Modelling the contribution from other mines

Air Quality Assessments prepared as part of the Environment Assessment/EIS process provide detailed emission inventories for local mines (PAEHolmes, 2010; PAEHolmes, 2011a; PAEHolmes, 2011b; PAEHolmes, 2012a). The existing emission inventories are used to derive emissions for cumulative assessment by scaling emissions according to the ratio of PM emissions (kg/annum) to ROM coal extraction (tonnes/annum) (i.e. $PM_{10}$/ROM ratio) for each mine.

Cumulative impacts are assessed using a combination of modelled emissions from other mining operations and baseline (2013) monitoring data from the on-site TEOM. The Boggabri and Tarrawonga Coal Mines were operational in 2013 and so the monitoring data will include some contribution from these operations proportional to the production rate during 2013. To avoid potential double-counting, the modelled emissions for the Boggabri and Tarrawonga Coal Mines have been estimated based on the incremental difference between the ROM coal extracted in 2013 (baseline year) and the maximum approved extraction rate for each mine. The amount of ROM coal extracted in 2013 has been sourced from Annual Environmental Management Reports (Boggabri Coal Pty Ltd, 2014; Whitehaven, 2014a).[17]

Although Rocglen Coal Mine was operational in 2013, Rocglen Coal Mine is included at maximum approved production (Year 3 only) as the contribution is expected to be negligible at the TEOM location due to the local prevailing winds. The amount of double-counting would therefore also be minimal. The estimated emissions for the Maules Creek Coal Mine in all years assessed are based on the maximum proposed extraction rate, as the Maules Creek Coal Mine did not extract ROM coal in 2013 (Whitehaven, 2014b).

This methodology is considered conservative as the maximum approved (or proposed) ROM extraction rate is used for each mine. Modelling emissions based on the incremental difference in ROM coal extraction rate reduces the potential to double-count the contribution from other mines to the background levels measured in 2013. The derived emissions for other mines, and the modelling years in which the emissions are included for cumulative assessment, are presented in **Table 6-5**.

Annual emissions are also split into wind-insensitive, wind-sensitive and wind erosion sources, and these splits are used to proportion emissions into these categories so that hourly emission files can be developed for modelling and varied according to the local wind speed (as described in **Section 6.4**).

**Table 6-5: Derived emissions for other mines (kg/annum)**

| Mine | TSP | $PM_{10}$ | $PM_{2.5}$ | Years included for cumulative assessment |
|---|---|---|---|---|
| Tarrawonga Coal Mine[1] | 1,095,247 | 428,242 | 51,477 | Year 3 and Year 7 |
| Rocglen Coal Mine[2] | 629,094 | 245,976 | 29,567 | Year 3 |
| Maules Creek Coal Mine[3] | 7,929,117 | 3,100,285 | 372,668 | Year 3 and Year 7 |
| Boggabri Coal Mine[4] | 2,750,929 | 1,075,613 | 129,294 | Year 3 and Year 7 |

Note:

[1] Emissions derived from inventory in PAEHolmes (2012a) and 2013 ROM coal extraction in Whitehaven (2014a).

[2] Emissions derived from inventory in PAEHolmes (2011b). [3] Emissions derived from inventory in PAEHolmes (2011a).

[4] Emissions derived from inventory in PAEHolmes (2010) and 2013 ROM coal extraction in Boggabri Coal Pty Ltd (2014).

[17] The ROM coal production for the period 1 May 2013 – 30 April 2014 at the Tarrawonga Coal Mine was used as an estimate for 2013 calendar year production.

# 7. DISPERSION MODELLING RESULTS

The predicted Project-only and cumulative modelling results are presented below, in tabular form, at each privately-owned receptor. Under the VLAMP, non-private (mine-owned or properties under option agreement with Whitehaven) receptors are not necessarily subject to impact assessment, mitigation or acquisition criteria, however provisions do apply for "use of the acquired land", primarily related to protecting existing or prospective tenants. The predicted Project-only and cumulative modelling results for non-private (mine-owned or properties under option agreement with Whitehaven) receptors are presented 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.

The modelling results incorporate a material level of conservatism through a number of conservative assumptions applied in the model input data and model settings, including:

- The dust emission estimates do not account for natural mitigation due to rainfall.
- The model does not incorporate wet deposition (removal of particles due to rainfall).
- The background $PM_{2.5}$ adopted for assessment represents the maximum annual average concentration of the four years considered.
- For cumulative assessment, maximum approved production rates are assumed for other mining operations.

## 7.1 $PM_{10}$ concentrations

The predicted Project-only and cumulative annual average $PM_{10}$ concentrations for private receptors are presented in **Table 7-1**. The cumulative results include a baseline concentration of 12 µg/m³ plus the contribution from the Maules Creek, Boggabri, Tarrawonga and Rocglen Coal Mines and the hauling of coal from other Whitehaven mines. There are no receptors where the Project-only or cumulative annual average $PM_{10}$ concentration is greater than 25 µg/m³.

**Table 7-1: Predicted Project-only and cumulative annual average $PM_{10}$ concentration (µg/m³) at private receptors**

| ID | Project-only annual ave $PM_{10}$ (µg/m³) | | | Cumulative annual ave $PM_{10}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 0.2 | 0.5 | 0.4 | 13.2 | 13.3 | 12.4 |
| 86 | 0.6 | 1.4 | 0.9 | 14.4 | 15.1 | 12.9 |
| 87a | 0.8 | 1.6 | 1.2 | 14.5 | 15.2 | 13.2 |
| 87b | 0.7 | 2.0 | 0.9 | 15.0 | 16.2 | 12.9 |
| 94 | 0.3 | 0.6 | 0.9 | 13.2 | 13.0 | 12.9 |
| 98 | 0.3 | 0.9 | 1.3 | 14.1 | 13.3 | 13.3 |
| 102 | 0.3 | 0.6 | 0.8 | 13.2 | 13.0 | 12.8 |
| 103 | 0.1 | 0.3 | 0.4 | 12.6 | 12.6 | 12.4 |
| 108a | 0.3 | 0.8 | 0.9 | 13.2 | 13.3 | 12.9 |
| 108b | 0.2 | 0.5 | 0.6 | 12.8 | 12.9 | 12.6 |
| 118 | 0.6 | 1.4 | 1.0 | 14.3 | 14.9 | 13.0 |
| 122 | 0.7 | 1.3 | 1.2 | 14.3 | 14.9 | 13.2 |
| 125 | 1.0 | 1.9 | 1.5 | 14.6 | 15.4 | 13.5 |
| 127a | 1.7 | 3.2 | 2.5 | 15.4 | 16.7 | 14.5 |
| 127b | 4.2 | 6.5 | 5.0 | 17.8 | 19.9 | 17.0 |
| 127c | 3.0 | 5.1 | 3.8 | 16.2 | 18.1 | 15.8 |
| 131a | 2.1 | 3.6 | 2.6 | 15.2 | 16.6 | 14.6 |
| 131b | 2.0 | 3.5 | 2.6 | 15.1 | 16.4 | 14.6 |
| 132 | 1.9 | 3.5 | 2.6 | 15.0 | 16.4 | 14.6 |

| ID | Project-only annual ave $PM_{10}$ (µg/m³) | | | Cumulative annual ave $PM_{10}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 133a | 1.5 | 2.9 | 1.7 | 14.8 | 16.0 | 13.7 |
| 137 | 0.5 | 1.0 | 0.8 | 13.7 | 14.2 | 12.8 |
| 138 | 0.4 | 0.8 | 0.6 | 13.4 | 13.8 | 12.6 |
| 139 | 0.5 | 1.1 | 0.9 | 13.8 | 14.3 | 12.9 |
| 140 | 0.5 | 1.1 | 0.8 | 13.8 | 14.3 | 12.8 |
| 141 | 1.4 | 2.5 | 1.8 | 14.5 | 15.5 | 13.8 |
| 143 | 0.8 | 1.6 | 1.1 | 13.8 | 14.6 | 13.1 |
| 144a | 0.6 | 1.4 | 0.9 | 13.6 | 14.3 | 12.9 |
| 144b | 0.7 | 1.4 | 1.0 | 13.7 | 14.3 | 13.0 |
| 146a | 0.3 | 0.7 | 0.5 | 13.1 | 13.4 | 12.5 |
| 146b | 0.3 | 0.7 | 0.5 | 13.1 | 13.4 | 12.5 |
| 147a | 0.5 | 1.2 | 0.8 | 13.3 | 13.9 | 12.8 |
| 153 | 0.8 | 1.9 | 1.7 | 13.6 | 14.5 | 13.7 |
| 174a | 0.3 | 0.7 | 0.8 | 12.9 | 13.1 | 12.8 |
| 174b | 0.2 | 0.6 | 0.7 | 12.9 | 13.0 | 12.7 |
| 221a | 0.1 | 0.4 | 0.3 | 13.0 | 13.1 | 12.3 |
| 221b | 0.2 | 0.4 | 0.3 | 13.1 | 13.1 | 12.3 |
| 310 | 0.3 | 0.6 | 0.7 | 13.0 | 13.0 | 12.7 |
| 313 | 0.1 | 0.3 | 0.2 | 12.9 | 12.9 | 12.2 |
| 317 | 0.2 | 0.5 | 0.6 | 12.9 | 12.8 | 12.6 |
| 318 | 0.2 | 0.5 | 0.6 | 13.0 | 12.9 | 12.6 |
| 319 | 0.2 | 0.5 | 0.5 | 12.8 | 12.8 | 12.5 |
| 334 | 0.7 | 1.4 | 1.1 | 14.2 | 14.8 | 13.1 |

The predicted Project-only and cumulative 24-hour average $PM_{10}$ concentrations for all private receptors are presented in **Table 7-2**. Cumulative predictions include a daily varying baseline plus the contribution from other local mines and the hauling of coal from other Whitehaven mines. There are no private receptors where the Project-only or cumulative 24-hour $PM_{10}$ concentration is greater than 50 µg/m³.

**Table 7-2: Predicted Project-only and cumulative 24-hour average $PM_{10}$ concentration (µg/m³) at private receptors**

| ID | Project-only 24-hr average $PM_{10}$ concentration (µg/m³) | | | Cumulative 24-hr average $PM_{10}$ concentration (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 3.3 | 5.6 | 7.0 | 32.2 | 32.3 | 31.0 |
| 86 | 4.2 | 7.2 | 6.7 | 35.4 | 35.6 | 32.0 |
| 87a | 4.5 | 9.2 | 7.2 | 35.2 | 35.6 | 32.4 |
| 87b | 6.2 | 9.8 | 6.2 | 36.7 | 37.1 | 31.3 |
| 94 | 4.2 | 7.6 | 13.4 | 32.5 | 31.8 | 34.6 |
| 98 | 5.0 | 10.0 | 16.7 | 34.6 | 32.9 | 42.1 |
| 102 | 3.4 | 4.1 | 13.3 | 32.5 | 32.3 | 31.7 |
| 103 | 1.4 | 2.4 | 4.5 | 31.6 | 31.8 | 31.3 |
| 108a | 7.9 | 8.2 | 13.3 | 32.6 | 32.3 | 31.3 |
| 108b | 5.3 | 5.6 | 7.0 | 31.8 | 31.8 | 31.1 |
| 118 | 4.1 | 7.6 | 6.1 | 35.0 | 35.3 | 32.4 |

| ID | Project-only 24-hr average $PM_{10}$ concentration (µg/m$^3$) | | | Cumulative 24-hr average $PM_{10}$ concentration (µg/m$^3$) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 122 | 4.0 | 6.6 | 8.9 | 34.8 | 35.4 | 32.1 |
| 125 | 6.6 | 8.2 | 10.6 | 34.6 | 35.1 | 33.1 |
| 127a | 11.2 | 11.8 | 15.3 | 35.0 | 36.2 | 35.7 |
| 127b | 23.4 | 24.2 | 32.6 | 37.4 | 39.7 | 40.0 |
| 127c | 19.0 | 20.7 | 33.0 | 38.7 | 44.3 | 49.1 |
| 131a | 11.2 | 15.3 | 21.7 | 37.6 | 40.9 | 41.5 |
| 131b | 11.9 | 14.1 | 24.7 | 37.3 | 41.6 | 34.9 |
| 132 | 10.8 | 14.1 | 24.9 | 36.7 | 41.3 | 32.5 |
| 133a | 14.8 | 16.0 | 31.3 | 35.9 | 37.1 | 37.3 |
| 137 | 3.1 | 4.8 | 8.0 | 33.8 | 34.1 | 31.7 |
| 138 | 3.3 | 4.4 | 9.0 | 33.4 | 33.6 | 31.6 |
| 139 | 4.6 | 6.7 | 11.3 | 33.8 | 34.1 | 31.8 |
| 140 | 5.7 | 7.2 | 11.6 | 33.7 | 34.0 | 31.7 |
| 141 | 7.6 | 12.8 | 16.6 | 36.3 | 37.5 | 38.4 |
| 143 | 11.6 | 12.2 | 20.7 | 33.9 | 35.1 | 31.3 |
| 144a | 7.9 | 8.2 | 14.7 | 33.6 | 34.5 | 31.3 |
| 144b | 3.8 | 6.4 | 8.7 | 34.0 | 35.0 | 34.4 |
| 146a | 2.8 | 4.2 | 5.4 | 32.7 | 33.1 | 31.0 |
| 146b | 2.8 | 4.2 | 5.4 | 32.7 | 33.1 | 31.0 |
| 147a | 3.1 | 6.1 | 9.4 | 33.5 | 34.6 | 31.1 |
| 153 | 5.5 | 12.6 | 12.1 | 33.4 | 34.0 | 35.3 |
| 174a | 3.4 | 4.6 | 8.1 | 32.4 | 33.9 | 31.9 |
| 174b | 3.0 | 4.3 | 7.9 | 32.2 | 33.3 | 31.4 |
| 221a | 2.8 | 6.6 | 2.3 | 31.9 | 32.0 | 30.8 |
| 221b | 2.7 | 7.1 | 2.3 | 32.0 | 32.1 | 30.9 |
| 310 | 3.6 | 4.0 | 7.5 | 32.0 | 32.0 | 31.7 |
| 313 | 2.5 | 5.9 | 2.0 | 31.8 | 31.8 | 30.8 |
| 317 | 5.0 | 5.3 | 9.0 | 31.9 | 31.6 | 30.9 |
| 318 | 2.5 | 4.4 | 5.7 | 32.2 | 32.0 | 31.5 |
| 319 | 3.2 | 3.1 | 6.4 | 31.7 | 31.7 | 31.5 |
| 334 | 5.2 | 7.0 | 9.3 | 34.2 | 34.6 | 32.1 |

## 7.2 $PM_{2.5}$ concentrations

The predicted Project-only and cumulative annual average $PM_{2.5}$ concentrations for all private receptors are presented in **Table 7-3**. The cumulative results include a baseline concentration of 5.3 µg/m³ plus the contribution from other local mines and the hauling of coal from other Whitehaven mines. There are no receptors where the Project-only or cumulative annual average $PM_{2.5}$ concentrations are greater than 8 µg/m³.

The predicted Project-only and cumulative 24-hour average $PM_{2.5}$ concentrations for all private receptors are presented in **Table 7-4**. Cumulative predictions include a daily varying baseline plus the contribution from other local mines and the hauling of coal from other Whitehaven mines. There are no private receptors where the Project-only or cumulative 24-hour $PM_{2.5}$ concentrations are greater than 25 µg/m³.

### 7.2.1 Long-term goals for $PM_{2.5}$

The revised AAQ NEPM includes long-term goals for $PM_{2.5}$, to achieve further reductions in maximum concentrations by 2025. The long-term goals (24-hour average goal of 20 µg/m³ and annual average goal of 7 µg/m³) would come into force from Year 9 of the Project, however the AAQ NEPM standards are not designed for the purposes of assessment of the impacts from any specific activity on private receptors. Notwithstanding, the imposition of these criteria would be expected to lead to further improvements in air quality management, which would lead to a reduction in cumulative (i.e. background) PM emissions in the airshed in the long-term.

**Table 7-3: Predicted Project-only and cumulative annual average $PM_{2.5}$ concentration (µg/m³) at private receptors**

| ID | Annual Ave $PM_{2.5}$ (µg/m³) | | | Cumulative Annual Ave $PM_{2.5}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 0.1 | 0.1 | 0.1 | 5.6 | 5.6 | 5.4 |
| 86 | 0.2 | 0.3 | 0.2 | 5.9 | 6.0 | 5.5 |
| 87a | 0.2 | 0.4 | 0.3 | 5.9 | 6.1 | 5.6 |
| 87b | 0.2 | 0.4 | 0.2 | 6.0 | 6.2 | 5.5 |
| 94 | 0.1 | 0.1 | 0.2 | 5.6 | 5.6 | 5.5 |
| 98 | 0.1 | 0.2 | 0.2 | 5.7 | 5.6 | 5.5 |
| 102 | 0.1 | 0.1 | 0.2 | 5.6 | 5.6 | 5.5 |
| 103 | 0.0 | 0.1 | 0.1 | 5.5 | 5.5 | 5.4 |
| 108a | 0.1 | 0.2 | 0.2 | 5.6 | 5.6 | 5.5 |
| 108b | 0.1 | 0.1 | 0.1 | 5.5 | 5.5 | 5.4 |
| 118 | 0.2 | 0.3 | 0.2 | 5.9 | 6.0 | 5.5 |
| 122 | 0.2 | 0.3 | 0.3 | 5.9 | 6.0 | 5.6 |
| 125 | 0.3 | 0.4 | 0.3 | 6.0 | 6.1 | 5.6 |
| 127a | 0.5 | 0.7 | 0.5 | 6.2 | 6.4 | 5.8 |
| 127b | 1.0 | 1.3 | 1.0 | 6.7 | 7.0 | 6.3 |
| 127c | 0.7 | 1.1 | 0.7 | 6.3 | 6.6 | 6.0 |
| 131a | 0.6 | 0.8 | 0.5 | 6.1 | 6.3 | 5.8 |
| 131b | 0.5 | 0.7 | 0.5 | 6.1 | 6.3 | 5.8 |
| 132 | 0.5 | 0.8 | 0.5 | 6.1 | 6.3 | 5.8 |
| 133a | 0.4 | 0.6 | 0.4 | 6.0 | 6.2 | 5.7 |
| 137 | 0.1 | 0.2 | 0.2 | 5.8 | 5.8 | 5.5 |
| 138 | 0.1 | 0.2 | 0.1 | 5.7 | 5.8 | 5.4 |
| 139 | 0.2 | 0.3 | 0.2 | 5.8 | 5.9 | 5.5 |
| 140 | 0.2 | 0.3 | 0.2 | 5.8 | 5.9 | 5.5 |
| 141 | 0.4 | 0.6 | 0.4 | 6.0 | 6.1 | 5.7 |

| ID | Annual Ave $PM_{2.5}$ (µg/m³) | | | Cumulative Annual Ave $PM_{2.5}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 143 | 0.2 | 0.4 | 0.2 | 5.8 | 5.9 | 5.5 |
| 144a | 0.2 | 0.3 | 0.2 | 5.7 | 5.9 | 5.5 |
| 144b | 0.2 | 0.3 | 0.2 | 5.8 | 5.9 | 5.5 |
| 146a | 0.1 | 0.2 | 0.1 | 5.6 | 5.7 | 5.4 |
| 146b | 0.1 | 0.2 | 0.1 | 5.6 | 5.7 | 5.4 |
| 147a | 0.2 | 0.3 | 0.2 | 5.7 | 5.8 | 5.5 |
| 153 | 0.2 | 0.4 | 0.4 | 5.7 | 5.9 | 5.7 |
| 174a | 0.1 | 0.2 | 0.2 | 5.6 | 5.6 | 5.5 |
| 174b | 0.1 | 0.2 | 0.2 | 5.5 | 5.6 | 5.5 |
| 221a | 0.0 | 0.1 | 0.1 | 5.6 | 5.6 | 5.4 |
| 221b | 0.0 | 0.1 | 0.1 | 5.6 | 5.6 | 5.4 |
| 310 | 0.1 | 0.2 | 0.1 | 5.6 | 5.6 | 5.4 |
| 313 | 0.0 | 0.1 | 0.0 | 5.5 | 5.5 | 5.3 |
| 317 | 0.1 | 0.1 | 0.1 | 5.5 | 5.5 | 5.4 |
| 318 | 0.1 | 0.1 | 0.1 | 5.5 | 5.5 | 5.4 |
| 319 | 0.1 | 0.1 | 0.1 | 5.5 | 5.5 | 5.4 |
| 334 | 0.2 | 0.3 | 0.2 | 5.9 | 6.0 | 5.5 |

**Table 7-4: Predicted Project-only and cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) at private receptors**

| ID | Project-only 24-hr average $PM_{2.5}$ concentration (µg/m³) | | | Cumulative 24-hr average $PM_{2.5}$ concentration (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 0.7 | 1.1 | 1.4 | 23.8 | 23.8 | 23.7 |
| 86 | 1.2 | 1.7 | 1.7 | 24.3 | 24.4 | 23.8 |
| 87a | 1.1 | 2.0 | 1.6 | 24.0 | 24.1 | 23.9 |
| 87b | 1.6 | 2.0 | 1.3 | 24.3 | 24.5 | 23.7 |
| 94 | 0.8 | 1.4 | 2.5 | 23.7 | 23.7 | 23.7 |
| 98 | 1.1 | 1.9 | 2.8 | 23.7 | 23.8 | 23.7 |
| 102 | 0.7 | 0.8 | 2.4 | 23.7 | 23.7 | 23.7 |
| 103 | 0.3 | 0.5 | 0.8 | 23.7 | 23.7 | 23.7 |
| 108a | 1.7 | 1.8 | 2.8 | 23.7 | 23.8 | 23.7 |
| 108b | 1.2 | 1.2 | 1.5 | 23.7 | 23.7 | 23.7 |
| 118 | 1.0 | 1.6 | 1.6 | 24.2 | 24.2 | 23.8 |
| 122 | 1.2 | 1.7 | 2.0 | 23.9 | 24.0 | 23.9 |
| 125 | 1.6 | 1.8 | 2.5 | 23.9 | 23.9 | 23.7 |
| 127a | 2.6 | 2.7 | 3.5 | 23.9 | 24.0 | 23.7 |
| 127b | 5.0 | 5.1 | 7.2 | 24.3 | 24.2 | 23.9 |
| 127c | 3.8 | 4.2 | 6.4 | 24.6 | 24.8 | 23.8 |
| 131a | 2.7 | 3.1 | 4.3 | 24.3 | 24.5 | 23.7 |
| 131b | 2.9 | 2.9 | 5.1 | 24.3 | 24.6 | 23.8 |
| 132 | 3.2 | 3.1 | 5.1 | 24.4 | 24.7 | 23.8 |
| 133a | 3.2 | 3.4 | 6.4 | 24.2 | 24.0 | 23.7 |
| 137 | 0.8 | 0.9 | 2.1 | 23.8 | 23.8 | 23.7 |
| 138 | 0.8 | 1.1 | 2.4 | 23.8 | 23.8 | 23.7 |

| ID | Project-only 24-hr average $PM_{2.5}$ concentration (µg/m³) | | | Cumulative 24-hr average $PM_{2.5}$ concentration (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 139 | 1.2 | 1.5 | 2.9 | 23.8 | 23.8 | 23.7 |
| 140 | 1.5 | 1.7 | 3.0 | 23.8 | 23.8 | 23.7 |
| 141 | 1.7 | 2.3 | 3.4 | 24.3 | 24.2 | 23.7 |
| 143 | 2.6 | 2.8 | 4.4 | 23.8 | 23.8 | 23.7 |
| 144a | 1.8 | 1.9 | 3.2 | 23.8 | 23.8 | 23.7 |
| 144b | 1.2 | 1.5 | 2.2 | 23.8 | 23.8 | 23.7 |
| 146a | 0.8 | 1.1 | 1.2 | 23.7 | 23.8 | 23.7 |
| 146b | 0.8 | 1.1 | 1.2 | 23.7 | 23.8 | 23.7 |
| 147a | 0.8 | 1.2 | 2.0 | 23.9 | 23.8 | 23.7 |
| 153 | 1.4 | 3.1 | 2.1 | 23.9 | 24.5 | 24.0 |
| 174a | 0.9 | 0.9 | 1.4 | 23.7 | 23.7 | 23.7 |
| 174b | 0.8 | 0.9 | 1.4 | 23.7 | 23.7 | 23.7 |
| 221a | 0.8 | 1.2 | 0.4 | 23.8 | 23.8 | 23.7 |
| 221b | 0.7 | 1.3 | 0.4 | 23.8 | 23.8 | 23.7 |
| 310 | 0.8 | 0.9 | 1.5 | 23.7 | 23.7 | 23.7 |
| 313 | 0.6 | 1.1 | 0.4 | 23.7 | 23.7 | 23.7 |
| 317 | 0.9 | 0.9 | 1.7 | 23.7 | 23.7 | 23.7 |
| 318 | 0.6 | 0.9 | 1.1 | 23.7 | 23.7 | 23.7 |
| 319 | 0.7 | 0.7 | 1.3 | 23.7 | 23.7 | 23.7 |
| 334 | 1.3 | 1.6 | 2.3 | 23.8 | 23.9 | 23.7 |

## 7.3 TSP concentration and dust deposition

The predicted Project-only and cumulative annual average TSP concentrations for all private receptors are presented in **Table 7-5**. The cumulative results include a baseline concentration of 23.9 µg/m³ plus the contribution from the other local mines and hauling of coal from other Whitehaven mines. There are no receptors where the Project-only or cumulative annual average TSP concentrations are greater than 90 µg/m³.

