Vickery Coal Project

Environmental Impact Statement

APPENDIX D

AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

Resource Strategies

WHITEHAVEN COAL

VICKERY COAL PROJECT – AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

Whitehaven Coal Limited

Job No: 6317

1 November 2012

A PEL Company

PROJECT TITLE:	**VICKERY COAL PROJECT – AIR QUALITY AND GREENHOUSE GAS ASSESSMENT**
JOB NUMBER:	**6317**
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DISCLAIMER & COPYRIGHT:	

DOCUMENT CONTROL

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1 INTRODUCTION

The Vickery Coal Mine (VCM) is owned by Whitehaven Coal Limited (Whitehaven) and is located approximately 25 kilometres (km) north of Gunnedah, New South Wales (NSW) in the Gunnedah Basin (refer **Figure 1.1**).

Whitehaven is seeking Development Consent under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) to recommence mining operations at the VCM (herein referred to as the Vickery Coal Project [the Project]).

PAEHolmes has been commissioned by Whitehaven to complete an Air Quality and Greenhouse Gas (GHG) Assessment for the Project.

1.1 Background

On 24 April 1986, Namoi Valley Coal Pty Ltd (a subsidiary of Conzinc Riotinto of Australia [to later become Rio Tinto Limited]) submitted dual applications to the Gunnedah Shire Council (Development Application [DA] 23/86) and the Narrabri Shire Council (DA 18/86) to construct and operate the VCM (then known as the Namoi Valley Coal Project). Development Consent for the mine was originally granted in October 1986 by the Minister for Planning and Environment pursuant to section 101 of the EP&A Act.

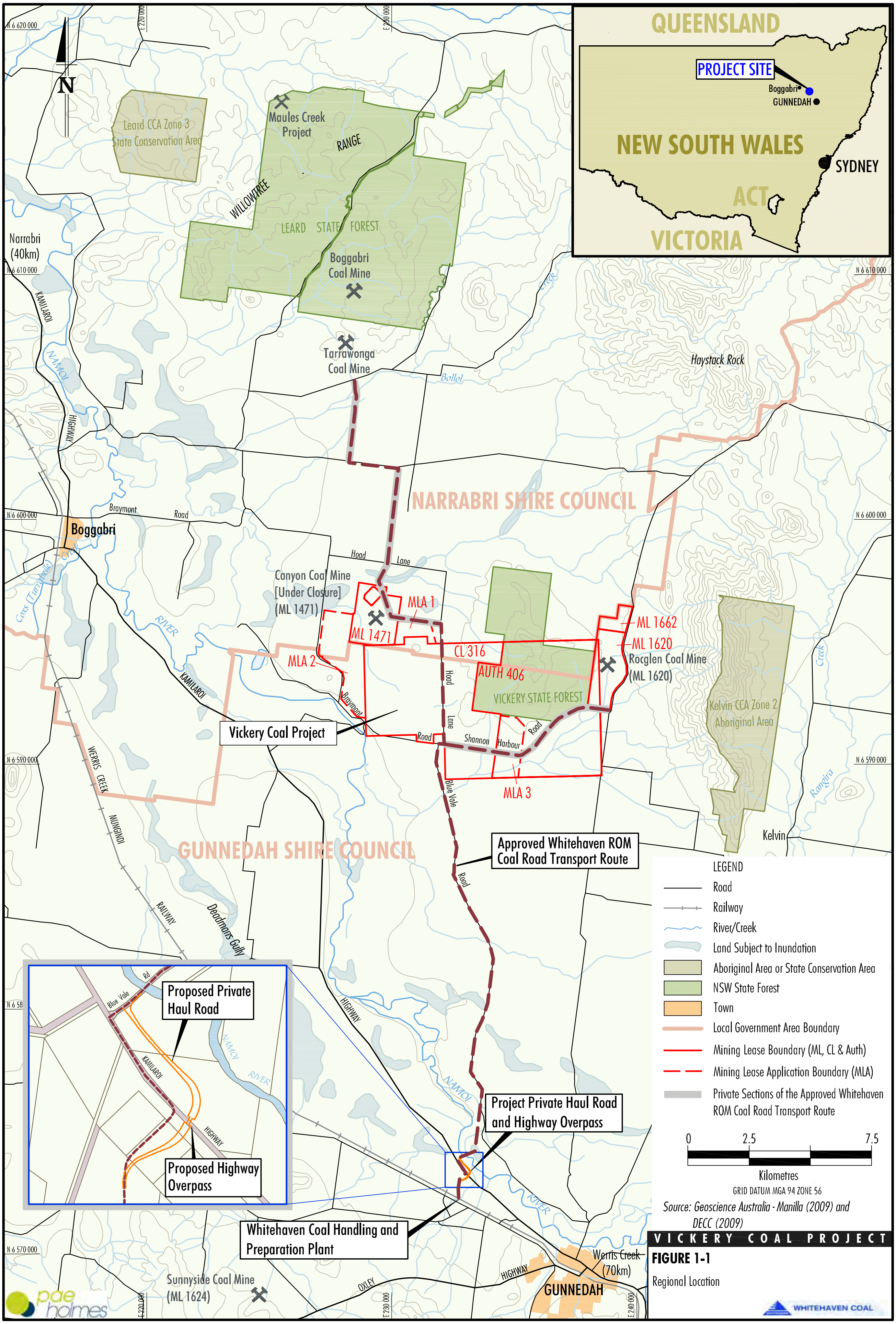
Mining commenced in 1986 with a small underground operation which continued until March 1991. Three minor modifications to the Development Consent were approved between 1987 and 1990. From 1991 to 1998 approximately 4 million tonnes (Mt) of coal was extracted using open cut mining methods.