**Table 7-5: Predicted Project-only and cumulative annual average TSP (µg/m³) at private receptors**

| ID | Annual Ave TSP (µg/m3) | | | Cumulative Annual Ave TSP (µg/m3) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 0.3 | 1.0 | 0.8 | 25.5 | 25.8 | 24.7 |
| 86 | 1.1 | 3.0 | 1.9 | 27.2 | 28.9 | 25.8 |
| 87a | 1.5 | 3.2 | 2.7 | 27.5 | 29.1 | 26.6 |
| 87b | 1.4 | 4.3 | 2.0 | 28.2 | 30.9 | 25.9 |
| 94 | 0.5 | 1.2 | 1.9 | 25.7 | 25.5 | 25.8 |
| 98 | 0.6 | 1.7 | 2.8 | 27.3 | 26.1 | 26.7 |
| 102 | 0.5 | 1.1 | 1.8 | 25.6 | 25.5 | 25.7 |
| 103 | 0.3 | 0.7 | 0.9 | 24.8 | 24.9 | 24.8 |
| 108a | 0.5 | 1.4 | 2.0 | 25.5 | 25.9 | 25.9 |
| 108b | 0.3 | 0.9 | 1.2 | 25.0 | 25.2 | 25.1 |
| 118 | 1.2 | 2.8 | 2.1 | 27.1 | 28.5 | 26.0 |
| 122 | 1.2 | 2.6 | 2.6 | 27.1 | 28.4 | 26.5 |
| 125 | 1.8 | 3.6 | 3.2 | 27.7 | 29.4 | 27.1 |
| 127a | 3.2 | 6.3 | 5.3 | 29.2 | 32.2 | 29.2 |

| ID | Annual Ave TSP (µg/m3) | | | Cumulative Annual Ave TSP (µg/m3) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 127b | 8.2 | 13.2 | 11.1 | 34.1 | 38.9 | 35.0 |
| 127c | 5.6 | 9.9 | 8.3 | 30.9 | 35.1 | 32.2 |
| 131a | 3.7 | 6.9 | 5.5 | 29.0 | 31.9 | 29.4 |
| 131b | 3.5 | 6.5 | 5.4 | 28.7 | 31.5 | 29.3 |
| 132 | 3.4 | 6.5 | 5.6 | 28.6 | 31.5 | 29.5 |
| 133a | 2.8 | 5.6 | 3.7 | 28.2 | 30.9 | 27.6 |
| 137 | 0.8 | 1.8 | 1.6 | 26.2 | 27.2 | 25.5 |
| 138 | 0.6 | 1.5 | 1.2 | 25.8 | 26.6 | 25.1 |
| 139 | 0.9 | 2.1 | 1.8 | 26.4 | 27.5 | 25.7 |
| 140 | 0.9 | 2.1 | 1.7 | 26.3 | 27.4 | 25.6 |
| 141 | 2.5 | 4.7 | 3.8 | 27.7 | 29.8 | 27.7 |
| 143 | 1.3 | 3.0 | 2.1 | 26.5 | 28.0 | 26.0 |
| 144a | 1.1 | 2.5 | 1.8 | 26.2 | 27.5 | 25.7 |
| 144b | 1.2 | 2.7 | 2.0 | 26.3 | 27.6 | 25.9 |
| 146a | 0.6 | 1.3 | 1.1 | 25.3 | 26.0 | 25.0 |
| 146b | 0.6 | 1.3 | 1.1 | 25.3 | 26.0 | 25.0 |
| 147a | 0.9 | 2.0 | 1.7 | 25.7 | 26.8 | 25.6 |
| 153 | 1.3 | 3.3 | 3.4 | 26.1 | 28.0 | 27.3 |
| 174a | 0.5 | 1.2 | 1.7 | 25.1 | 25.6 | 25.6 |
| 174b | 0.4 | 1.1 | 1.5 | 25.1 | 25.5 | 25.4 |
| 221a | 0.3 | 0.8 | 0.6 | 25.3 | 25.5 | 24.5 |
| 221b | 0.3 | 0.9 | 0.6 | 25.4 | 25.6 | 24.5 |
| 310 | 0.5 | 1.2 | 1.5 | 25.4 | 25.5 | 25.4 |
| 313 | 0.2 | 0.7 | 0.5 | 25.1 | 25.3 | 24.4 |
| 317 | 0.4 | 0.9 | 1.4 | 25.2 | 25.2 | 25.3 |
| 318 | 0.4 | 1.0 | 1.3 | 25.2 | 25.3 | 25.2 |
| 319 | 0.4 | 0.9 | 1.1 | 25.0 | 25.2 | 25.0 |
| 334 | 1.2 | 2.7 | 2.4 | 27.0 | 28.3 | 26.3 |

The predicted Project-only and cumulative annual average dust deposition for all private receptors is presented in **Table 7-6**. For all receptors, Project-only modelling predictions are less than 2 g/m$^2$/month. Cumulative dust deposition is presented based on a baseline of 2.8 g/m$^2$/month plus the contribution from other local mines and hauling. There are no receptors where the cumulative annual average dust deposition is greater than 4 g/m$^2$/month.

**Table 7-6: Predicted Project-only and cumulative dust deposition (g/m$^2$/month) at private receptors**

| ID | Dust Deposition | | | Cumulative Dust Deposition | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 67 | 0.0 | 0.0 | 0.0 | 2.8 | 2.8 | 2.8 |
| 86 | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 87a | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 87b | 0.1 | 0.3 | 0.1 | 2.9 | 3.1 | 2.9 |
| 94 | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 98 | 0.0 | 0.1 | 0.2 | 2.9 | 2.9 | 3.0 |
| 102 | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |

| ID | Dust Deposition | | | Cumulative Dust Deposition | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 103 | 0.0 | 0.0 | 0.1 | 2.8 | 2.8 | 2.9 |
| 108a | 0.0 | 0.0 | 0.1 | 2.8 | 2.8 | 2.9 |
| 108b | 0.0 | 0.0 | 0.0 | 2.8 | 2.8 | 2.8 |
| 118 | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 122 | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 125 | 0.1 | 0.2 | 0.3 | 2.9 | 3.0 | 3.1 |
| 127a | 0.2 | 0.4 | 0.4 | 3.0 | 3.2 | 3.2 |
| 127b | 0.6 | 0.8 | 1.0 | 3.4 | 3.7 | 3.8 |
| 127c | 0.3 | 0.4 | 0.5 | 3.1 | 3.2 | 3.3 |
| 131a | 0.2 | 0.3 | 0.3 | 3.0 | 3.1 | 3.1 |
| 131b | 0.2 | 0.3 | 0.3 | 3.0 | 3.1 | 3.1 |
| 132 | 0.1 | 0.3 | 0.3 | 2.9 | 3.1 | 3.1 |
| 133a | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 137 | 0.0 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 138 | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 139 | 0.1 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 140 | 0.1 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 141 | 0.1 | 0.2 | 0.2 | 2.9 | 3.0 | 3.0 |
| 143 | 0.1 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 144a | 0.1 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 144b | 0.1 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 146a | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 146b | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 147a | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 153 | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 174a | 0.0 | 0.0 | 0.1 | 2.8 | 2.8 | 2.9 |
| 174b | 0.0 | 0.0 | 0.1 | 2.8 | 2.8 | 2.9 |
| 221a | 0.0 | 0.0 | 0.0 | 2.8 | 2.8 | 2.8 |
| 221b | 0.0 | 0.0 | 0.0 | 2.8 | 2.8 | 2.8 |
| 310 | 0.0 | 0.0 | 0.1 | 2.8 | 2.9 | 2.9 |
| 313 | 0.0 | 0.0 | 0.0 | 2.8 | 2.8 | 2.8 |
| 317 | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 318 | 0.0 | 0.0 | 0.1 | 2.8 | 2.9 | 2.9 |
| 319 | 0.0 | 0.0 | 0.1 | 2.8 | 2.8 | 2.9 |
| 334 | 0.1 | 0.1 | 0.2 | 2.9 | 2.9 | 3.0 |

## 7.4 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 are unlikely to exceed 50 µg/m³ across more than 25% of any privately-owned land.

To assess against voluntary land acquisition criteria for cumulative annual average $PM_{10}$ and TSP, a fixed background value, described in **Section 5.2.3**, is added to the incremental contour plots presented in **Appendix 7**. Based on this, no additional land would be subject to voluntary land acquisition.

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 (when a conservative background of 2.8 $g/m^2$/month is added) does not exceed 4 $g/m^2$/month across more than 25% of any private property.

## 7.5 Potential impacts on townships

Potential impacts on townships such as Boggabri and Gunnedah were not explicitly modelled, however impacts can be inferred from analysis of the dispersion modelling results presented in Tables 7-1 to 7-6 and Appendix 7.

For Boggabri, the annual average $PM_{10}$ Project-only contribution would be less than 3% of the relevant air quality criterion, while on a worst case day, the 24-hour $PM_{10}$ Project-only contribution would be less than 10% of the relevant air quality criterion. For Gunnedah, which is more than 20 km from the Project boundary, the Project-only contribution would be negligible (effectively zero).

This suggests the Project would have minimal air quality impacts on these townships.

## 7.6 Construction phase impacts

The activities which would contribute to dust and particulate matter emissions include site clearing, earthworks, material handling and heavy vehicle movements, during construction of the Project CHPP, administration buildings, train load-out facility, rail spur and mine access roads.

On an annual basis, the emissions intensity during construction is significantly less than for the operational mine scenarios assessed in this report. Consequently, construction phase emissions are not inventoried or modelled.

Compared to mining operations, construction phases are short in duration and relatively easy to manage through commonly applied dust control measures, such as watering. Procedures for controlling dust impacts during construction will be outlined in an Air Quality Management Plan.

# 8. ASSESSMENT OF IMPACTS FROM RAIL TRANSPORTATION OF COAL

There have been a number of recent studies looking at fugitive dust from coal wagons in the Newcastle and Lower Hunter rail corridor, commencing in 2012 when the Australian Rail Track Corporation were issued with PRPs in their EPL.

The PRPs required trackside monitoring of particulate emissions from coal trains and results of the monitoring campaign were reported in ENVIRON (2012b) and Katestone (2013). Subsequent re-analysis of the Katestone (2013) data was commissioned by the EPA, which found evidence of elevated particle concentrations when trains passed the monitoring stations, but found no evidence that loaded trains had a stronger association with particle levels than freight trains or unloaded trains (Ryan and Ward, 2014).

The NSW EPA then commissioned additional analysis of the data to examine the contribution that diesel emissions from locomotives have on particle levels (Ryan and Malecki, 2015). This report concluded that the increase in PM levels following a train pass is not likely to be caused by diesel exhaust, because the number of locomotives had no influence on particle levels. The latest re-analysis suggests that the likely mechanism for the increased particle levels was passing trains 'stirring up' dust particles that had previously settled on the tracks. This conclusion was reached when the data were re-analysed and a strong association was found between the previous day's rainfall at Maitland and the recorded ambient particle levels. That is, ambient particle levels during train pass-bys were lower when it had rained the previous day.

The Queensland Rail (QR) Environmental Evaluation (Connell Hatch, 2008) was an extensive study which included trackside monitoring, dispersion modelling, wind tunnel tests and Computational Fluid Dynamics analysis. The purpose of this study was to determine the extent of environmental harm caused by fugitive dust from coal wagons, in the context of nuisance and health impacts. The QR study concluded that fugitive dust from coal wagons presents a minimal risk of adverse impacts.

The NSW EPA are also currently running a depositional dust monitoring study in the Newcastle and Lower Hunter region, and the first interim report (first 6 months of monitoring) has been released. The interim results have, thus far, indicated that nuisance coal dust in the vicinity of the rail corridor is not an issue. This is based on all results being well below the nuisance dust criteria, with coal comprising, on average, 6.2% of the measured deposited dust.

In summary, based on the outcomes of previous assessment, dust levels associated with transportation of coal are low relative to ambient air quality goals, and the risk of adverse impacts from fugitive coal dust emissions associated with coal transportation is considered low.

# 9. GREENHOUSE GAS ASSESSMENT

## 9.1 Introduction

The estimation of greenhouse gas (GHG) emissions for the Project is based on the Australian Government Department of the Environment (DoE) *National Greenhouse Accounts Factors (NGAF) workbook* (DoE, 2015). 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* (Technical Guidelines) (DoE, 2014). The Technical Guidelines are used for the purpose of reporting under the (*National Greenhouse and Energy Reporting Act 2007)* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2015). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream use of products and services or the upstream extraction and production of raw materials.

Scope 3 is an optional reporting category (Bhatia et al, 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels (relating to extraction and transport) and purchased electricity (relating to transmission and distribution losses), making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

## 9.2 Emission sources

The GHG emissions sources included in this assessment are listed in **Table 9-1**, representing the most significant sources associated with the Project. 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 9-1: Scope 1, 2 and 3 emission sources**

| Scope 1 | Scope 2 | Scope 3 |
|---|---|---|
| Direct emissions from fuel combustion (diesel) by on-site plant and equipment. | Indirect emissions associated with the consumption of purchased electricity. | Indirect upstream emissions from the extraction, production and transport of diesel fuel. |
| Fugitive emissions of gas from disturbed coal seams. | | Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network. |
| | | Downstream emissions generated from off-site transportation of product coal to Gunnedah by road (Year 1 only) and by rail (Years 2-25). |
| Emissions from the use of explosives. | | Downstream emissions generated from transportation and end use of product coal. |

## 9.3 Activity data

Activity data for the emission estimates are presented in **Table 9-2**. The annual on-site diesel consumption and electricity usage have been projected based on an intensity factor (kilolitres per tonne [kL/tonne] ROM and kilowatt hour [kWh]/tonne ROM) derived from other Whitehaven operations.

An estimate of diesel consumption from product coal transportation in Year 1 (road transport from the Project to the Whitehaven CHPP) has been made based on the NSW average fuel consumption rate for articulated trucks of 0.029 litres per tonne kilometre (L/tonne.km) (Australian Bureau of Statistics, 2015[18]) and a return travel distance of 50 km. An estimate of diesel consumption from product coal transportation by rail (all remaining years) is based on a NSW fleet average diesel consumption rate of 4.03 L/kilotonne.km (NSW EPA, 2012) and a travel distance of 350 km. The annual Vickery Coal Mine product coal production (i.e. excluding coal from other Whitehaven mines) and the travel distance of 350 km are combined to estimate the gross-tonne-km travelled for loaded trains. For the return trip, an estimate of the gross-tonne-km for empty trains is made based on a wagon weight of 23 tonnes (t), an average of 88 wagons per train and average train capacity of 8,336 t.

An estimate of explosives usage is made based on an intensity factor (tonnes Ammonium Nitrate Fuel Oil/Mbcm of overburden) derived from other Whitehaven operations.

**Table 9-2: Annual ROM coal production schedule and activity data**

| Project Year | ROM production (Mt) | Diesel consumption (kL) - mining | Diesel consumption (kL) - transport | Explosives usage (t) | Electricity (kWh) |
|---|---|---|---|---|---|
| 2 | 1.0 | 6,148 | 1,284[1] | 9,210 | 18,084,786 |
| 3 | 2.7 | 16,313 | 5,049 | 19,048 | 29,587,732 |
| 4 | 4.3 | 26,242 | 8,197 | 28,358 | 35,526,712 |
| 5 | 5.5 | 33,884 | 10,327 | 36,500 | 41,602,173 |
| 6 | 7.2 | 43,973 | 13,576 | 41,593 | 49,623,125 |
| 7 | 8.4 | 51,441 | 15,858 | 36,311 | 55,560,734 |
| 8 | 8.5 | 51,992 | 15,989 | 36,223 | 55,998,551 |
| 9 | 9.8 | 60,316 | 18,549 | 36,223 | 62,616,640 |
| 10 | 9.3 | 56,903 | 17,560 | 36,223 | 59,903,268 |
| 11 | 8.8 | 54,085 | 16,507 | 36,223 | 57,662,915 |
| 12 | 8.6 | 52,642 | 15,917 | 37,403 | 56,515,669 |
| 13 | 8.6 | 52,586 | 15,735 | 38,665 | 41,807,355 |
| 14 | 8.3 | 50,952 | 15,523 | 38,665 | 40,508,967 |
| 15 | 9.1 | 55,946 | 16,892 | 38,665 | 44,478,798 |
| 16 | 9.9 | 60,864 | 18,683 | 38,665 | 48,389,022 |
| 17 | 9.6 | 58,904 | 17,725 | 38,665 | 46,830,422 |
| 18 | 9.7 | 59,684 | 18,102 | 38,665 | 47,450,872 |
| 19 | 9.5 | 58,574 | 17,879 | 38,665 | 46,568,314 |
| 20 | 8.9 | 54,802 | 16,316 | 36,630 | 43,569,795 |
| 21 | 9.9 | 60,592 | 18,432 | 38,665 | 48,172,613 |
| 22 | 7.8 | 47,778 | 14,364 | 28,490 | 37,984,945 |
| 23 | 6.5 | 39,823 | 11,726 | 22,385 | 31,660,308 |
| 24 | 4.0 | 24,453 | 7,161 | 14,245 | 19,440,940 |
| 25 | 2.1 | 13,151 | 3,925 | 6,105 | 10,455,309 |
| 26 | 1.1 | 6,594 | 1,978 | 2,198 | 5,242,186 |

Note: [1] For Year 1 road transportation from the Project to the Whitehaven CHPP.

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

## 9.4 Emission factors

Emissions are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and Scope 1, 2 and 3 emission factors (EF) for coal, diesel, and electricity use in NSW. The EF are taken from DoE (2015), with the exception of fugitive methane, which is based on a site-specific EF of 0.00087 tonnes of carbon dioxide equivalent per tonne of ROM coal (t $CO_2$-e/t). This site-specific EF is based on borehole samples taken by GeoGas and reported in PAEHolmes (2012b).

## 9.5 Emission estimates

The estimated annual GHG emissions for each source are presented in **Table 9-3**. Annual average Scope 1 emissions represent approximately 0.099% of total GHG emissions for NSW and 0.024% of total GHG emissions for Australia, based on the *National Greenhouse Gas Inventory* for 2016[19].

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

## 9.6 Emissions intensity

The estimated GHG emissions intensity for the Project is approximately 0.02 t $CO_2$-e/t ROM (this includes all Scope 1 and 2 emissions). This is comparable to the GHG emissions intensity of other existing local mines, including the Tarrawonga Coal Mine (0.07 t $CO_2$-e/t ROM), Boggabri Coal Mine (0.06 t $CO_2$-e/t ROM), Rocglen Coal Mine (0.06 t $CO_2$-e/t ROM) and Maules Creek Coal Mine (0.02 t $CO_2$-e/t ROM).

It should be noted the Project would have the benefit of reducing the GHG emission intensities of the Rocglen Coal Mine and Tarrawonga Coal Mine as a result of reduced coal and reject haulage distances to the Project CHPP, instead of to the Whitehaven CHPP.

19 http://ageis.climatechange.gov.au/

**Table 9-3: Estimated GHG emissions (tonnes $CO_2$-e)**

| Project Year | ROM (Mt) | Scope 1 | | | | Scope 2 | Scope 3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diesel (mining) | Fugitive gas | Blasting | Total | Electricity | Diesel (mining) | Electricity | Diesel (product[20] transportation) | End use of[21] product coal | Total |
| 2 | 1.0 | 16,493 | 870 | 1,566 | 18,929 | 15,191 | 854 | 2,170 | 3,673 | 2,152,355 | 2,159,052 |
| 3 | 2.7 | 43,762 | 2,308 | 3,238 | 49,309 | 24,854 | 2,267 | 3,551 | 14,440 | 5,869,531 | 5,889,789 |
| 4 | 4.3 | 70,400 | 3,714 | 4,821 | 78,934 | 29,842 | 3,647 | 4,263 | 23,447 | 9,530,514 | 9,561,871 |
| 5 | 5.5 | 90,900 | 4,795 | 6,205 | 101,900 | 34,946 | 4,708 | 4,992 | 29,537 | 12,005,911 | 12,045,149 |
| 6 | 7.2 | 117,965 | 6,223 | 7,071 | 131,259 | 41,683 | 6,110 | 5,955 | 38,830 | 15,783,538 | 15,834,434 |
| 7 | 8.4 | 138,001 | 7,280 | 6,173 | 151,453 | 46,671 | 7,148 | 6,667 | 45,358 | 18,436,668 | 18,495,841 |
| 8 | 8.5 | 139,478 | 7,357 | 6,158 | 152,993 | 47,039 | 7,225 | 6,720 | 45,733 | 18,589,212 | 18,648,890 |
| 9 | 9.8 | 161,810 | 8,535 | 6,158 | 176,503 | 52,598 | 8,382 | 7,514 | 53,056 | 21,565,928 | 21,634,880 |
| 10 | 9.3 | 152,654 | 8,052 | 6,158 | 166,864 | 50,319 | 7,907 | 7,188 | 50,226 | 20,415,477 | 20,480,799 |
| 11 | 8.8 | 145,094 | 7,654 | 6,158 | 158,906 | 48,437 | 7,516 | 6,920 | 47,214 | 19,191,447 | 19,253,096 |
| 12 | 8.6 | 141,223 | 7,450 | 6,359 | 155,031 | 47,473 | 7,315 | 6,782 | 45,526 | 18,505,201 | 18,564,824 |
| 13 | 8.6 | 141,071 | 7,441 | 6,573 | 155,086 | 35,118 | 7,307 | 5,017 | 45,006 | 18,293,835 | 18,351,165 |
| 14 | 8.3 | 136,690 | 7,210 | 6,573 | 150,474 | 34,028 | 7,080 | 4,861 | 44,399 | 18,047,158 | 18,103,499 |
| 15 | 9.1 | 150,086 | 7,917 | 6,573 | 164,576 | 37,362 | 7,774 | 5,337 | 48,315 | 19,638,677 | 19,700,104 |
| 16 | 9.9 | 163,280 | 8,613 | 6,573 | 178,466 | 40,647 | 8,458 | 5,807 | 53,438 | 21,721,341 | 21,789,044 |
| 17 | 9.6 | 158,021 | 8,336 | 6,573 | 172,929 | 39,338 | 8,185 | 5,620 | 50,698 | 20,607,537 | 20,672,040 |
| 18 | 9.7 | 160,114 | 8,446 | 6,573 | 175,133 | 39,859 | 8,294 | 5,694 | 51,777 | 21,045,979 | 21,111,744 |
| 19 | 9.5 | 157,136 | 8,289 | 6,573 | 171,998 | 39,117 | 8,139 | 5,588 | 51,138 | 20,786,386 | 20,851,252 |
| 20 | 8.9 | 147,018 | 7,755 | 6,227 | 161,001 | 36,599 | 7,615 | 5,228 | 46,668 | 18,969,273 | 19,028,785 |
| 21 | 9.9 | 162,550 | 8,574 | 6,573 | 177,697 | 40,465 | 8,420 | 5,781 | 52,721 | 21,429,910 | 21,496,832 |
| 22 | 7.8 | 128,173 | 6,761 | 4,843 | 139,778 | 31,907 | 6,639 | 4,558 | 41,086 | 16,700,354 | 16,752,637 |
| 23 | 6.5 | 106,832 | 5,635 | 3,805 | 116,273 | 26,595 | 5,534 | 3,799 | 33,538 | 13,632,388 | 13,675,259 |
| 24 | 4.0 | 65,600 | 3,460 | 2,422 | 71,482 | 16,330 | 3,398 | 2,333 | 20,481 | 8,325,079 | 8,351,291 |
| 25 | 2.1 | 35,280 | 1,861 | 1,038 | 38,178 | 8,782 | 1,827 | 1,255 | 11,226 | 4,563,038 | 4,577,346 |
| 26 | 1.1 | 17,689 | 933 | 374 | 18,996 | 4,403 | 916 | 629 | 5,657 | 2,299,349 | 2,306,551 |

[20,21] These GHG emission estimates do not include emissions associated with processing, transport and end use of coal from other Whitehaven mines. While coal from other Whitehaven mines would be handled, transported and processed at the Project CHPP, these GHG emissions have been accounted for, as required, in the environmental assessments for the other Whitehaven mines, and would run regardless of the Project.

# 10. MANAGEMENT AND MONITORING

The proposed dust management measures applied to the emission estimates are outlined in **Section** 6. 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:

- Direct placement of waste rock and soil where possible, reducing the double handling of material, haulage distances and potential for wind erosion.
- Progressive rehabilitation of disturbed areas.
- Minimising the double handling of ROM coal, wherever practicable (i.e. direct movement of ROM coal to the ROM hopper).
- Avoiding disturbance wherever practicable, and temporary rehabilitation of long-term soil stockpiles and waste rock emplacements.

In addition to the preventative measures outlined above, reactive or corrective measures would be employed. For example, watering may be increased or certain activities may be ceased or relocated to more sheltered areas where water is not sufficient (as determined through monitoring and/or visual inspection).

Further details would be provided in the Air Quality Management Plan for the Project.

Management measures for blast fume prevention and monitoring would be provided in the Blast Management Plan for the Project.

## 10.1 Real-time monitoring and management

Appendix 4 of development consent (SSD-5000) for the Approved Mine outlines the statement of commitments for air quality, and requires implementation of:

- A meteorological monitoring network, a real-time air quality monitoring network and a meteorological forecasting system.
- A real-time proactive air quality management system to prevent exceedances at sensitive receptors.
- An Air Quality Management Plan.

Whitehaven currently operate a meteorological monitoring station and real-time air quality monitoring station in the vicinity of the Project (labelled as 'Met Station' and 'TEOM', respectively, on **Figure 4-2**). The Wil-gai TEOM site is included in the NSW EPA's Namoi district air quality monitoring portal.

The existing real-time monitoring network would be reviewed and augmented, if required, for the operation of the Project, and detailed in the Air Quality Management Plan for the Project. Consideration should be given to installing a TEOM at (or moving a TEOM to) receptor 1z or 1v (located closest to 127b where the highest Project-only 24-hour $PM_{10}$ concentrations are predicted). These locations would act as an early warning trigger for dust impacts, to enable proactive dust management at the closest impacted receptors.

Full details of the proactive air quality management system should be outlined in the Air Quality Management Plan, and may be based on a combination of:

- Meteorological forecasts [22] - to predict when the risk of dust emissions may be high (due to adverse weather) and allow procedures and preparatory measures to be implemented.
- Visual monitoring - to provide an effective mechanism for proactive control of dust at source, before it leaves the site. For example, using the NSW EPA Dust Assessment Handbook, visual triggers for unacceptable dust at source (i.e. wheel-generated dust above tray height) are established to determine the need for action and response.

[22] Packaged 3-day Bureau of Meteorology forecasts can be obtained from weatherzone.com.au

- Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.

Modelling predictions indicate that the source that contributes most to the predicted additional exceedance for cumulative 24-hour $PM_{10}$ concentrations is wheel-generated dust from hauling. An example of how a proactive dust management system could be used to minimise the likelihood of these potential exceedances occurring is outlined in **Table 10-1**.

**Table 10-1: Example of proactive dust management**

| Aspect | Description | Example of action/response |
|---|---|---|
| Meteorological forecast | Daily review of the 3-day forecasts to identify potential for adverse weather for the following day.<br>In the case of hauling, this might include elevated temperature, high evaporation potential, no rainfall, wind direction aligning with haul roads and towards sensitive receptors. | Utilise additional water carts or prepare for increased application intensity. |
| Visual monitoring | Using the NSW EPA Dust Assessment Handbook, identify when triggers are breached.<br>In the case of hauling, for example, when wheel dust exceeds the height of the wheel or tray. | Call for additional haul road watering. |
| Real-time monitoring | Air quality triggers identified that take into account wind speed, direction and distance from source to receptor.<br>SMS alarms would be sent when triggers are breached, to notify site personnel that concentrations are increasing and investigation is warranted. | Review operations, meteorological conditions, regional dust levels.<br>Call for additional dust suppression, limit haul distances, shut down non-essential roads, limit grading. |

# 11. CONCLUSION

Air quality impacts from the Project are assessed using a Level 2 assessment approach in general accordance with the Approved Methods for Modelling and Assessment of Air Pollutants in NSW. Emissions inventories have been developed for four representative years of mining operations, selected to assess the air quality impacts of worst-case operations.

Dispersion modelling was used to predict ground level concentrations for key pollutants from the Project, at surrounding private and mine-owned receptors. Cumulative impacts were assessed, taking into account the combined effect of existing baseline air quality, other local sources of emissions, reasonably foreseeable future emissions and any indirect or induced effects.

The modelling results incorporate conservatism through a number of assumptions applied in the model input data and model settings, including:

- The dust emission estimates do not account for natural mitigation due to rainfall.
- The model does not incorporate wet deposition (removal of particles due to rainfall).
- The background $PM_{2.5}$ adopted for assessment represents the maximum annual average concentration of the four years considered.
- For cumulative assessment, maximum approved production rates are assumed for other mining operations.

The modelled Project-only and cumulative annual average $PM_{10}$, $PM_{2.5}$ and TSP concentrations and dust deposition levels predict no exceedances of the annual average impact assessment criteria at private receptors. Similarly, the modelled Project-only and cumulative 24-hour $PM_{10}$ and $PM_{2.5}$ predict no exceedances of the 24-hour average impact assessment criteria at private receptors. There are no receivers (i.e. dwellings) or vacant land requiring acquisition or mitigation in accordance with the VLAMP policy.

It is noted that future background dust levels may be higher than the historic levels considered in this assessment due to factors unrelated to the Project (e.g. dust storms, bushfires and prolonged drought). If elevated background levels were to occur proactive dust management would be implemented to minimise cumulative dust levels at private receptors.

The impacts from rail transportation of coal have been qualitatively assessed, and the risk of adverse impacts is considered low. Annual average Scope 1 emissions represent approximately 0.16% of total GHG emissions for NSW and 0.04% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2015.

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# APPENDIX 1
# OVERVIEW OF DISPERSION MODELLING

**Local Air Quality Modelling**

Local 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 from the Vickery meteorological station. The year chosen for modelling is 2013, which is 99% complete for most parameters. 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 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 were sourced from NASA's Shuttle Radar Topography Mission data. This data set provided a high-resolution topography at 3 arc-second (~90 m) grid spacing. Within the Project boundary, the 90 m terrain data were replaced with detailed mine plan terrain data for each of the modelled mine plan scenarios. This allows for a fine resolution of terrain data where the sources are located and from where the emissions are released. For example, sources within the open cut are released at lower elevations, while sources at the waste rock emplacement are released at higher elevations.

Activities (hauling, dozers, excavators, wind erosion, etc.) are represented by a series of volume sources located according to the mine plan for each scenario. The modelled volume source locations and modelled haul road locations are shown on Figures A1-1 and A1-2. For modelling volume sources, estimates of horizontal spread (initial sigma y [$\sigma y$]) and vertical spread (initial sigma z [$\sigma z$]) need to be assigned. For sources other than hauling, a value of 10 m is assigned for sigma y and 2 m 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 was completed for three size fractions; TSP, $PM_{10}$ and $PM_{2.5}$.

**Cumulative Air Quality Modelling**

The cumulative assessment includes modelling of existing operations at Maules Creek, Boggabri, Tarrawonga and Rocglen Coal Mines. Also, as part of the Project, it is also proposed that coal from other Whitehaven mines would be hauled to the processing plant at the Project. The haulage of coal from the other Whitehaven mines, along a sealed road, is also included in the cumulative modelling.

Cumulative modelling uses a combination of TAPM, CALMET and CALPUFF, to account for regional scale variation in wind flow. CALPUFF and TAPM are commonly used in NSW for applications involving regional or far field dispersion. TAPM was used to generate gridded three-dimensional meteorological data for input into CALMET (as '3D.dat') to drive the 'initial guess' of the meteorological field. Surface observations from regional Bureau of Meteorology (BoM) sites are incorporated into the CALMET modelling to refine the wind field. CALPUFF then calculates the dispersion of emissions within this three-dimensional meteorological field.

Activities at each mine are represented as a series of volume sources spaced at relatively large intervals within the boundary or extent of mining operations. Values for σy are assigned based on source separation divided by 4.3. The initial sigma z was chosen based on recommendations made in the US EPA Haul Road Workgroup. Modelling was completed for three size fractions; TSP, $PM_{10}$ and $PM_{2.5}$.

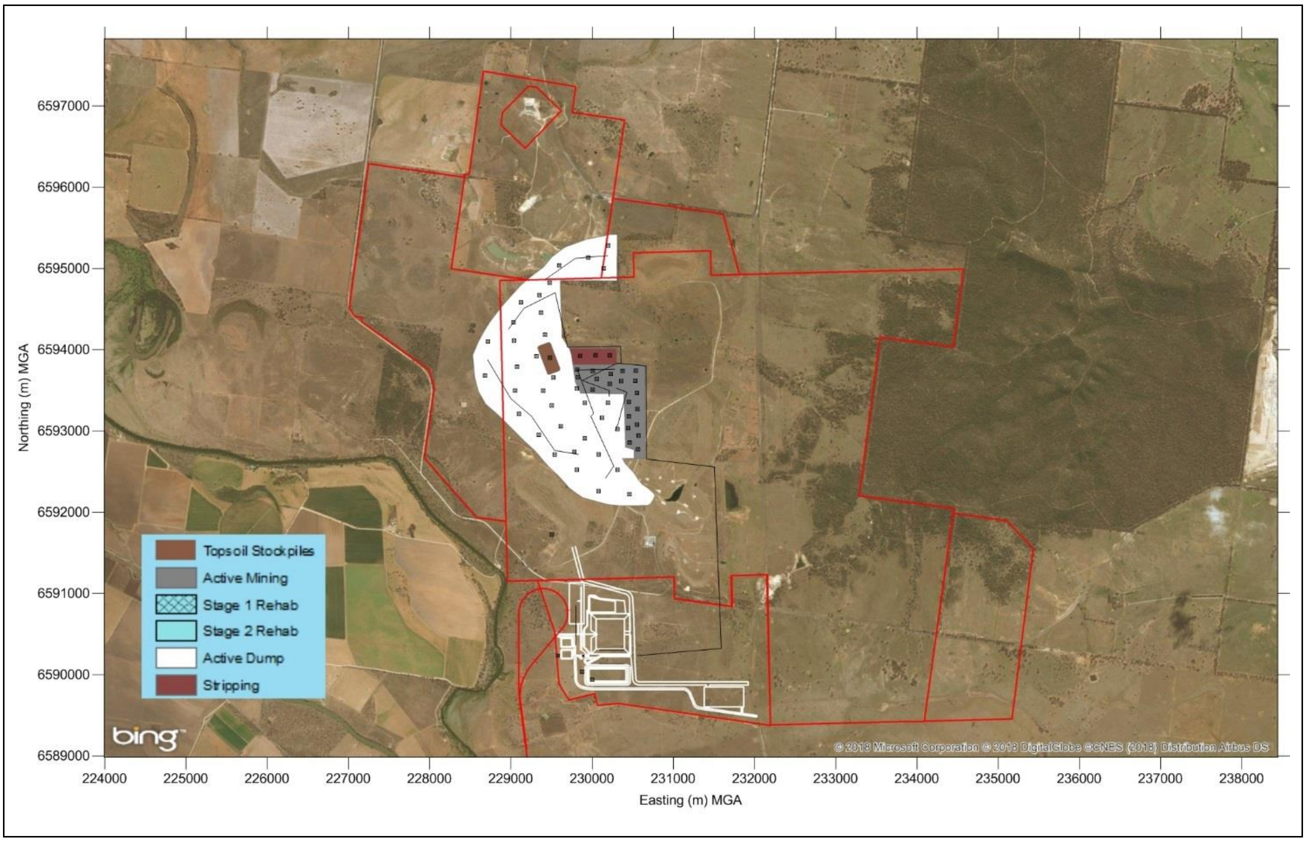



**Figure A1-1: Modelled source locations – Year 3**

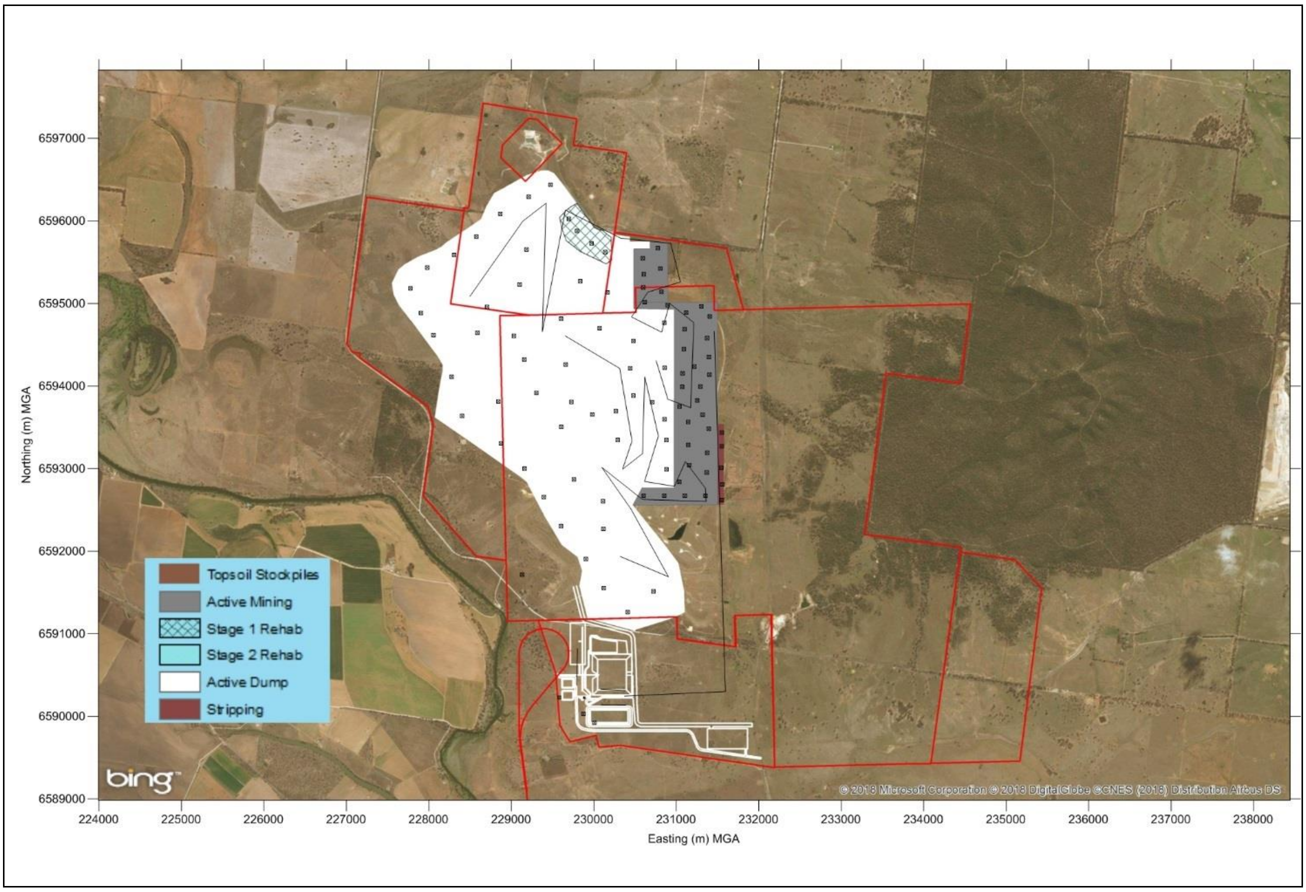



**Figure A1-2: Modelled source locations – Year 7**

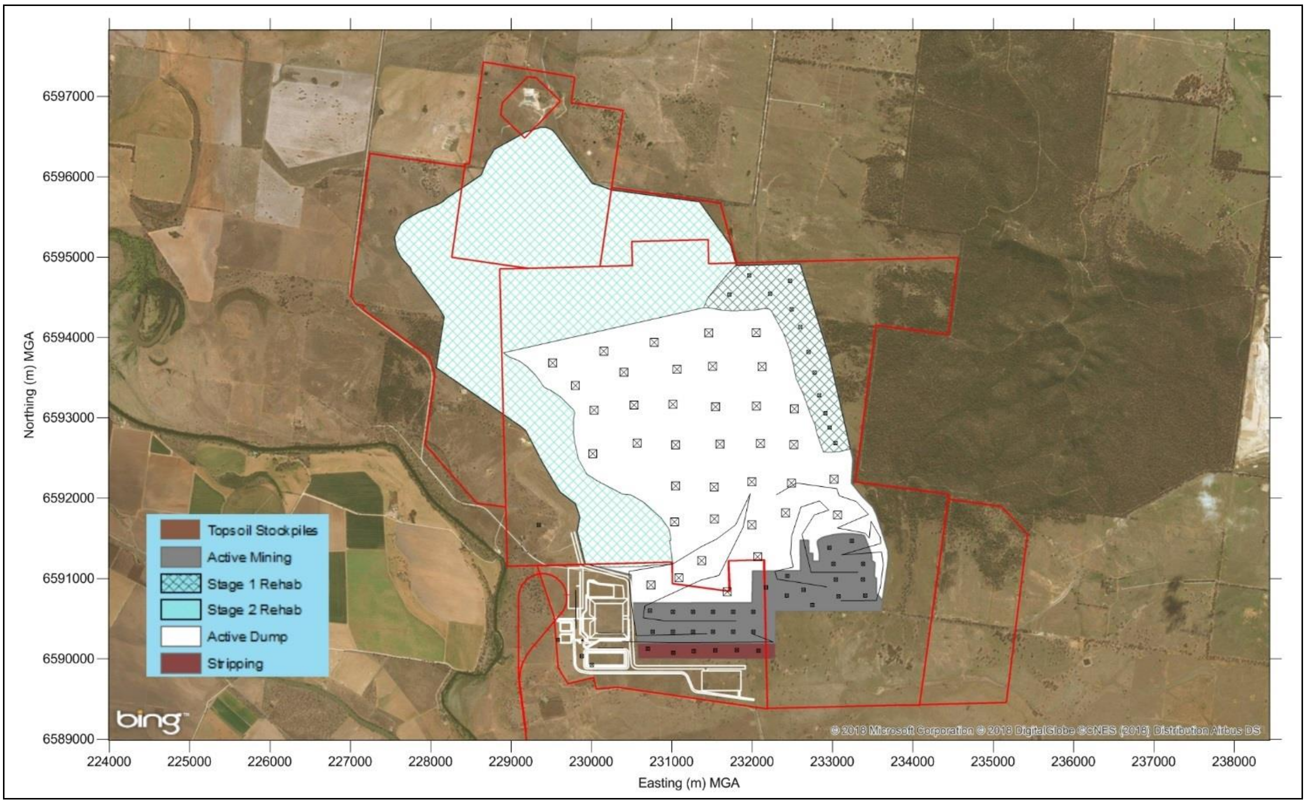



**Figure A1-3: Modelled source locations – Year 21**

# APPENDIX 2
# ASSESSMENT LOCATIONS

**Table A2-1: Assessment locations**

| Dwelling ID | Land Ownership | Location (m MGA, Zone 55) | | Elevation (m AHD) |
|---|---|---|---|---|
| | | Easting | Northing | |
| 1aa | WHITEHAVEN COAL MINING LIMITED | 233861 | 6598699 | 286 |
| 1ab | WHITEHAVEN COAL MINING LIMITED | 234447 | 6598461 | 294 |
| 1ac | WHITEHAVEN COAL MINING LIMITED | 234948 | 6599352 | 270 |
| 1ad | WHITEHAVEN COAL MINING LIMITED | 231216 | 6597110 | 261 |
| 1ae | WHITEHAVEN COAL MINING LIMITED | 232895 | 6596896 | 278 |
| 1af | WHITEHAVEN COAL MINING PTY LIMITED | 225528 | 6585491 | 254 |
| 1aj | WHITEHAVEN COAL MINING LIMITED | 228572 | 6598981 | 256 |
| 1f | WHITEHAVEN COAL MINING PTY LIMITED | 229210 | 6597384 | 271 |
| 1g | WHITEHAVEN COAL MINING LIMITED | 237902 | 6595557 | 298 |
| 1h* | WHITEHAVEN COAL MINING LIMITED | 229822 | 6594225 | 339 |
| 1i | WHITEHAVEN COAL MINING PTY LIMITED | 238936 | 6598071 | 287 |
| 1l | WHITEHAVEN COAL MINING PTY LIMITED | 236436 | 6590934 | 270 |
| 1m | WHITEHAVEN COAL MINING PTY LIMITED | 240723 | 6593582 | 327 |
| 1n | WHITEHAVEN COAL MINING PTY LIMITED | 240796 | 6594733 | 329 |
| 1o | WHITEHAVEN COAL MINING LIMITED | 239405 | 6595779 | 299 |
| 1t | WHITEHAVEN COAL MINING LIMITED | 231547 | 6598184 | 261 |
| 1u | WHITEHAVEN COAL MINING LIMITED | 226404 | 6592924 | 251 |
| 1v | WHITEHAVEN COAL MINING LIMITED | 229434 | 6589512 | 256 |
| 1w | WHITEHAVEN COAL MINING LIMITED | 228025 | 6588084 | 254 |
| 1x | WHITEHAVEN COAL MINING LIMITED | 231784 | 6596439 | 268 |
| 1y | WHITEHAVEN COAL MINING LIMITED | 226067 | 6587121 | 253 |
| 1z | WHITEHAVEN COAL MINING LIMITED | 227521 | 6589134 | 252 |
| 67 | R L & K A PENROSE AS JOINT TENANTS | 239020 | 6599961 | 298 |
| 86 | PETER J WATSON HOLDINGS PTY LTD | 221297 | 6599230 | 254 |
| 87a | D S RILEY | 222139 | 6597432 | 247 |
| 87b | D S RILEY | 223342 | 6598974 | 248 |
| 88 | WHITEHAVEN COAL MINING LIMITED | 225481 | 6598912 | 247 |
| 94 | R J & A BARNES AS TENANTS IN COMMON IN EQUAL SHARES | 240569 | 6589808 | 280 |
| 98 | R S RENNICK | 238803 | 6590526 | 269 |