Mining operations at the VCM ceased in May 1998, when approval from the NSW Department of Primary Industries was granted to suspend operations and complete rehabilitation works on-site.

In September 2008, the then NSW Department of Planning (DoP) (now the NSW Department of Planning and Infrastructure [DP&I]) approved a modification to the Development Consent in accordance with section 96(1A) of the EP&A Act to extend the mine life by an additional three years (to 15 June 2012) to allow for further coal exploration, continued environmental monitoring and rehabilitation.

Rehabilitation activities are now complete and the site is currently in care and maintenance. Whitehaven acquired 100 percent (%) of Coal Lease (CL) 316 and Authorisation (AUTH) 406 from Rio Tinto Limited in January 2010.

The Project would involve the recommencement of mining at the VCM, with a run-of-mine (ROM) coal production rate of up to 4.5 million tonnes per annum (Mtpa) over a Project life of 30 years.



QUEENSLAND
PROJECT SITE
Boggabri
GUNNEDAH
NEW SOUTH WALES
SYDNEY
ACT
VICTORIA
Maules Creek Project
RANGE
WILLOWTREE
Leard CCA Zone 3 State Conservation Area
LEARD STATE FOREST
Boggabri Coal Mine
Tarrawonga Coal Mine
Narrabri (40km)
KAMILAROI
NAMOI
HIGHWAY
Haystack Rock
Bollol
NARRABRI SHIRE COUNCIL
Braymont Road
Boggabri
Hood Lane
Canyon Coal Mine [Under Closure] (ML 1471)
MLA 1
ML 1471
MLA 2
CL 316
AUTH 406
VICKERY STATE FOREST
ML 1662
ML 1620
Rocglen Coal Mine (ML 1620)
Kelvin CCA Zone 2 Aboriginal Area
Vickery Coal Project
Shannon Harbour Road
Blue Vale Road
MLA 3
Kelvin
WERRIS CREEK
MUNGINDI
GUNNEDAH SHIRE COUNCIL
Approved Whitehaven ROM Coal Road Transport Route
RAILWAY
Deadmans Gully
Proposed Private Haul Road
Proposed Highway Overpass
Project Private Haul Road and Highway Overpass
Whitehaven Coal Handling and Preparation Plant
Sunnyside Coal Mine (ML 1624)
OXLEY HIGHWAY
GUNNEDAH
Werris Creek (70km)
LEGEND
Road
Railway
River/Creek
Land Subject to Inundation
Aboriginal Area or State Conservation Area
NSW State Forest
Town
Local Government Area Boundary
Mining Lease Boundary (ML, CL & Auth)
Mining Lease Application Boundary (MLA)
Private Sections of the Approved Whitehaven ROM Coal Road Transport Route
0 2.5 7.5
Kilometres
GRID DATUM MGA 94 ZONE 56
Source: Geoscience Australia - Manilla (2009) and DECC (2009)
VICKERY COAL PROJECT
FIGURE 1-1
Regional Location
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WHITEHAVEN COAL
WHC-10-03_EIS_App AQ_101D

1.2 Study Requirements

The Air Quality and GHG Assessment is guided by the Director-General's Requirements (DGRs), outlined in **Table 1.1**. Comments have also been outlined by the Namoi Catchment Management Authority (attached to the DGRs from the DP&I dated 19 January 2012), and are provided in **Table 1.2**.