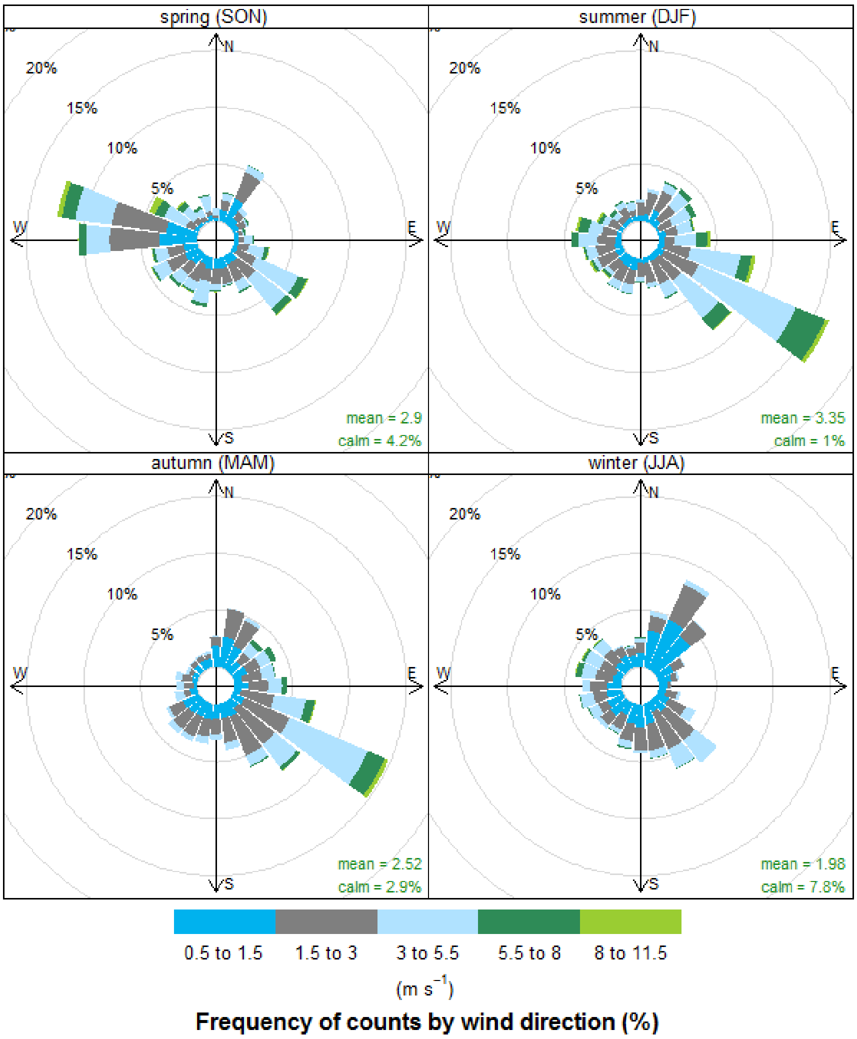
| Dwelling ID | Land Ownership | Location (m MGA, Zone 55) | | Elevation (m AHD) |
|---|---|---|---|---|
| | | Easting | Northing | |
| 102 | J C & J E MEYERS AS JOINT TENANTS | 238951 | 6588235 | 271 |
| 103 | K G PERRETT | 241327 | 6586074 | 283 |
| 108a | A C WANNAN & P M WINTER AS JOINT TENANTS | 234727 | 6585868 | 265 |
| 108b | A C WANNAN & P M WINTER AS JOINT TENANTS | 236385 | 6584280 | 271 |
| 118 | A D WATSON | 221075 | 6598682 | 251 |
| 122 | NANDEWAR PTY LIMITED | 221722 | 6596321 | 249 |
| 125 | S & A J MAUNDER AS JOINT TENANTS | 224132 | 6592990 | 250 |
| 127a | J K BARLOW | 225805 | 6592537 | 249 |
| 127b | J K BARLOW | 227568 | 6591875 | 252 |
| 127c | J K BARLOW | 228190 | 6589314 | 252 |
| 131a | B J & D P KEELER AS JOINT TENANTS | 227562 | 6588753 | 252 |
| 131b | B J & D P KEELER AS JOINT TENANTS | 227591 | 6588442 | 253 |
| 132 | ESTATE: PERPETUAL LEASE E J & C A HANNAN AS JOINT TENANTS | 227705 | 6588285 | 253 |
| 133a | G A MCILVEEN | 226677 | 6589676 | 254 |
| 137 | A C & G T CARRIGAN AS TENANTS IN COMMON IN EQUAL SHARES | 221496 | 6592978 | 250 |
| 138 | A C CARRIGAN | 220402 | 6592427 | 250 |
| 139 | K L & S R CRAWFORD AS TENANTS IN COMMON IN EQUAL SHARES | 222442 | 6592051 | 248 |
| 140 | D A & J E WATT AS TENANTS IN COMMON IN EQUAL SHARES | 222425 | 6591809 | 249 |
| 141 | D M & A M HEINEMANN AS JOINT TENANTS | 226706 | 6588336 | 257 |
| 143 | S L JOHNS | 224801 | 6588624 | 251 |
| 144a | E F & J T DARLEY | 224237 | 6588209 | 251 |
| 144b | E F & J T DARLEY | 224612 | 6587904 | 252 |
| 146 | G C CARRIGAN | 221518 | 6586661 | 254 |
| 147a | T J & C LOVERIDGE AS TENANTS IN COMMON IN EQUAL SHARES | 224118 | 6586104 | 253 |
| 153 | R G & H K MANSFIELD AS JOINT TENANTS | 227491 | 6585556 | 255 |
| 174a | SELKIRK PASTORAL CO PTY LIMITED | 232731 | 6583847 | 256 |
| 174b | SELKIRK PASTORAL CO PTY LIMITED | 232948 | 6583387 | 258 |
| 221a | M E GEDDES | 240378 | 6599756 | 310 |
| 221b | M E GEDDES | 240241 | 6599341 | 308 |
| 303a | WHITEHAVEN COAL MINING LIMITED & BOGGABRI COAL PTY LIMITED | 224469 | 6600621 | 248 |
| 303b | WHITEHAVEN COAL MINING LIMITED & BOGGABRI COAL PTY LIMITED | 224507 | 6600300 | 246 |

| Dwelling ID | Land Ownership | Location (m MGA, Zone 55) | | Elevation (m AHD) |
|---|---|---|---|---|
| | | Easting | Northing | |
| 310 | A J & L E LAURIE | 237192 | 6586408 | 267 |
| 313 | ASTON COAL 2 PTY LIMITED & ICRA MC PTY LIMITED & J-POWER AUSTRALIA PTY LIMITED | 241425 | 6599480 | 329 |
| 317 | T & P A DIMARCHOS | 241581 | 6588865 | 290 |
| 318 | J C WISE & L D MILLER & W LICHTI & M LICHTI | 238432 | 6586589 | 273 |
| 319 | L J & J L BARKER | 238238 | 6585305 | 271 |
| 334 | D L & K J STUART | 223205 | 6592888 | 249 |
| 339 | WHITEHAVEN COAL MINING LIMITED | 233318 | 6598234 | 295 |

Note: m AHD = metres Australian Height Datum; MGA = Map Grid of Australia

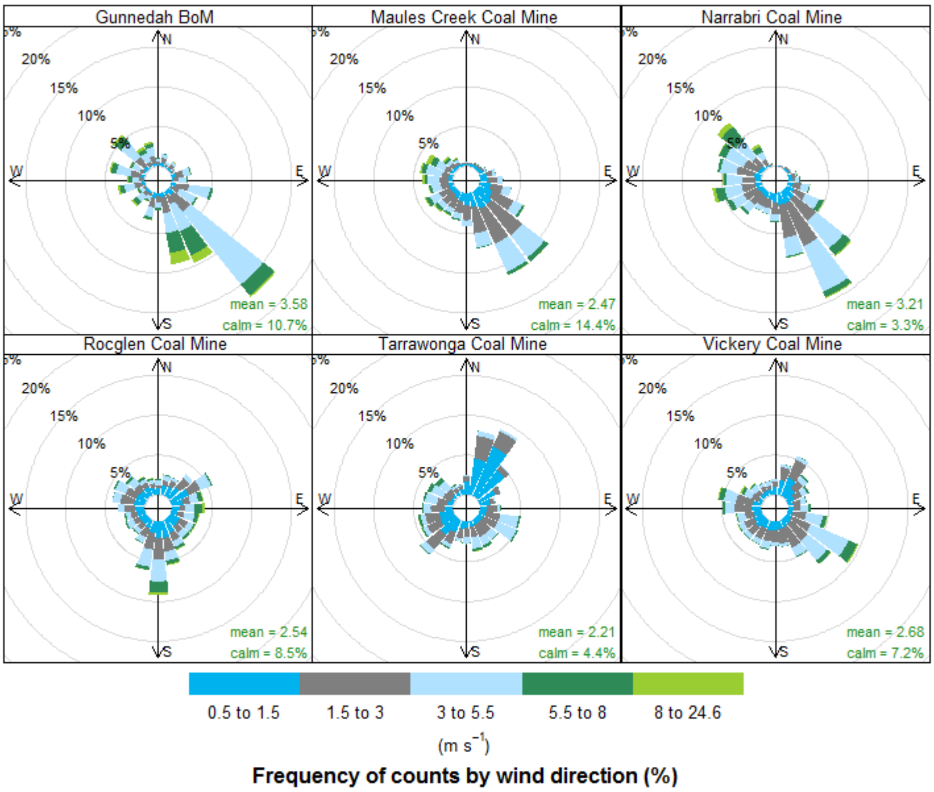
* This dwelling would not be occupied during the Project and, therefore, has not been assessed in detail.

# APPENDIX 3
# WIND ROSES




**Seasonal wind roses 2013**

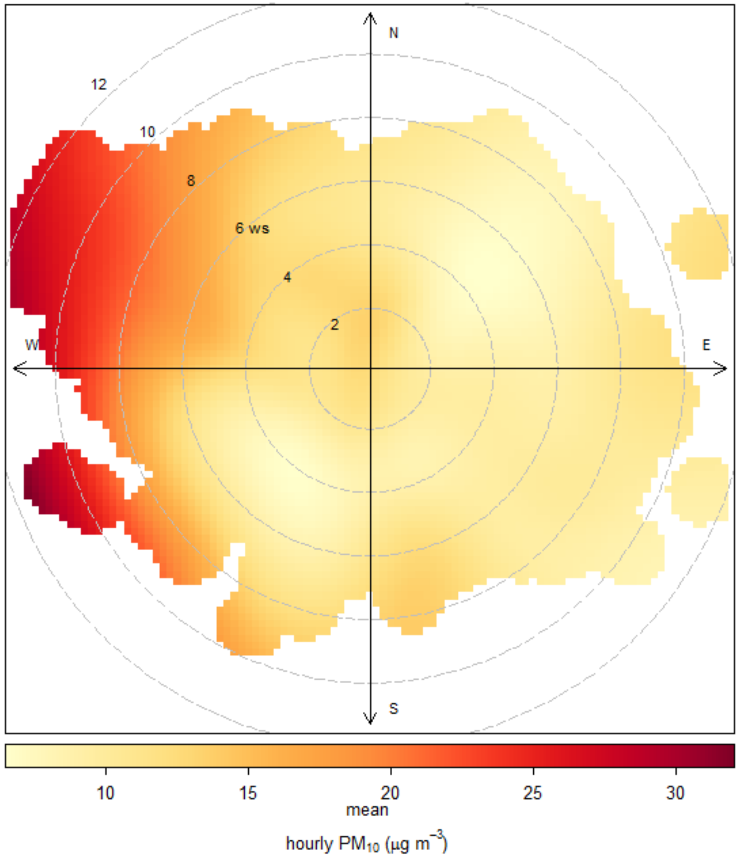
**Figure A3-1: Seasonal wind roses for 2013**

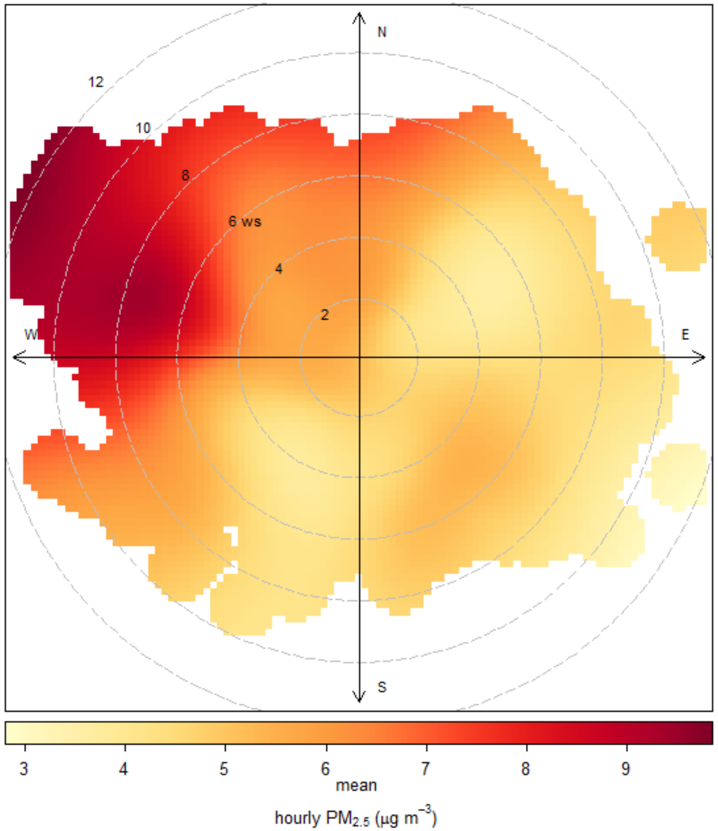



**Regional wind roses 2013**

**Figure A3-2: Regional wind roses for 2013**

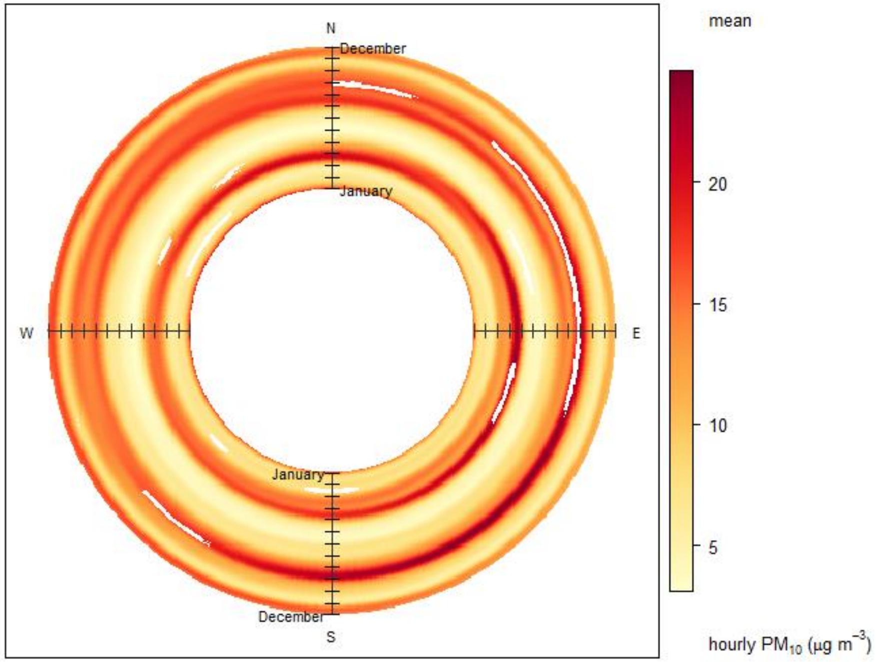
# APPENDIX 4
# ANALYSIS OF $PM_{10}$ AND $PM_{2.5}$ CONCENTRATIONS FOR WIL-GAI

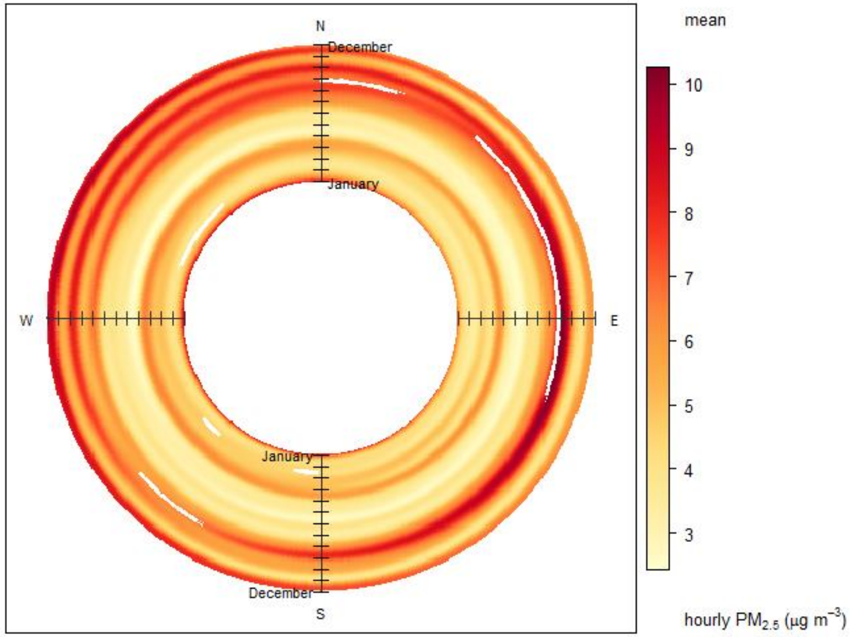
<table>
<tr>
<th>Bivariate polar plot of hourly $PM_{10}$ concentrations with wind speed (m/s) and direction - Wil-gai TEOM (2013)</th>
<th>Bivariate polar plot of hourly $PM_{2.5}$ concentrations with wind speed (m/s) and direction - Wil-gai TEOM (2013)</th>
</tr>
<tr>
<td>


</td>
<td>


</td>
</tr>
<tr>
<td>High $PM_{10}$ concentrations are associated with high wind speeds from the north-west and west-southwest. When winds are from the north-northwest (i.e. mining operations are upwind) $PM_{10}$ concentrations are similar to background.</td>
<td>High $PM_{2.5}$ concentrations are associated with high wind speeds from the north-west. There is a slight signal when winds are from the north-northwest (i.e. mining operations are upwind).</td>
</tr>
</table>

**Figure A4-1: Bivariate polar plots (wind speed/direction) for $PM_{10}$ and $PM_{2.5}$**

<table>
<tr>
<th>Temporal plot (by month) of hourly $PM_{10}$ concentrations with wind direction - Wil-gai TEOM (2013)</th>
<th>Temporal plot (by month) of hourly $PM_{2.5}$ concentrations with wind direction - Wil-gai TEOM (2013)</th>
</tr>
<tr>
<td>


</td>
<td>


</td>
</tr>
<tr>
<td>A pattern of high $PM_{10}$ concentrations is evident in spring and autumn, associated with winds from the south through north.</td>
<td>A pattern of high $PM_{2.5}$ concentrations is evident in spring and summer months associated with winds from the southeast through northeast in spring and northwest quadrant in summer.</td>
</tr>
</table>

**Figure A4-2: Temporal plots (by month) for $PM_{10}$ and $PM_{2.5}$ concentrations**

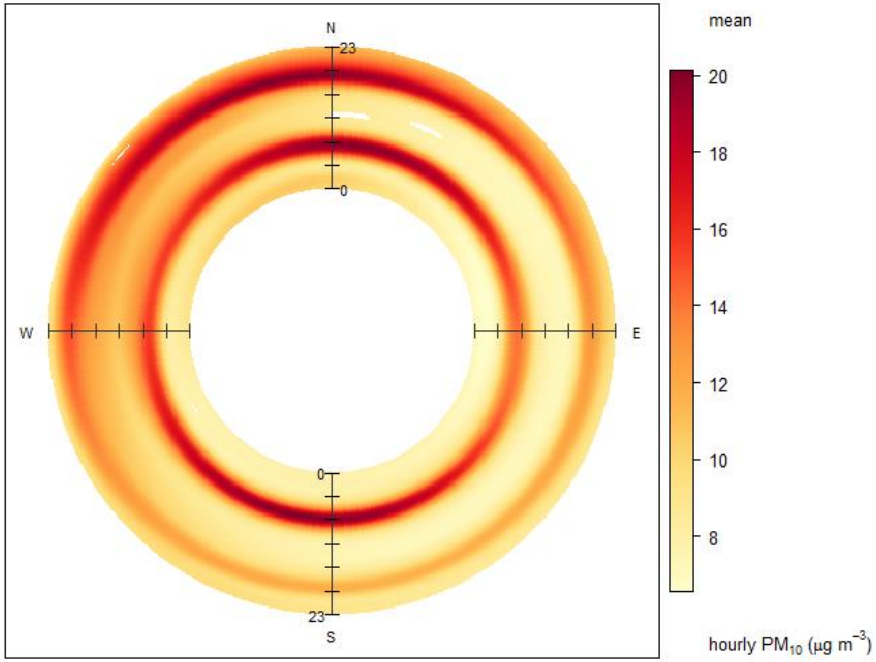
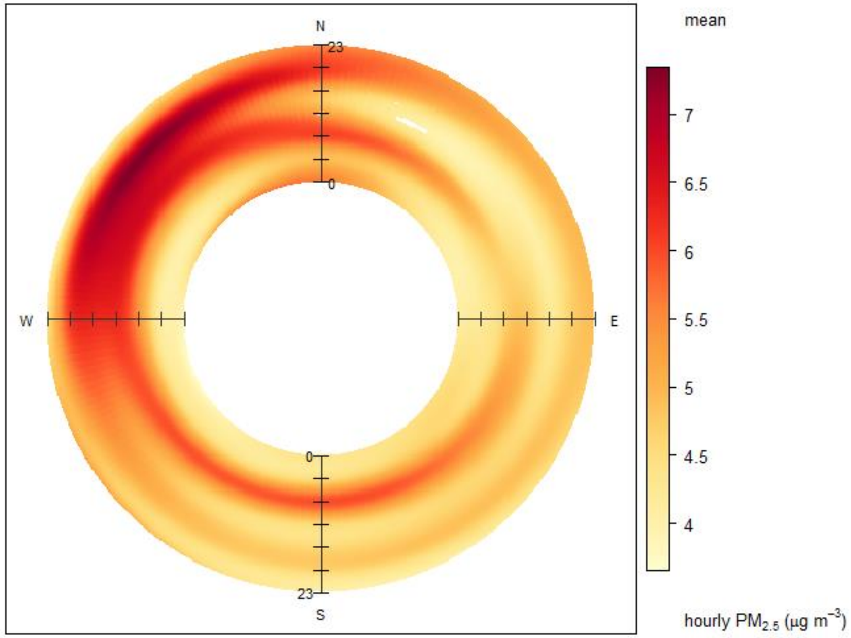
| Temporal plot (by hour) of hourly $PM_{10}$ concentrations with wind direction - Wil-gai TEOM (2013-2015) | Temporal plot (by hour) of hourly $PM_{2.5}$ concentrations with wind direction - Wil-gai TEOM (2013-2015) |
|---|---|
|   |   |
| High $PM_{10}$ concentrations occur in the morning around 8am (from most directions and in particular the south and north) and in the evenings from the northwest through to north. | High $PM_{2.5}$ concentrations occur in the evening from the north-west and in the morning around 8am from most directions. |

**Figure A4-3: Temporal plots (by hour) for $PM_{10}$ and $PM_{2.5}$ concentrations**

# APPENDIX 5
# EMISSIONS INVENTORY DEVELOPMENT

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

The material properties listed in **Table A5-1** are used as input to the various emission factor equations listed in **Table A5-2** to derive site-specific uncontrolled emission factors for each source.

In the absence of site-specific material properties, the silt and moisture contents (%) for each material handled are generally based on bulk sampling taken at a number of open cut coal mines as part of ACARP project C22027 (Roddis et al., 2015). Table ES7 of Roddis et al. (2015) lists the recommended material properties to be used in the development of emission inventories for Australian open cut coal mines, in the absence of site-specific information (see Recommendation 6.2 of executive summary). The material properties sampling and analysis in Roddis et al. (2015) was conducted in accordance with US EPA AP-42 sampling procedures (Appendices C.1 and C.2 of AP-42). The sampling methodology is described in Appendix E of Roddis et al. (2015). For ROM coal, the method recommends that representative samples should be collected for material recently loaded onto the ROM Pad and samples should be collected from the top, middle and bottom of the ROM Pad where possible. To characterise material properties important for wind erosion, the methodology recommends the depth of the sample should be 2.5 centimetres.

**Table A5-1: Material properties**

| Properties | Value | Source of Information |
|---|---|---|
| Silt content of unpaved roads | 4% | ACARP project C22027 (Roddis et al., 2015). |
| Silt content of overburden | 4% | ACARP project C22027 (Roddis et al., 2015). |
| Silt content of ROM coal | 2.4% | ACARP project C22027 (Roddis et al., 2015). |
| Moisture content of overburden | 4.1% | ACARP project C22027 (Roddis et al., 2015). |
| Moisture content of ROM coal | 4.7% | Taken from the difference in the measured total moisture and measured inherent moisture for recent coal testing at the Narrabri Coal Mine. |
| Moisture content of product coal | 7% | ACARP project C22027 notes that the product coal moisture is typically between 7-9%. |

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 A5-2**).

**Table A5-2: 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 OB, unloading trucks [coal and OB], rehandle, conveyor transfer, loading trains) | 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 |
| Material handling (loading trucks with coal) | kg/t | $\frac{0.58}{M^{1.2}}$ | $\frac{0.75 * 0.0596}{M^{0.9}}$ | 0.019 x TSP | AP42 11.9 |
| Dozers on coal | kg/hr | $35.6 \times \frac{s^{1.2}}{M^{1.3}}$ | $6.33 \times \frac{s^{1.5}}{M^{1.4}}$ | 0.022 x TSP | AP42 11.9 |
| Dozers on OB | 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 | $0.85 \times 1000$ | 0.5 * TSP | 0.075 * TSP | AP42 11.9 & 13.2.5 |
| Wind erosion and maintenance of stockpiles and ROM pads | kg/ha/hr | 1.8 * u | 0.5 * TSP | 0.075 * TSP | AP42 11.9 & 13.2.5 |
| Hauling on unsealed roads (including diesel exhaust) | 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 |
| Crushing coal (controlled) | kg/t | 0.0006 | 0.00027 | 0.00005 | AP42 11.19.2 |
| Screening coal (controlled) | kg/t | 0.0011 | 0.00037 | 0.00003 | AP42 11.19.2 |
| Soil stripping | kg/t | 0.029 | TSP x 0.5 | TSP x 0.105 | AP42 11.9 |

Note: OB = Overburden; 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.

# APPENDIX 6
# MODELLING RESULTS FOR NON-PRIVATE RECEPTORS

**Table A6-1: Predicted Project-only and cumulative annual average $PM_{10}$ concentration (µg/m³) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Project-only annual ave $PM_{10}$ (µg/m³) | | | Cumulative annual ave $PM_{10}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 9 | Year 20 |
| 1aa | 0.5 | 1.5 | 0.7 | 15.0 | 15.4 | 12.7 |
| 1ab | 0.4 | 1.3 | 0.7 | 14.9 | 15.1 | 12.7 |
| 1ac | 0.4 | 1.2 | 0.7 | 14.1 | 14.5 | 12.7 |
| 1ad | 1.6 | 5.7 | 1.3 | 16.3 | 20.0 | 13.3 |
| 1ae | 0.9 | 2.9 | 1.2 | 15.6 | 16.9 | 13.2 |
| 1af | 0.7 | 1.4 | 1.1 | 13.5 | 14.1 | 13.1 |
| 1aj | 0.8 | 2.8 | 0.9 | 16.9 | 18.7 | 12.9 |
| 1f | 1.5 | 6.4 | 1.2 | 17.5 | 22.0 | 13.2 |
| 1g | 0.3 | 0.9 | 0.6 | 24.2 | 13.6 | 12.6 |
| 1i | 0.2 | 0.6 | 0.4 | 13.5 | 13.3 | 12.4 |
| 1l | 0.5 | 1.3 | 2.1 | 14.8 | 14.0 | 14.1 |
| 1m | 0.2 | 0.6 | 0.3 | 14.0 | 13.1 | 12.3 |
| 1n | 0.1 | 0.5 | 0.3 | 13.7 | 13.1 | 12.3 |
| 1o | 0.2 | 0.6 | 0.5 | 17.2 | 13.2 | 12.5 |
| 1t | 1.0 | 3.2 | 1.0 | 15.8 | 17.6 | 13.0 |
| 1u | 2.2 | 3.9 | 3.2 | 16.0 | 17.6 | 15.2 |
| 1v | 6.2 | 11.1 | 11.4 | 19.5 | 24.1 | 23.4 |
| 1w | 1.9 | 3.6 | 2.9 | 14.9 | 16.5 | 14.9 |
| 1x | 1.6 | 6.2 | 1.5 | 16.3 | 20.3 | 13.5 |
| 1y | 1.0 | 1.9 | 1.4 | 13.9 | 14.7 | 13.4 |
| 1z | 2.2 | 3.7 | 2.6 | 15.4 | 16.7 | 14.6 |
| 88 | 0.8 | 2.5 | 0.9 | 15.9 | 17.5 | 12.9 |
| 303a | 0.5 | 1.5 | 0.7 | 15.5 | 16.4 | 12.7 |
| 303b | 0.5 | 1.6 | 0.7 | 15.4 | 16.4 | 12.7 |
| 339 | 0.6 | 1.7 | 0.8 | 15.5 | 16.0 | 12.8 |

**Table A6-2: Predicted Project-only and cumulative 24-hour average $PM_{10}$ concentration (µg/m³) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Project-only 24-hr average $PM_{10}$ concentration (µg/m³) | | | Cumulative 24-hr average $PM_{10}$ concentration (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 1aa | 4.3 | 11.0 | 8.5 | 35.6 | 36.9 | 31.4 |
| 1ab | 4.3 | 9.1 | 11.3 | 35.0 | 35.9 | 31.6 |
| 1ac | 3.6 | 8.3 | 9.4 | 33.6 | 34.6 | 31.5 |
| 1ad | 13.4 | 44.5 | 12.6 | 37.1 | **55.8** | 32.4 |
| 1ae | 5.4 | 17.3 | 14.2 | 35.8 | 38.7 | 31.5 |
| 1af | 5.0 | 7.8 | 10.2 | 34.8 | 36.5 | 32.0 |
| 1aj | 7.0 | 19.6 | 8.9 | 40.6 | 42.8 | 31.9 |
| 1f | 10.9 | 37.1 | 12.7 | 40.9 | 45.8 | 32.7 |
| 1g | 5.4 | 10.8 | 8.7 | **51.6** | 34.3 | 31.0 |
| 1i | 4.9 | 9.2 | 3.1 | 32.8 | 32.4 | 30.9 |
| 1l | 5.3 | 13.8 | 21.8 | 36.1 | 34.1 | 45.5 |
| 1m | 3.1 | 7.3 | 4.8 | 36.8 | 32.6 | 30.9 |
| 1n | 2.3 | 6.0 | 12.1 | 34.4 | 32.6 | 30.9 |
| 1o | 5.5 | 8.1 | 17.6 | 47.8 | 32.7 | 31.0 |
| 1t | 9.6 | 24.3 | 11.4 | 36.7 | 47.3 | 31.2 |
| 1u | 12.9 | 13.8 | 25.5 | 35.5 | 37.2 | 34.2 |
| 1v | 42.9 | 44.1 | **69.3** | 49.6 | **65.5** | **76.0** |
| 1w | 10.1 | 18.0 | 19.6 | 35.4 | 40.7 | 33.8 |
| 1x | 13.0 | 36.3 | 17.9 | 37.2 | 44.1 | 32.3 |
| 1y | 5.7 | 9.8 | 15.1 | 35.4 | 36.5 | 31.5 |
| 1z | 12.4 | 15.1 | 22.5 | 37.9 | 39.8 | 44.5 |
| 88 | 6.6 | 16.5 | 7.3 | 37.9 | 38.5 | 31.4 |
| 303a | 3.8 | 12.6 | 5.9 | 38.4 | 38.8 | 31.2 |
| 303b | 4.5 | 14.1 | 5.7 | 38.0 | 38.4 | 31.2 |
| 339 | 5.1 | 13.9 | 11.1 | 36.9 | 38.4 | 31.2 |

**Table A6-3: Predicted Project-only and cumulative annual average $PM_{2.5}$ concentration (µg/m³) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Annual Ave $PM_{2.5}$ (µg/m³) | | | Cumulative Annual Ave $PM_{2.5}$ (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 1aa | 0.1 | 0.3 | 0.1 | 6.0 | 6.1 | 5.4 |
| 1ab | 0.1 | 0.3 | 0.1 | 6.0 | 6.0 | 5.4 |
| 1ac | 0.1 | 0.3 | 0.1 | 5.8 | 5.9 | 5.4 |
| 1ad | 0.4 | 1.1 | 0.3 | 6.3 | 7.0 | 5.6 |
| 1ae | 0.2 | 0.6 | 0.2 | 6.1 | 6.3 | 5.5 |
| 1af | 0.2 | 0.3 | 0.2 | 5.7 | 5.8 | 5.5 |
| 1aj | 0.2 | 0.6 | 0.2 | 6.4 | 6.7 | 5.5 |
| 1f | 0.4 | 1.2 | 0.2 | 6.6 | 7.3 | 5.5 |
| 1g | 0.1 | 0.2 | 0.1 | 7.1 | 5.7 | 5.4 |
| 1i | 0.1 | 0.1 | 0.1 | 5.6 | 5.6 | 5.4 |
| 1l | 0.1 | 0.3 | 0.4 | 5.9 | 5.8 | 5.7 |
| 1m | 0.0 | 0.1 | 0.1 | 5.7 | 5.6 | 5.4 |
| 1n | 0.0 | 0.1 | 0.1 | 5.7 | 5.6 | 5.4 |
| 1o | 0.1 | 0.1 | 0.1 | 6.1 | 5.6 | 5.4 |
| 1t | 0.3 | 0.7 | 0.2 | 6.2 | 6.5 | 5.5 |
| 1u | 0.6 | 0.8 | 0.7 | 6.3 | 6.5 | 6.0 |
| 1v | 1.2 | 2.0 | 1.9 | 6.8 | 7.6 | 7.2 |
| 1w | 0.5 | 0.8 | 0.6 | 6.1 | 6.3 | 5.9 |
| 1x | 0.4 | 1.2 | 0.3 | 6.3 | 7.0 | 5.6 |
| 1y | 0.3 | 0.4 | 0.3 | 5.8 | 6.0 | 5.6 |
| 1z | 0.6 | 0.8 | 0.5 | 6.2 | 6.4 | 5.8 |
| 88 | 0.2 | 0.5 | 0.2 | 6.2 | 6.5 | 5.5 |
| 303a | 0.1 | 0.3 | 0.1 | 6.1 | 6.3 | 5.4 |
| 303b | 0.2 | 0.4 | 0.1 | 6.1 | 6.3 | 5.4 |
| 339 | 0.1 | 0.4 | 0.2 | 6.1 | 6.2 | 5.5 |

**Table A6-4: Predicted Project-only and cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Project-only 24-hr average $PM_{2.5}$ concentration (µg/m³) | | | Cumulative 24-hr average $PM_{2.5}$ concentration (µg/m³) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 1aa | 0.9 | 2.1 | 1.6 | 23.9 | 23.9 | 23.7 |
| 1ab | 0.8 | 1.6 | 2.0 | 23.9 | 23.8 | 23.7 |
| 1ac | 0.7 | 1.5 | 1.7 | 23.8 | 23.8 | 23.7 |
| 1ad | 2.8 | 8.1 | 2.5 | 24.0 | **25.4** | 23.8 |
| 1ae | 1.1 | 3.0 | 2.6 | 24.0 | 24.4 | 23.8 |
| 1af | 1.2 | 1.7 | 1.8 | 24.0 | 24.3 | 23.7 |
| 1aj | 1.8 | 3.3 | 1.6 | 24.2 | 24.6 | 23.8 |
| 1f | 2.6 | 6.0 | 2.1 | 24.4 | **25.1** | 23.9 |
| 1g | 1.4 | 2.2 | 1.9 | **25.5** | 23.8 | 23.7 |
| 1i | 1.1 | 1.7 | 0.6 | 23.8 | 23.8 | 23.7 |
| 1l | 1.2 | 2.4 | 3.4 | 23.8 | 23.8 | 23.7 |
| 1m | 0.7 | 1.4 | 0.8 | 23.8 | 23.7 | 23.7 |
| 1n | 0.5 | 1.4 | 1.9 | 23.8 | 23.7 | 23.7 |
| 1o | 1.0 | 1.7 | 3.1 | 24.4 | 23.8 | 23.7 |
| 1t | 2.0 | 4.6 | 2.3 | 24.0 | 24.5 | 23.8 |
| 1u | 3.3 | 3.5 | 5.7 | 24.0 | 24.0 | 24.0 |
| 1v | 8.5 | 8.3 | 13.4 | 24.7 | **26.3** | 24.6 |
| 1w | 3.0 | 3.9 | 4.1 | 24.3 | 24.9 | 23.9 |
| 1x | 3.0 | 6.0 | 3.4 | 24.0 | **25.5** | 23.8 |
| 1y | 1.4 | 1.9 | 3.2 | 24.1 | 24.2 | 23.7 |
| 1z | 2.6 | 2.8 | 4.6 | 24.4 | 24.4 | 23.7 |
| 88 | 1.6 | 3.1 | 1.3 | 24.1 | 24.6 | 23.8 |
| 303a | 1.0 | 2.4 | 1.1 | 24.2 | 24.4 | 23.8 |
| 303b | 1.2 | 2.7 | 1.0 | 24.1 | 24.4 | 23.8 |
| 339 | 1.1 | 2.3 | 2.0 | 24.0 | 24.0 | 23.8 |

**Table A6-5: Predicted Project-only and cumulative TSP (µg/m$^3$) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Annual Ave TSP (µg/m3) | | | Cumulative Annual Ave TSP (µg/m3) | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 1aa | 1.0 | 3.2 | 1.6 | 34.1 | 35.4 | 31.5 |
| 1ab | 0.9 | 2.8 | 1.6 | 34.0 | 34.8 | 31.5 |
| 1ac | 0.7 | 2.3 | 1.4 | 33.0 | 33.8 | 31.3 |
| 1ad | 3.1 | 12.6 | 2.8 | 36.6 | 45.3 | 32.7 |
| 1ae | 1.8 | 6.6 | 2.6 | 35.3 | 38.8 | 32.5 |
| 1af | 1.1 | 2.5 | 2.2 | 31.9 | 33.2 | 32.1 |
| 1aj | 1.5 | 5.8 | 1.8 | 30.9 | 34.8 | 25.7 |
| 1f | 3.0 | 14.4 | 2.6 | 38.3 | 49.2 | 32.5 |
| 1g | 0.5 | 1.8 | 1.3 | 57.9 | 32.6 | 31.2 |
| 1i | 0.4 | 1.2 | 0.9 | 32.1 | 31.9 | 30.8 |
| 1l | 1.0 | 2.6 | 4.9 | 34.4 | 33.3 | 34.8 |
| 1m | 0.4 | 1.3 | 0.7 | 33.2 | 31.8 | 30.6 |
| 1n | 0.3 | 1.1 | 0.9 | 32.7 | 31.6 | 30.8 |
| 1o | 0.4 | 1.2 | 1.1 | 42.4 | 31.9 | 31.0 |
| 1t | 1.9 | 6.7 | 2.1 | 35.5 | 39.6 | 32.0 |
| 1u | 4.2 | 8.0 | 7.2 | 36.4 | 40.0 | 37.1 |
| 1v | 13.1 | 25.6 | 28.9 | 44.5 | 56.7 | 58.8 |
| 1w | 3.3 | 6.8 | 6.2 | 34.4 | 37.7 | 36.1 |
| 1x | 3.3 | 14.1 | 3.3 | 36.7 | 46.6 | 33.2 |
| 1y | 1.7 | 3.4 | 2.9 | 32.7 | 34.3 | 32.8 |
| 1z | 3.9 | 7.1 | 5.5 | 35.2 | 38.2 | 35.4 |
| 88 | 1.5 | 5.5 | 1.9 | 29.5 | 33.2 | 25.8 |
| 303a | 0.9 | 3.0 | 1.4 | 28.7 | 30.6 | 25.3 |
| 303b | 0.9 | 3.3 | 1.4 | 28.6 | 30.8 | 25.3 |
| 339 | 1.2 | 3.8 | 1.8 | 34.9 | 36.5 | 31.7 |

**Table A6-6: Predicted Project-only and cumulative dust deposition (g/m²/month) at mine-owned receptors (and properties under option agreement with Whitehaven)**

| ID | Dust Deposition | | | Cumulative Dust Deposition | | |
|---|---|---|---|---|---|---|
| | Year 3 | Year 7 | Year 21 | Year 3 | Year 7 | Year 21 |
| 1aa | 0.0 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 1ab | 0.0 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 1ac | 0.0 | 0.1 | 0.1 | 2.9 | 2.9 | 2.9 |
| 1ad | 0.1 | 0.6 | 0.1 | 3.0 | 3.4 | 2.9 |
| 1ae | 0.1 | 0.3 | 0.1 | 2.9 | 3.1 | 2.9 |
| 1af | 0.0 | 0.1 | 0.1 | 2.8 | 2.9 | 2.9 |
| 1aj | 0.1 | 0.2 | 0.1 | 2.9 | 3.1 | 2.9 |
| 1f | 0.1 | 0.7 | 0.1 | 2.9 | 3.5 | 2.9 |
| 1g | 0.0 | 0.1 | 0.1 | 3.1 | 2.9 | 2.9 |
| 1i | 0.0 | 0.0 | 0.0 | 2.8 | 2.9 | 2.8 |
| 1l | 0.1 | 0.1 | 0.3 | 2.9 | 2.9 | 3.1 |
| 1m | 0.0 | 0.1 | 0.0 | 2.9 | 2.9 | 2.8 |
| 1n | 0.0 | 0.1 | 0.0 | 2.8 | 2.9 | 2.8 |
| 1o | 0.0 | 0.1 | 0.1 | 3.0 | 2.9 | 2.9 |
| 1t | 0.1 | 0.3 | 0.1 | 2.9 | 3.1 | 2.9 |
| 1u | 0.3 | 0.5 | 0.6 | 3.1 | 3.3 | 3.4 |
| 1v | 0.7 | 1.2 | 1.6 | 3.5 | 4.0 | **4.4** |
| 1w | 0.1 | 0.2 | 0.3 | 2.9 | 3.0 | 3.1 |
| 1x | 0.2 | 0.7 | 0.1 | 3.0 | 3.5 | 2.9 |
| 1y | 0.1 | 0.1 | 0.2 | 2.9 | 2.9 | 3.0 |
| 1z | 0.2 | 0.3 | 0.3 | 3.0 | 3.1 | 3.1 |
| 88 | 0.1 | 0.3 | 0.1 | 2.9 | 3.2 | 2.9 |
| 303a | 0.0 | 0.2 | 0.1 | 2.9 | 3.0 | 2.9 |
| 303b | 0.0 | 0.2 | 0.1 | 2.9 | 3.0 | 2.9 |
| 339 | 0.1 | 0.2 | 0.1 | 2.9 | 3.0 | 2.9 |