The Air Quality and GHG Assessment has been prepared in accordance with the DGRs, NSW Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (**NSW Department of Environment and Conservation [DEC], 2005**) and in consideration of the Namoi Catchment Management Authority's comments in regards to the Project.

Table 1.1: Director-General's Requirements

Discipline	Requirement
Air Quality	*including a quantitative assessment of potential:* - *construction and operational impacts, with a particular focus on dust emissions (including $PM_{2.5}$ and PM_{10} emissions, and dust generation from coal transport), as well as diesel and blast fume emissions;* - *spontaneous combustion properties of overburden or reject material;* - *reasonable and feasible mitigation measures to minimise dust, diesel, and blast fume emissions, including evidence that there are no such measures available other than those proposed; and* - *monitoring and management measures, in particular real-time air quality monitoring and predictive meteorological forecasting.*
Greenhouse Gases	*including:* - *a quantitative assessment of the potential Scope 1, 2 and 3 greenhouse gas emissions;* - *a qualitative assessment of the potential impacts of these emissions on the environment; and* - *an assessment of the reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy efficiency.*

Table 1.2: Namoi Catchment Management Authority's Comments Relevant to Air Quality

Comment
1.5 Noise and Blasting, Air Quality and Greenhouse Gas, Traffic and Transport, Visual Amenity, Social Impact Assessment and Economics. *The EIS should address and consider the potential impacts, mitigation measures and safeguards on all of the above issues especially with regard to impacts on both the local and broader catchment community.*