# APPENDIX 7
# CONTOUR PLOTS

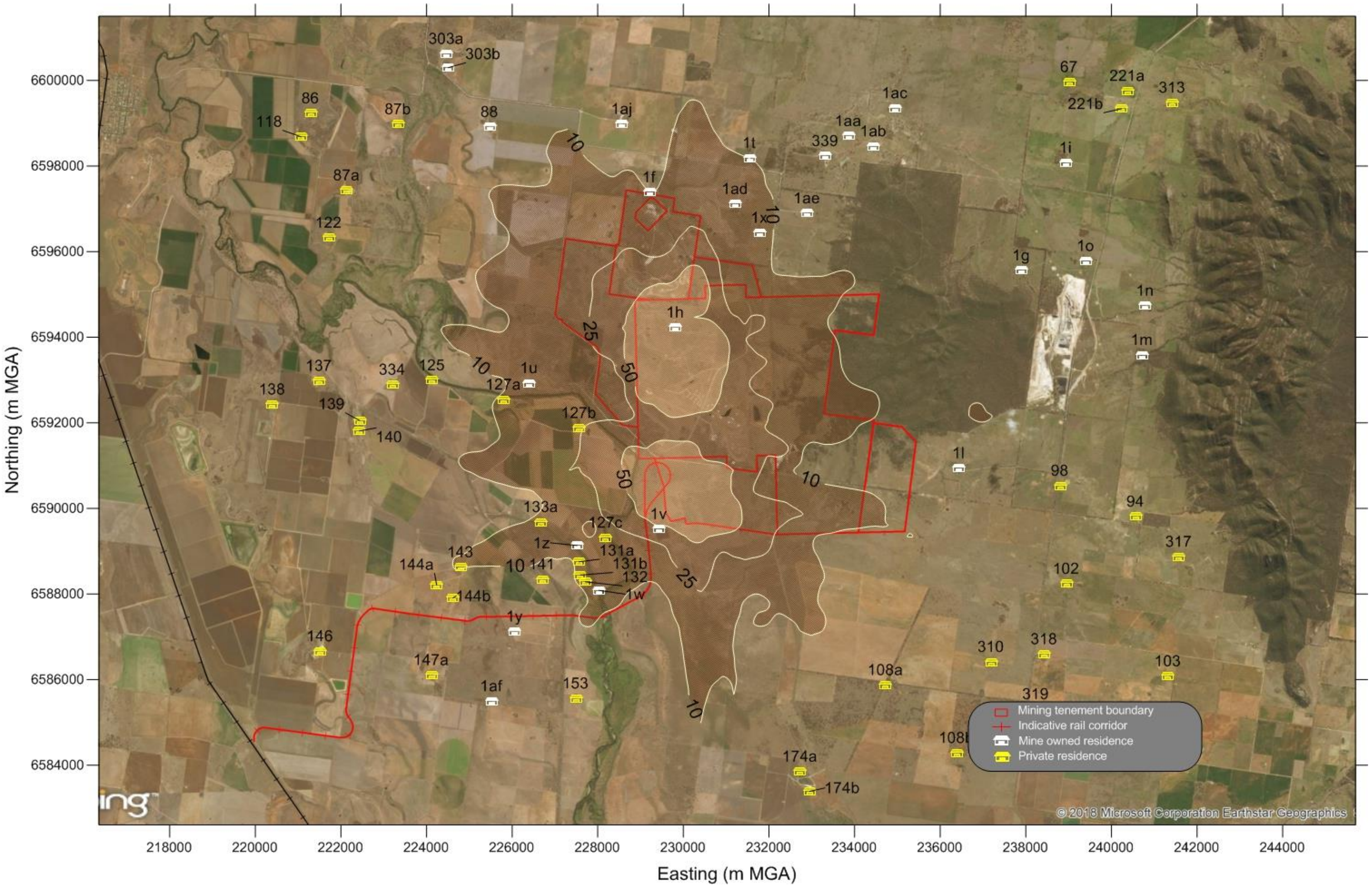



**Figure A7-1: Project-only 24-hour average $PM_{10}$ contours – Year 3**

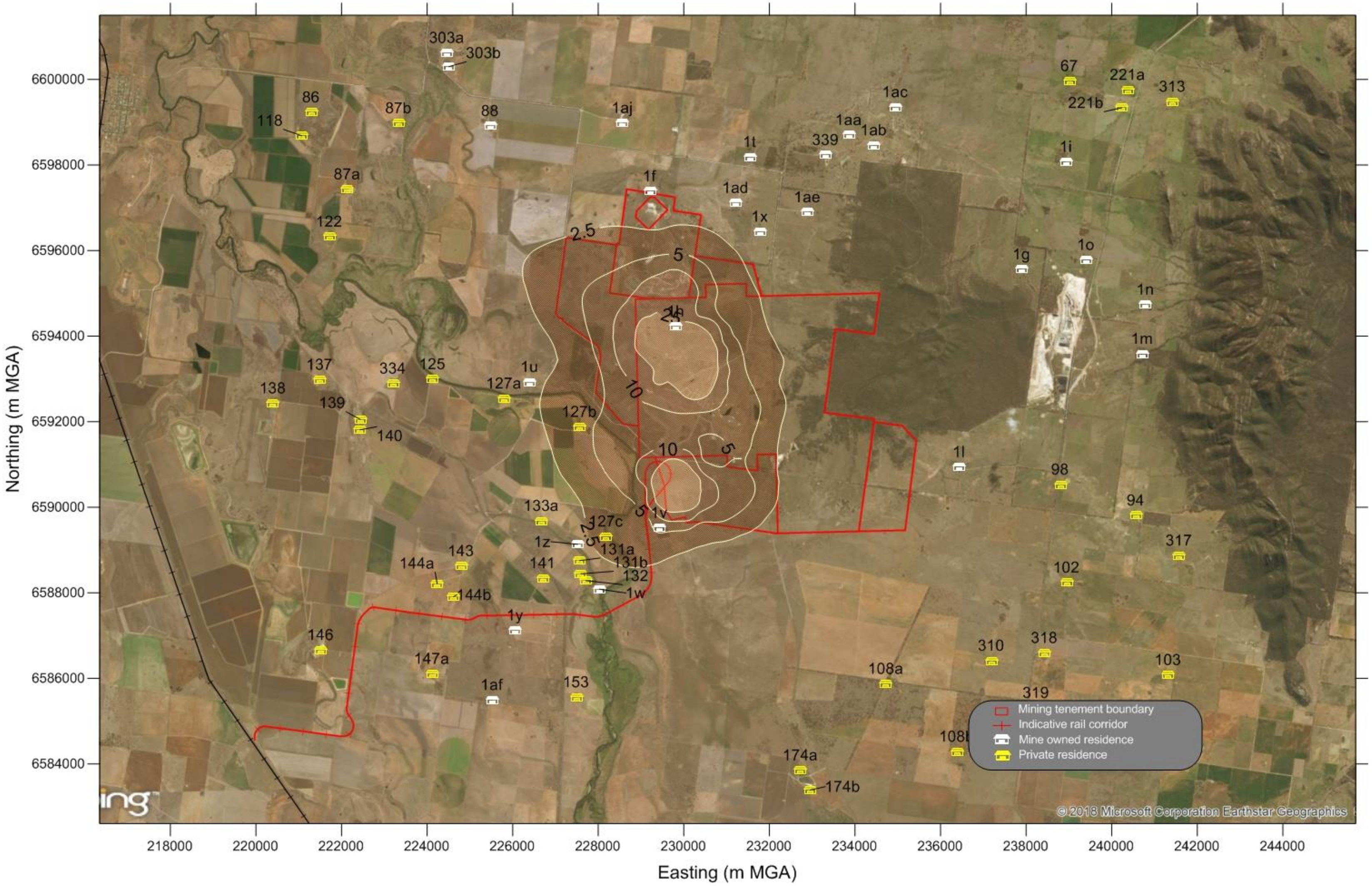



**Figure A7-2: Project-only annual average $PM_{10}$ contours – Year 3**

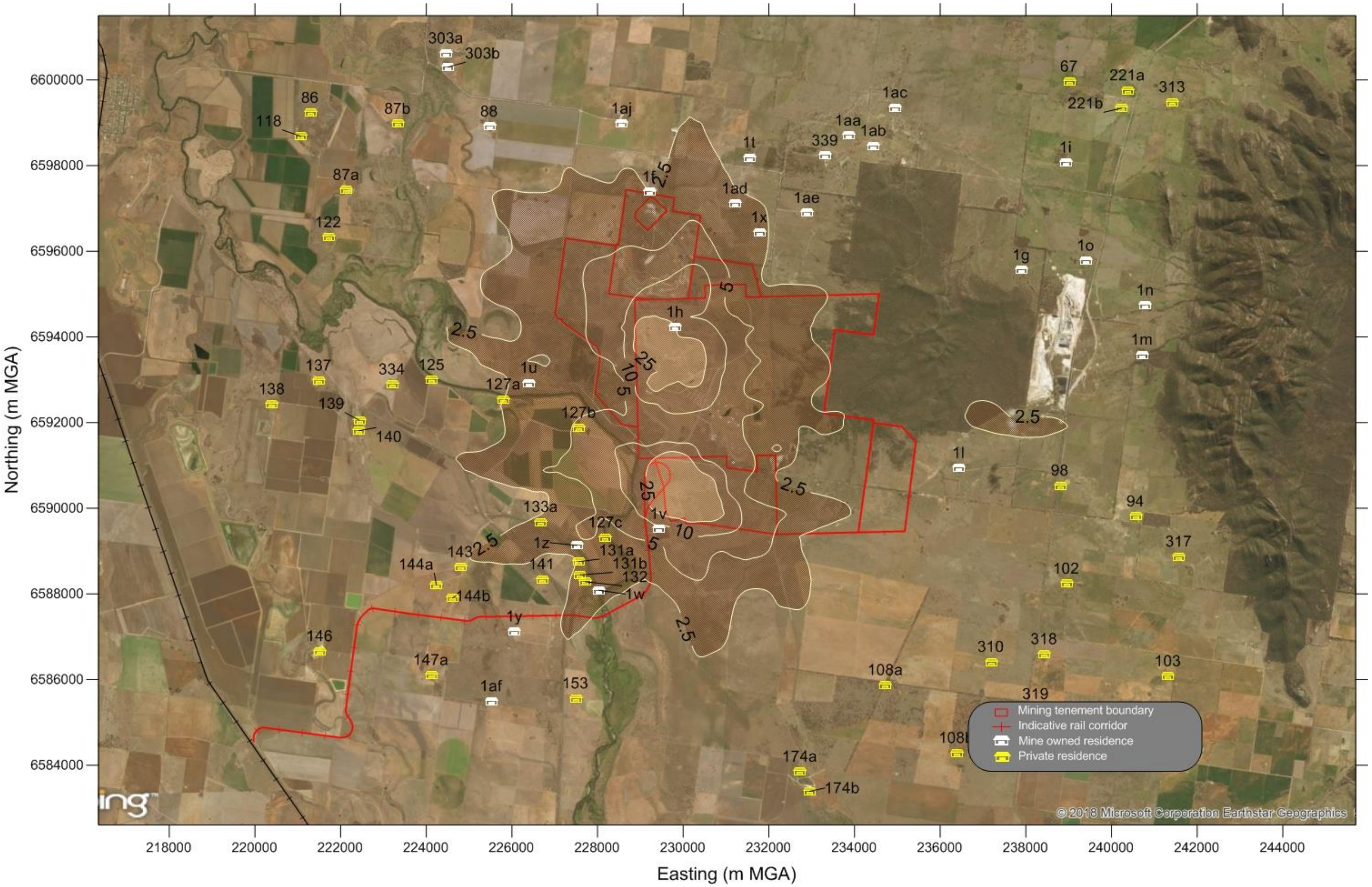



**Figure A7-3: Project-only 24-hour average $PM_{2.5}$ contours – Year 3**

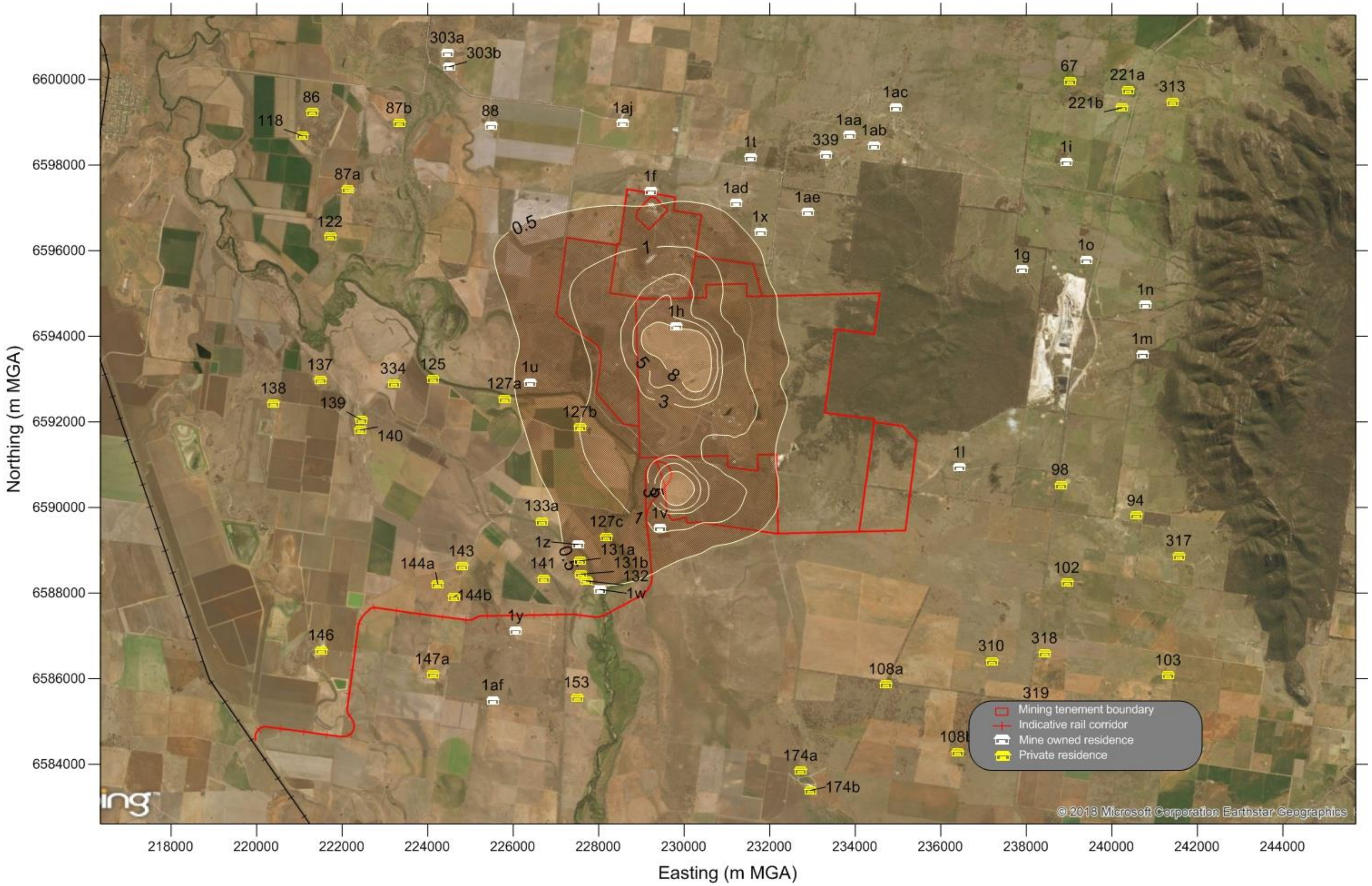



Figure A7-4: Project-only annual average $PM_{2.5}$ contours – Year 3

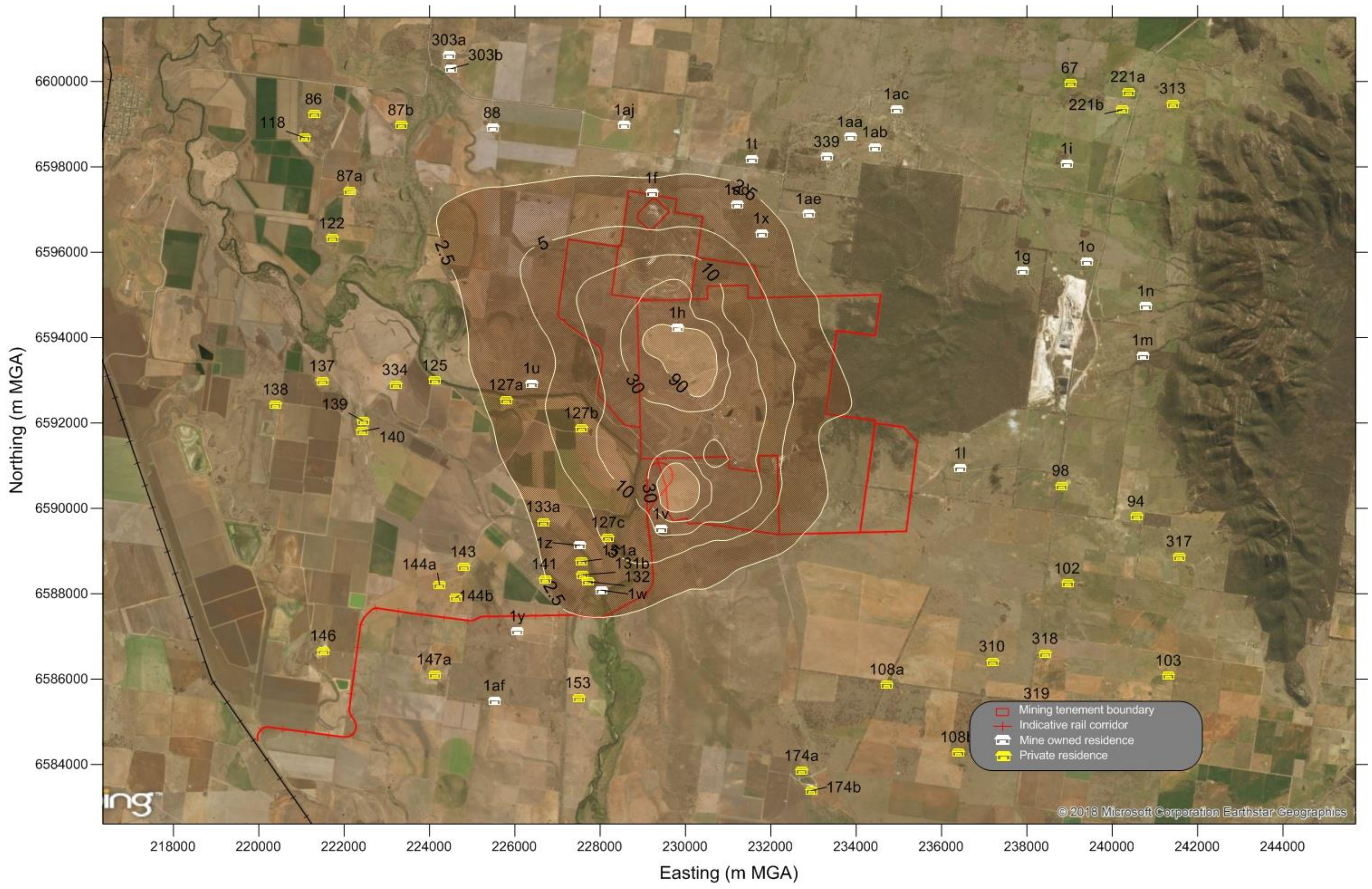



**Figure A7-5: Project-only annual average TSP contours – Year 3**

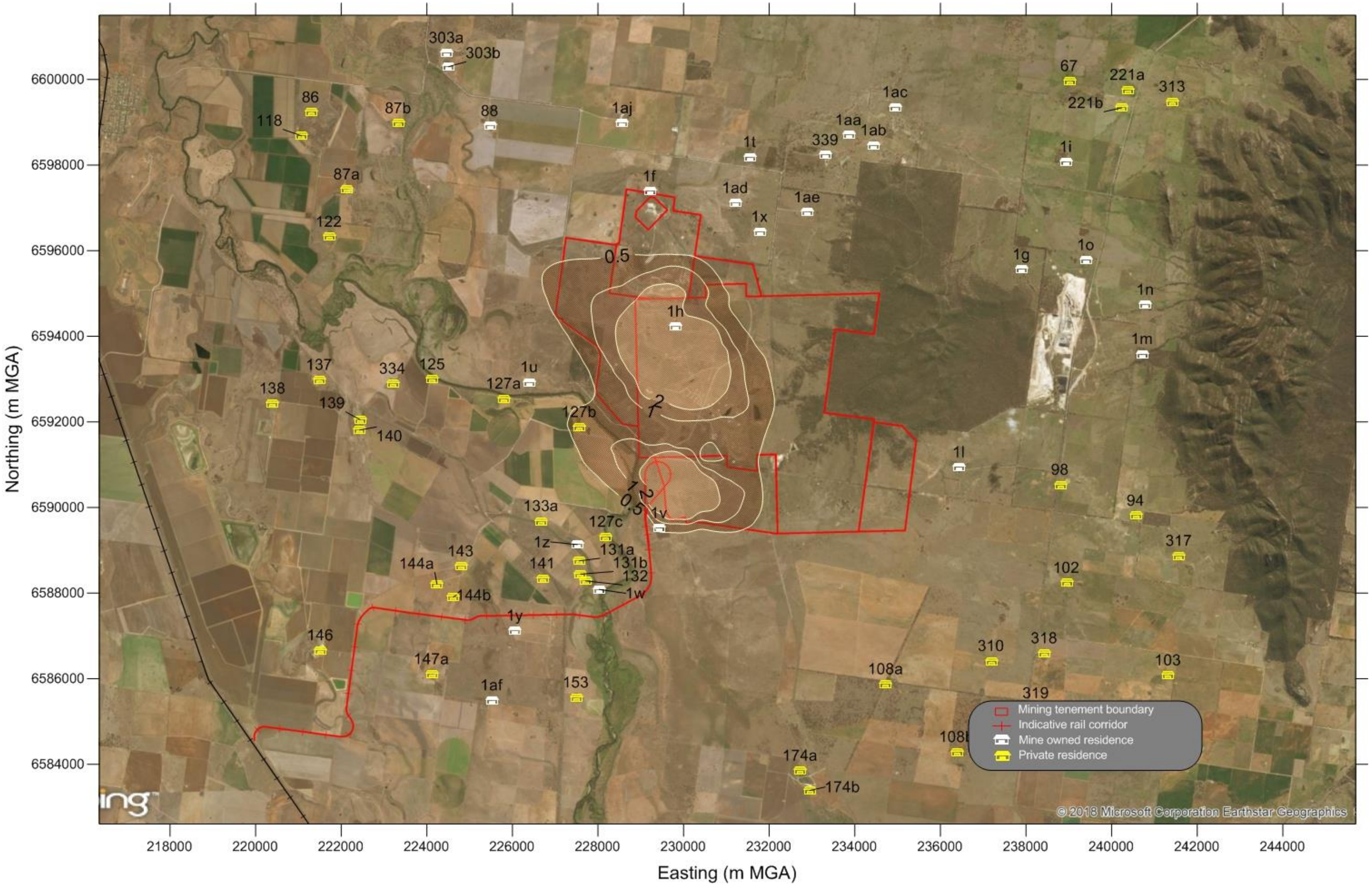



**Figure A7-6: Project-only annual average dust deposition contours – Year 3**

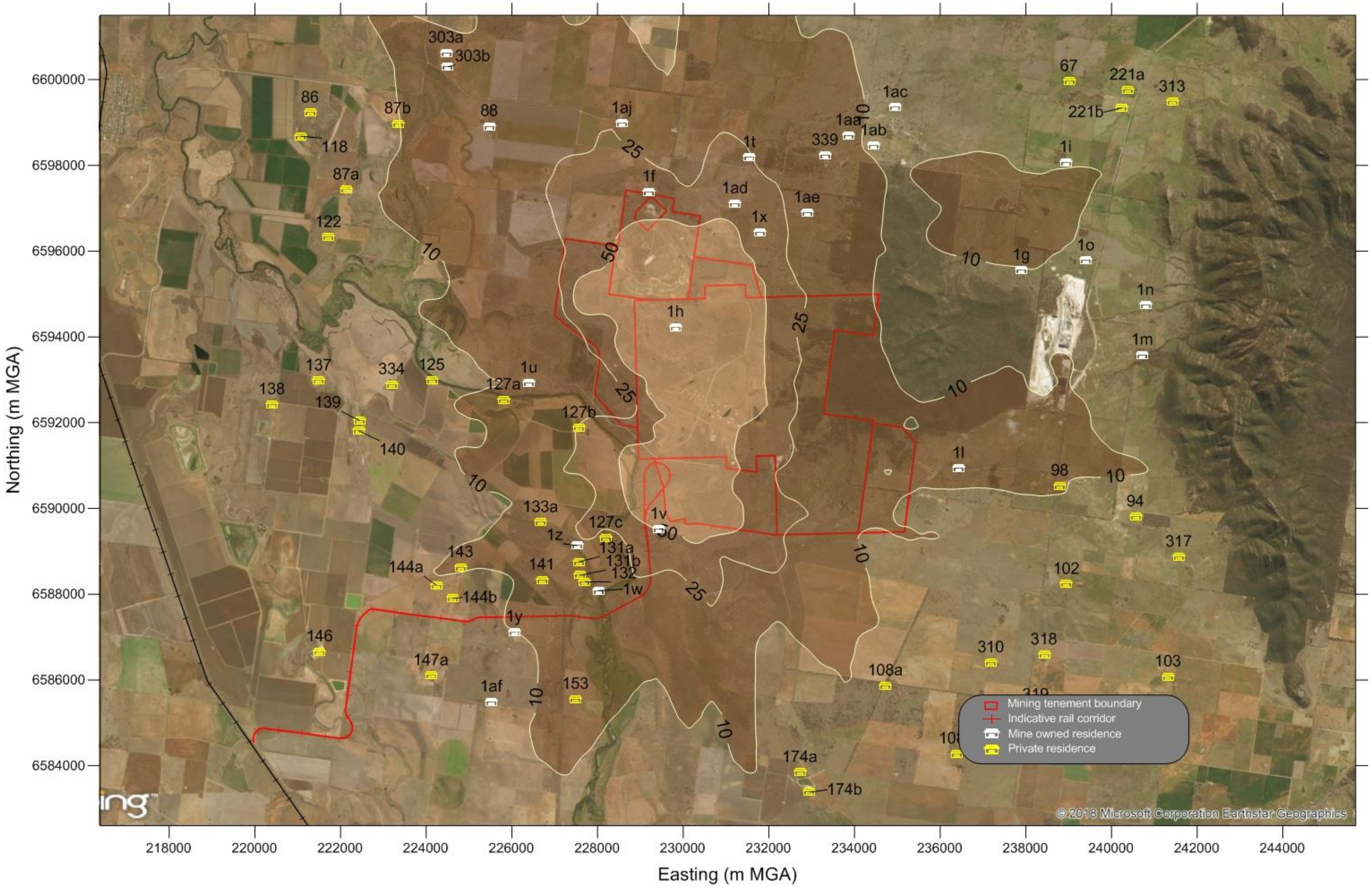



**Figure A7-7: Project-only 24-hour average $PM_{10}$ contours – Year 7**

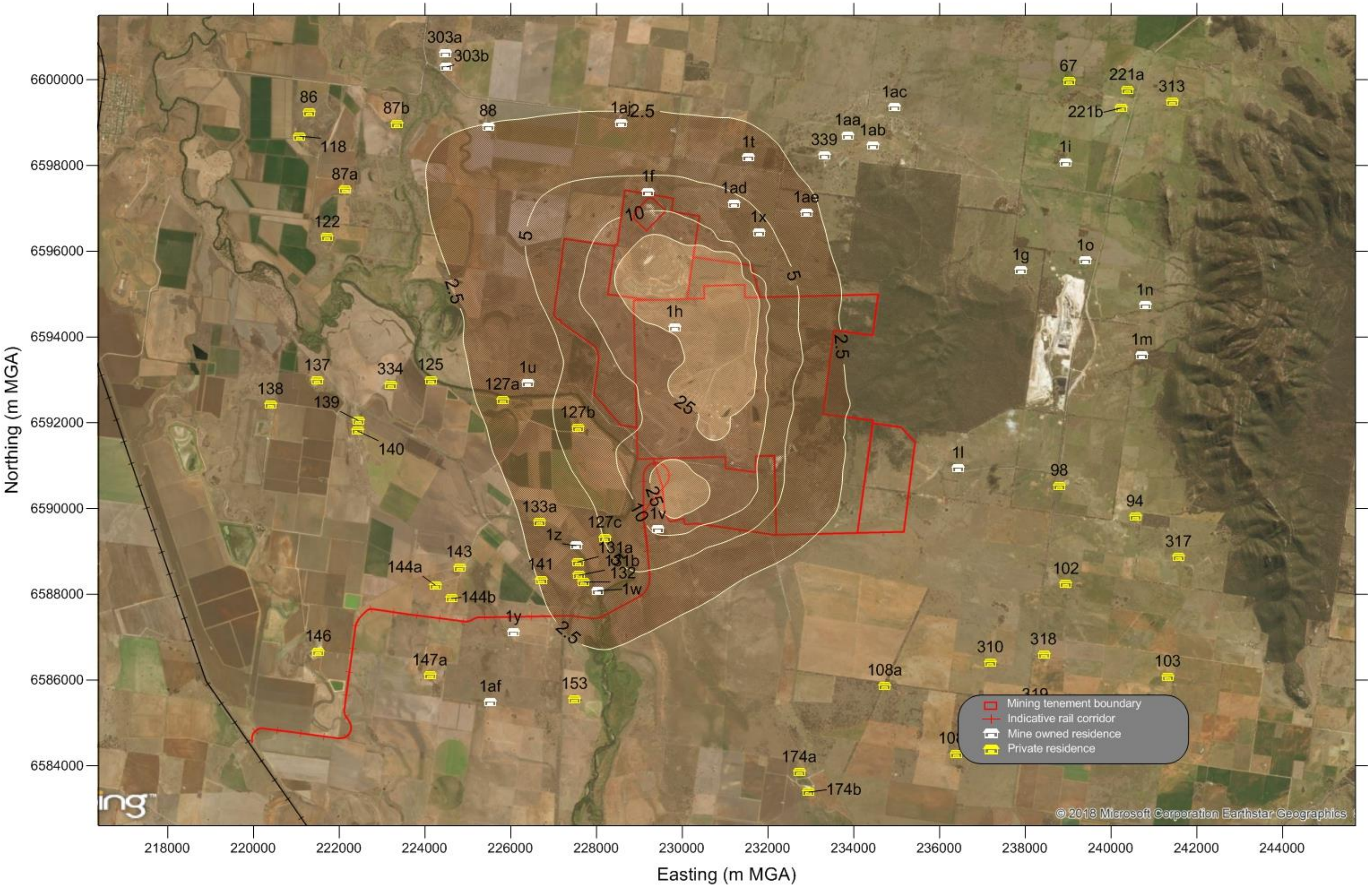



Figure A7-8: Project-only annual average $PM_{10}$ contours – Year 7

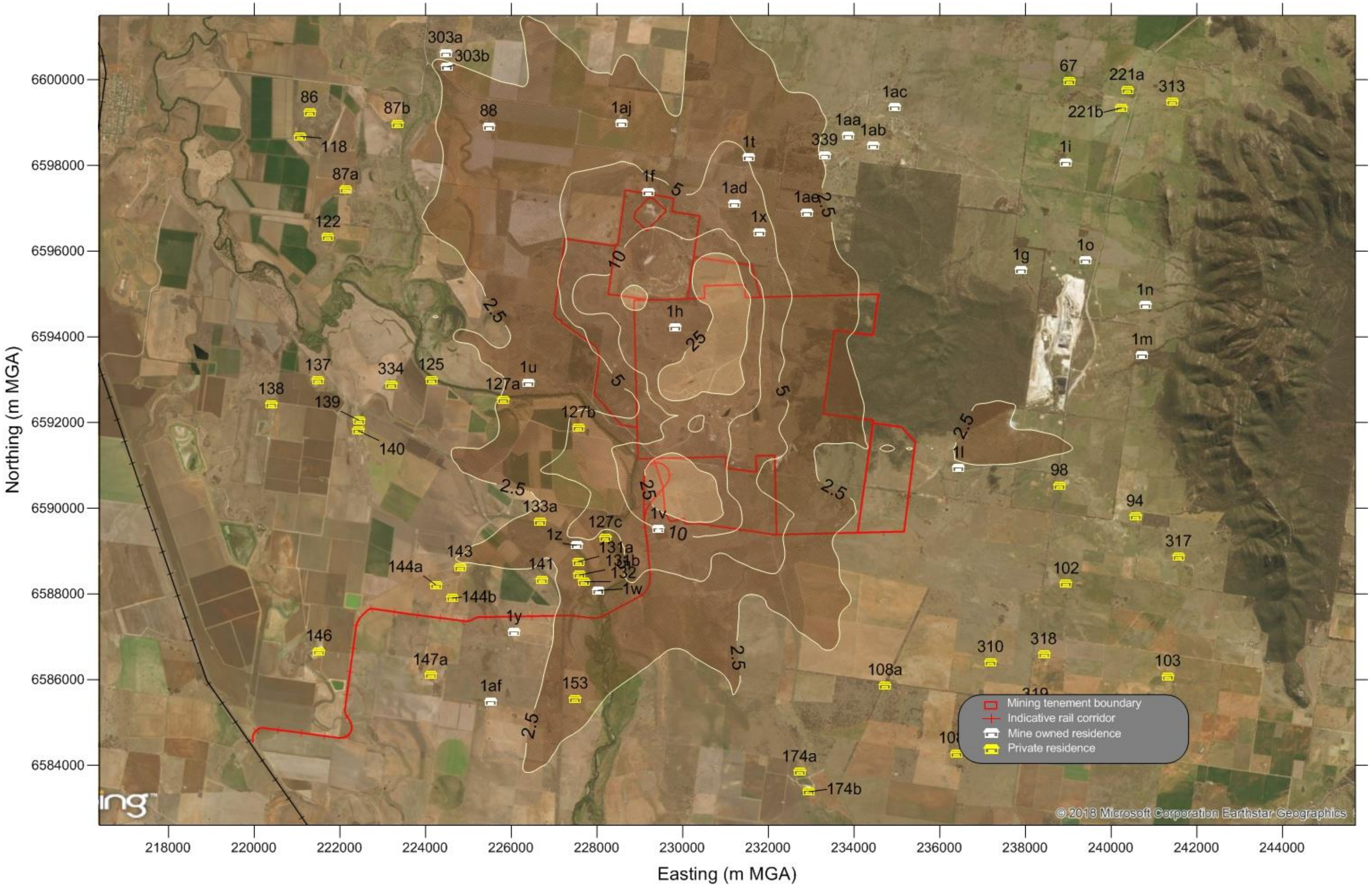



**Figure A7-9: Project-only 24-hour average $PM_{2.5}$ contours – Year 7**

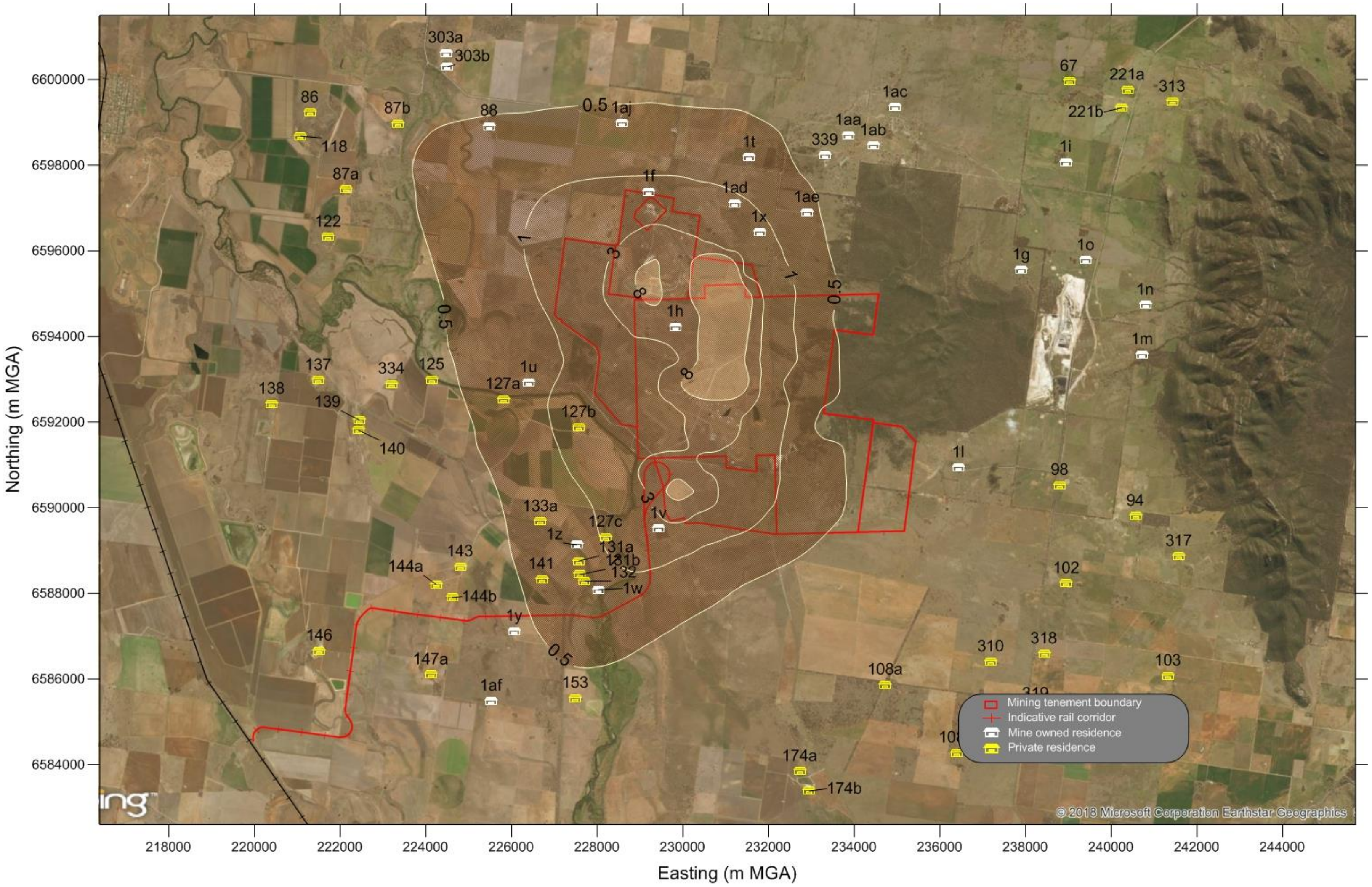



**Figure A7-10: Project-only annual average $PM_{2.5}$ contours – Year 7**

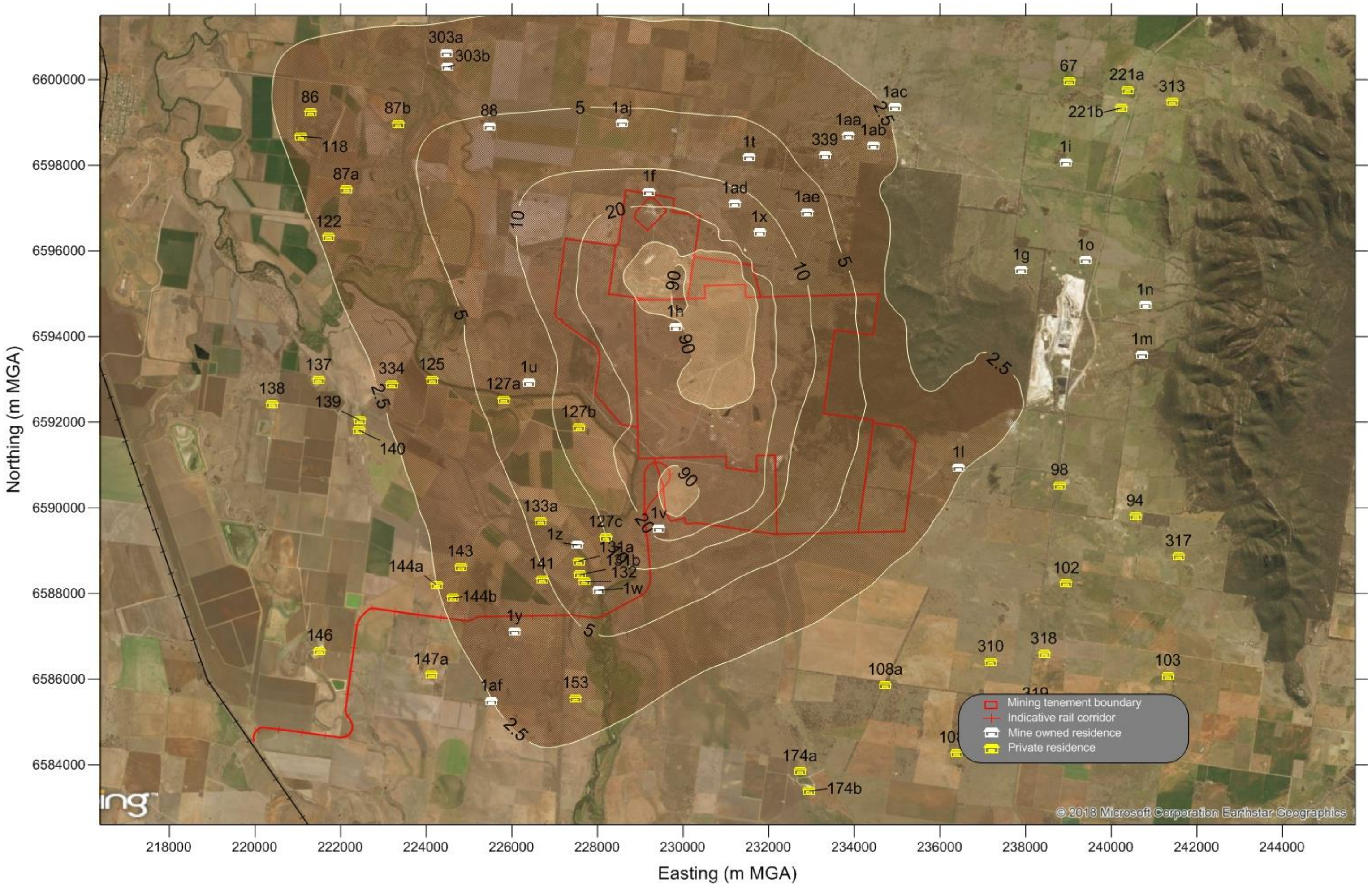



**Figure A7-11: Project-only annual average TSP contours – Year 7**

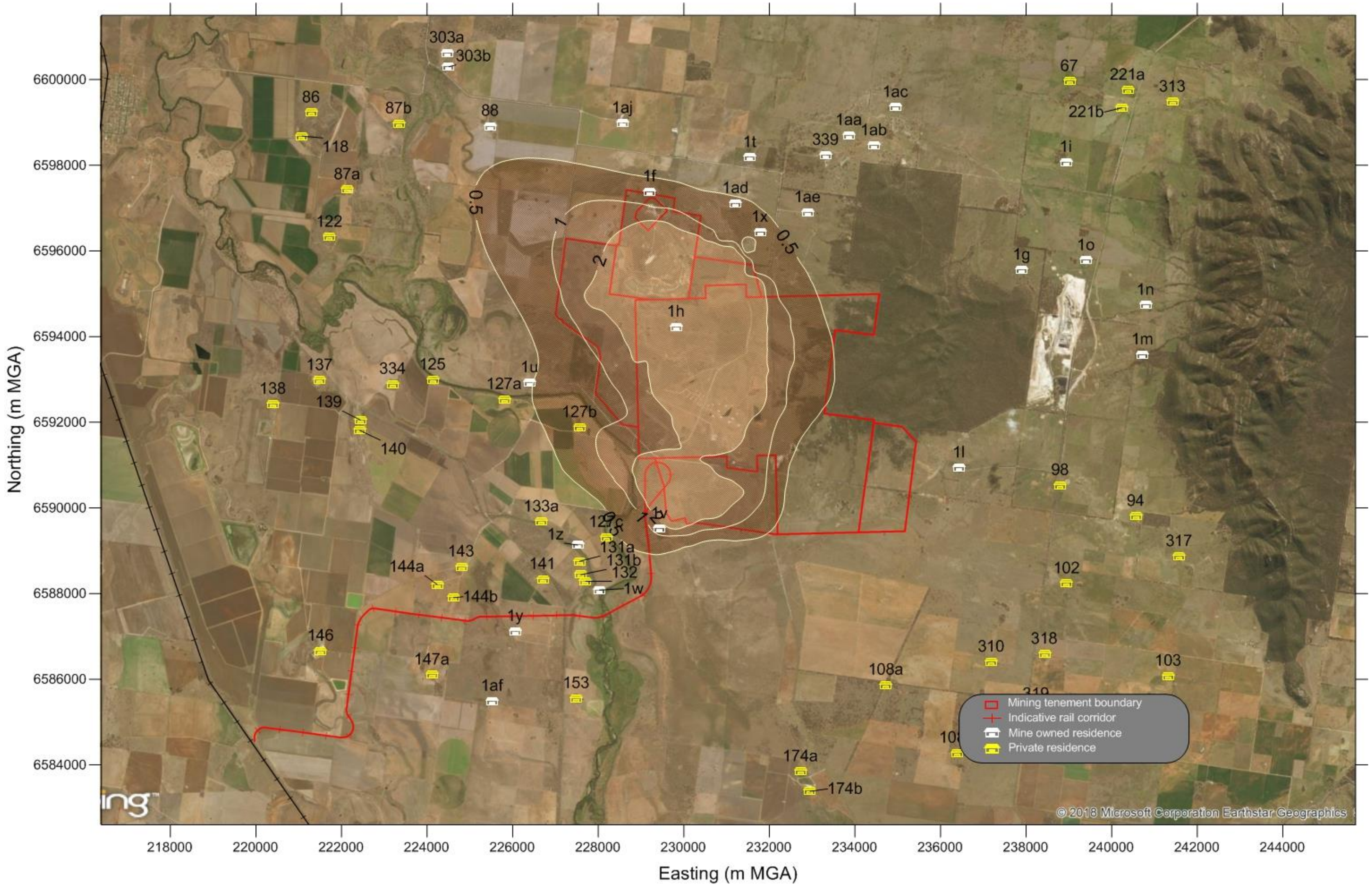



**Figure A7-12: Project-only annual average dust deposition contours – Year 7**

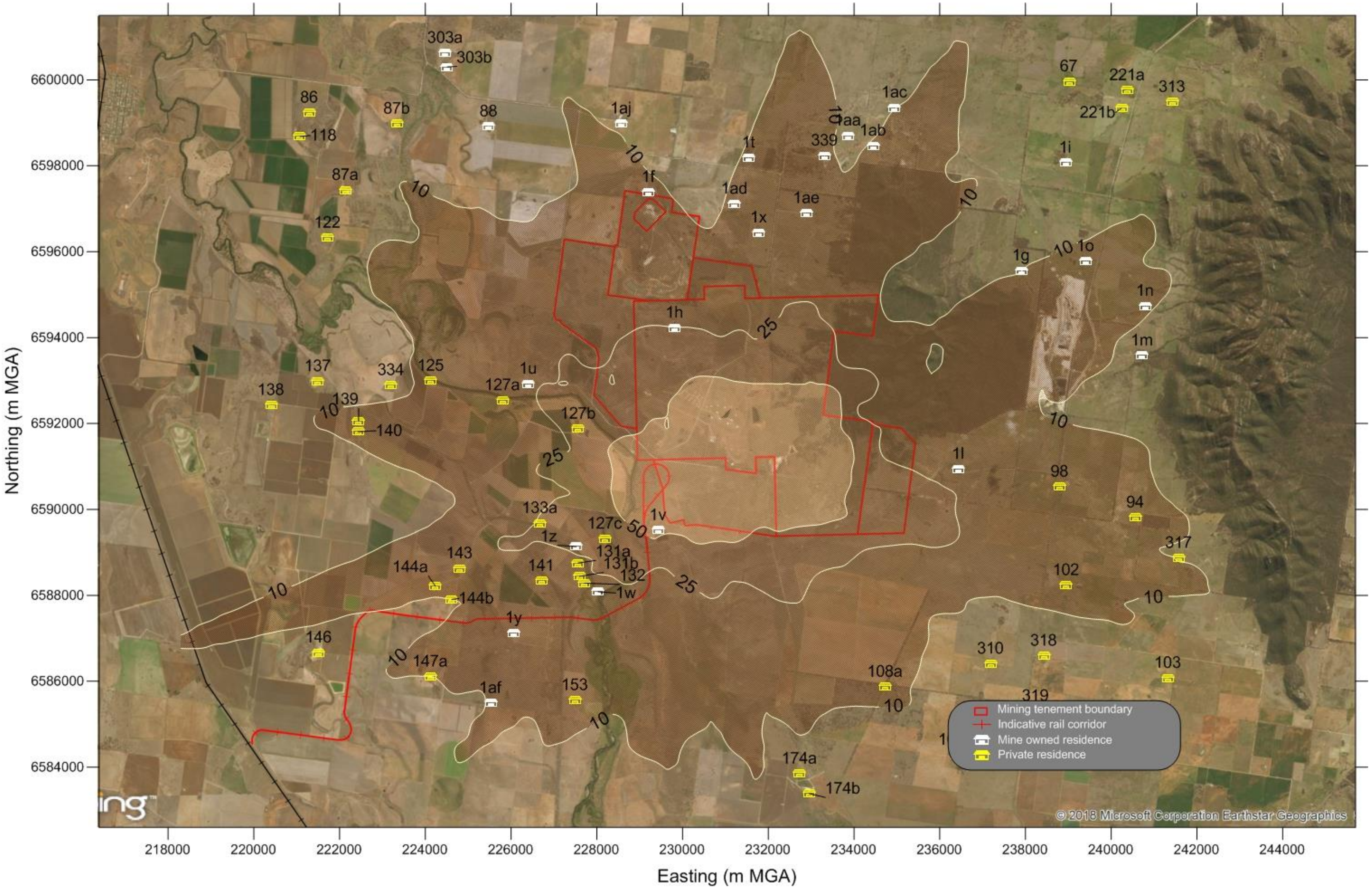



**Figure A7-13: Project-only 24-hour average $PM_{10}$ contours – Year 21**

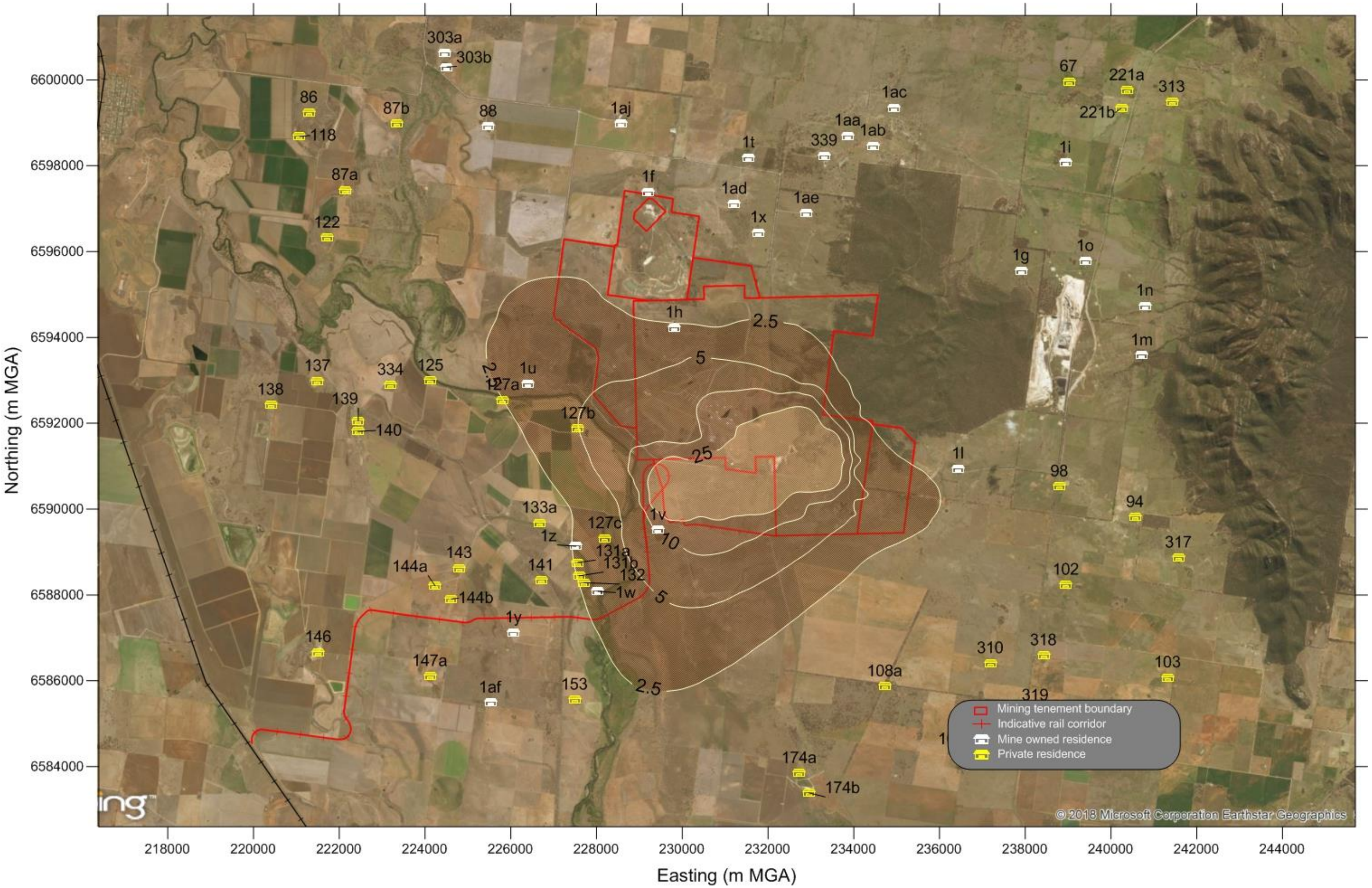



**Figure A7-14: Project-only annual average $PM_{10}$ contours – Year 21**

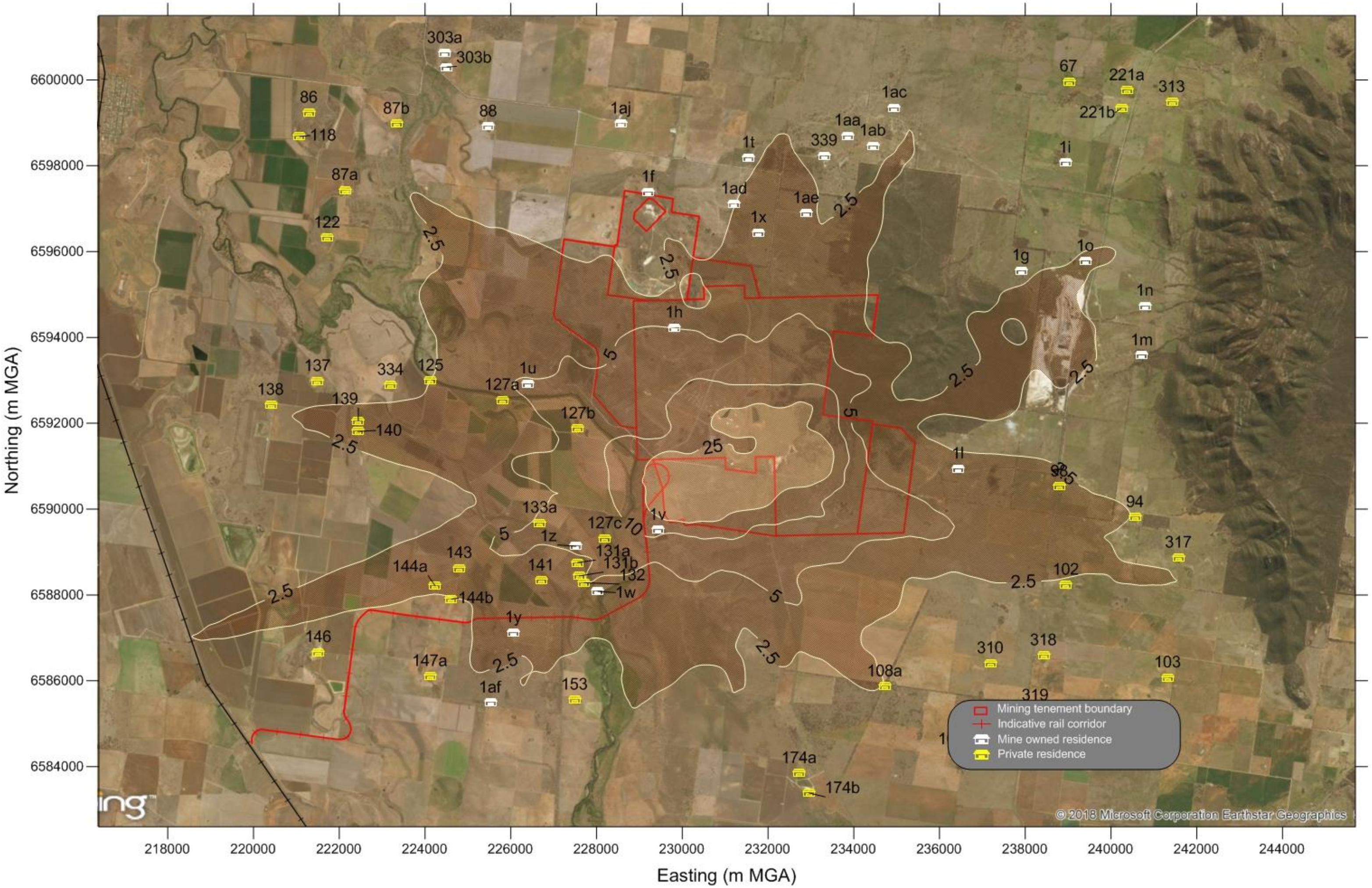



**Figure A7-15: Project-only 24-hour average $PM_{2.5}$ contours – Year 21**

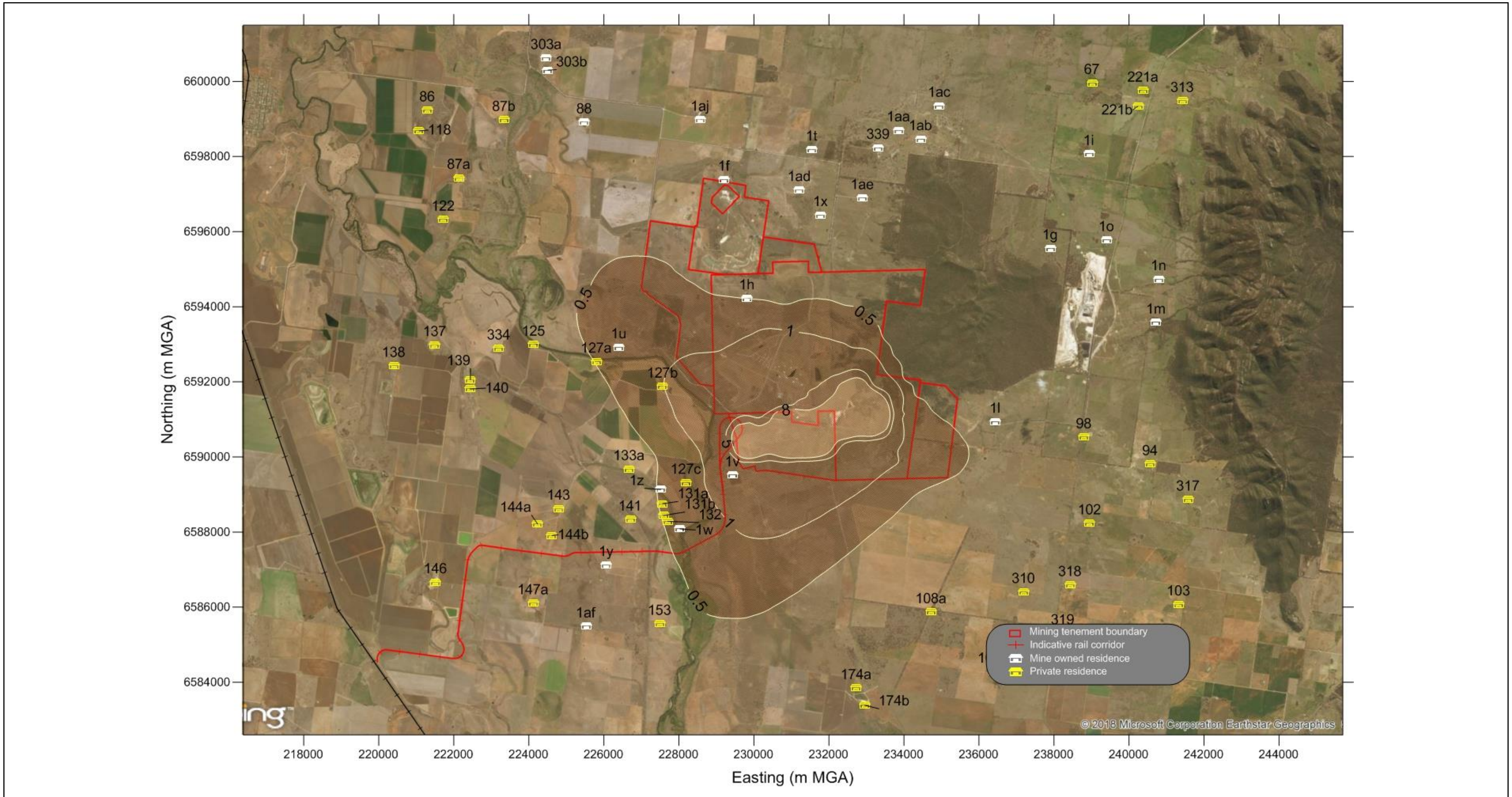



**Figure A7-16: Project-only annual average $PM_{2.5}$ contours – Year 21**

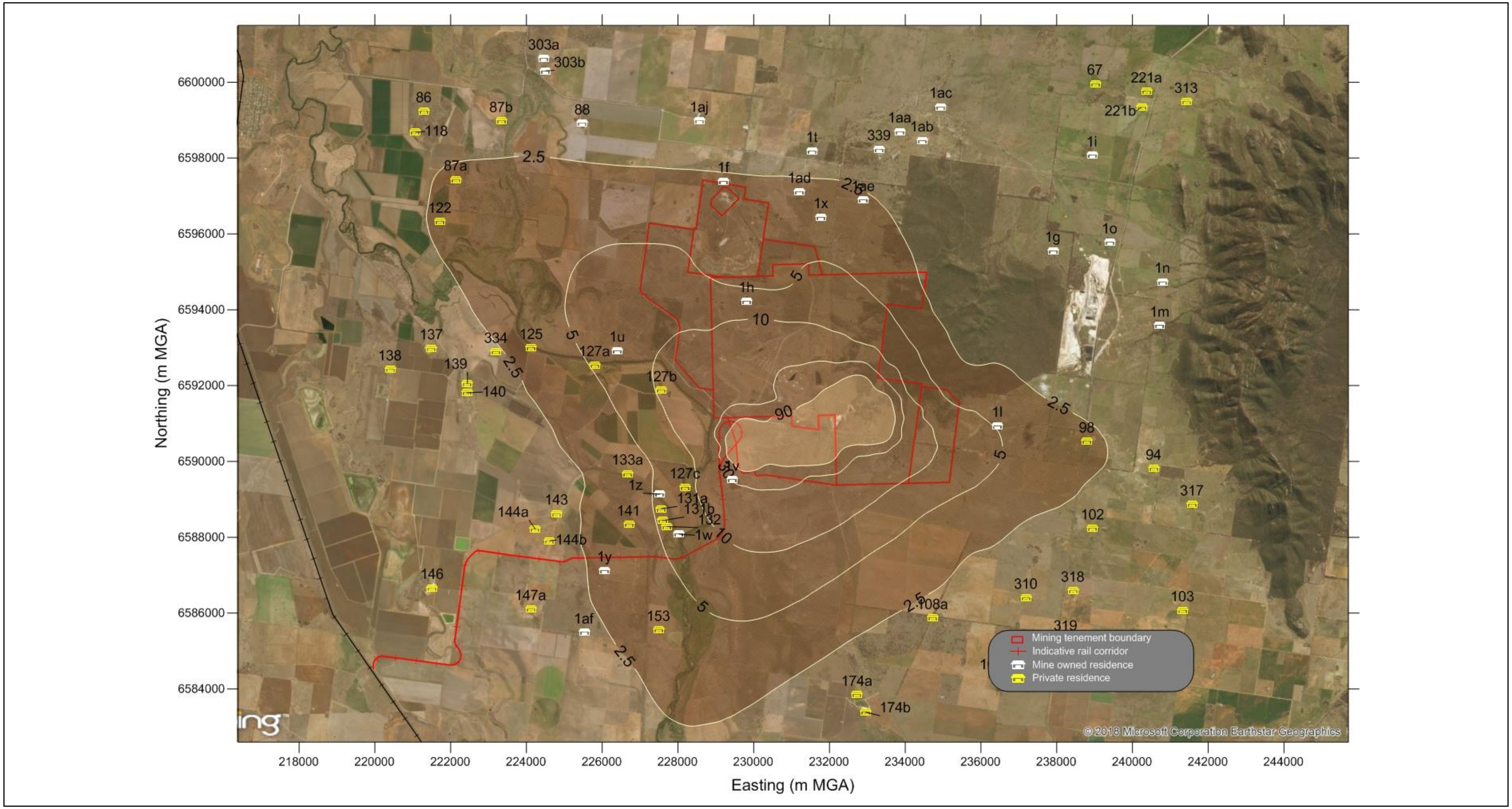



**Figure A7-17: Project-only annual average TSP contours – Year 21**

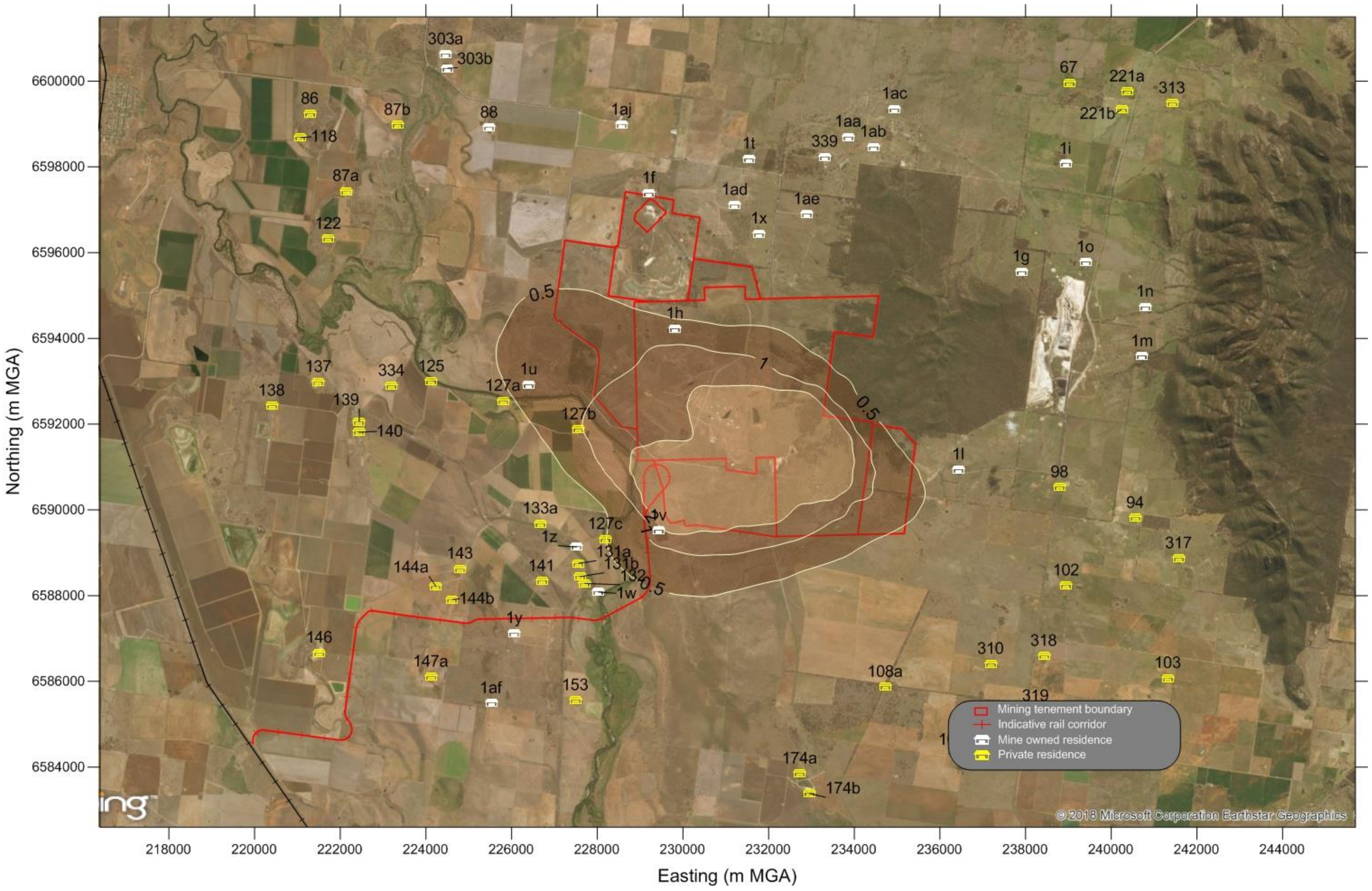



Figure A7-18: Project-only annual average dust deposition contours – Year 21