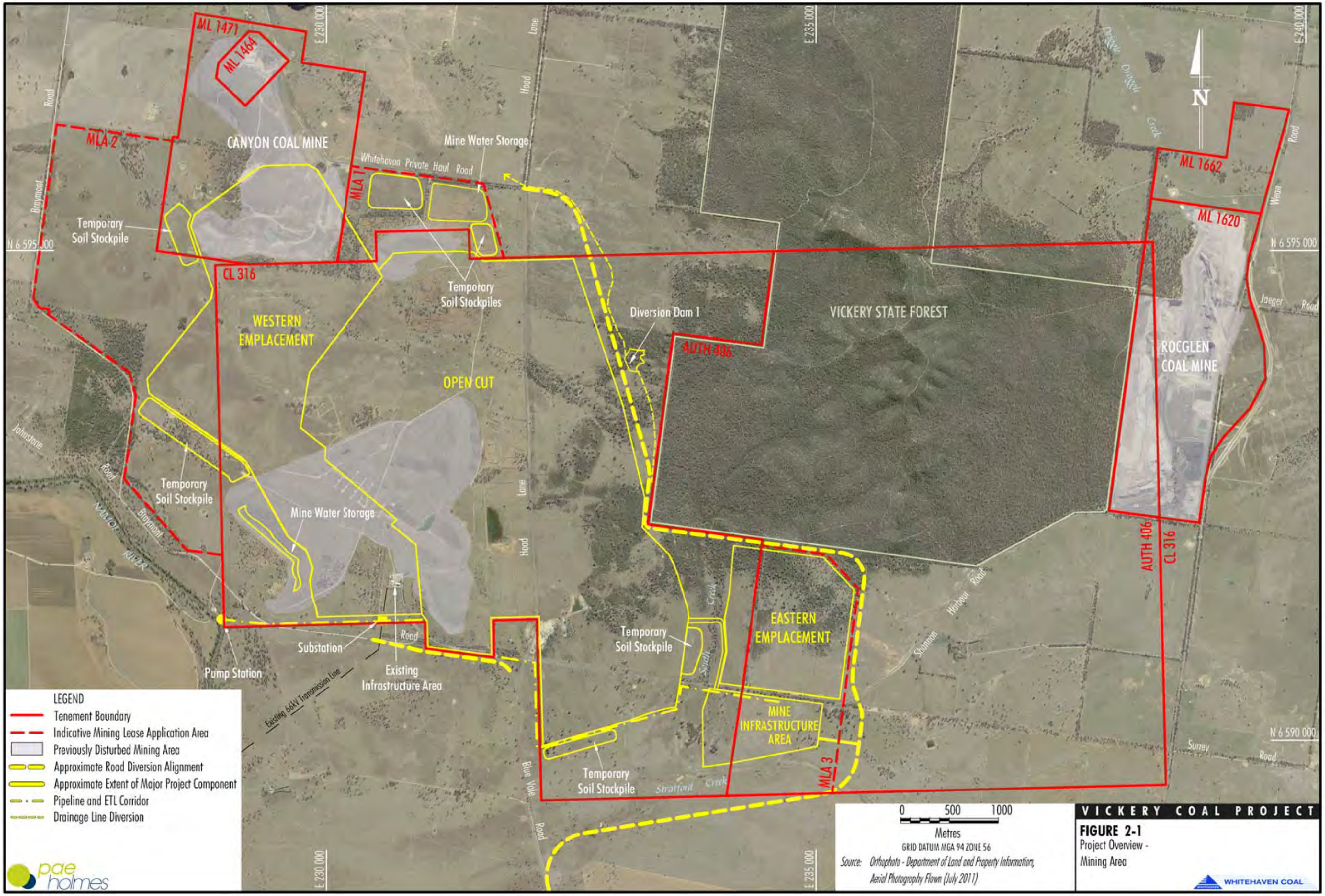
2 PROJECT DESCRIPTION

2.1 Overview

The main activities associated with the development of the Project would include:

- Development and operation of an open cut mine within CL 316, AUTH 406, Mining Lease (ML) 1471, Mining Lease Application (MLA) 1, MLA 2 and MLA 3.
- Use of conventional mining equipment, haul trucks and excavators to remove up to 4.5 Mtpa of ROM coal and approximately 48 million bank cubic metres (Mbcm) of waste rock per annum from the planned open cut.
- Placement of waste rock (i.e. overburden and interburden/partings) within external emplacements to the west and east of the planned open cut (i.e. Western Emplacement and Eastern Emplacement) and within mined-out voids.
- Construction and use of on-site coal crushing, screening and handling facilities to produce sized ROM coal.
- Transport of ROM coal by haulage trucks to the Whitehaven Coal Handling and Preparation Plant (CHPP) on the outskirts of Gunnedah (approximately 20 km to the south of the Project open cut) for processing.
- Use of an on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes (t) of domestic specification coal per annum for direct collection by customers at the Project site.
- Use an on-site mobile crusher to produce up to approximately 90,000 cubic metres (m^3) of gravel materials per annum for direct collection by customers at the Project site.
- Construction and use of water supply bores, and a surface water extraction point on the bank of the Namoi River and associated pump and pipeline systems.
- Construction and use of new dams, sediment basins, channels, dewatering bores and other water management infrastructure required to operate the mine.
- Construction and use of new soil stockpile areas, laydown areas and gravel/borrow areas.
- Construction of a 66 kilovolt (kV)/11 kV electricity substation and 11 kV electricity transmission line.
- Transport of coarse rejects generated within the Whitehaven CHPP via truck to the Project for emplacement within an in-pit emplacement area.
- Transport of tailings (i.e. fine rejects) generated within the Whitehaven CHPP via truck to the Project for emplacement within co-disposal storage areas in the open cut and/or disposal in existing off-site licensed facilities (e.g. the Brickworks Pit).
- Realignment of sections of Blue Vale Road, Shannon Harbour Road and Hoad Lane to the east and south of the open cut.
- Realignment of the southern extent of Braymont Road to the south of the open cut.
- Construction of an approximately 1 km long section of private haul road (including an overpass over the Kamilaroi Highway) between Blue Vale Road and the Whitehaven CHPP.
- Ongoing exploration, monitoring and rehabilitation activities.
- Construction and use of other associated infrastructure, equipment and mine service facilities.

The proposed life of the Project is 30 years, commencing 2014. The main components associated with the development of the Project are shown in **Figure 2.1**.



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VICKERY COAL PROJECT

FIGURE 2-1
Project Overview - Mining Area

WHITEHAVEN COAL

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General Project arrangements for Years 2, 7, 17 and 26 are shown on **Figures 2.2** to **2.5**, respectively. These general arrangements are based on planned maximum production and mine progression.

A description of the Project is provided in Section 2 in the Main Report of the Project Environmental Impact Statement (EIS).

2.2 Mining Operations and Coal Transportation

Project mining operations would be conducted 24-hours per day, seven days per week.

The Project includes open cut mining within the Maules Creek Formation. Up to seven coal seams of the Maules Creek Formation would be mined, with the Cranleigh Seam generally defining the base of the open cut. Depth to the base of the open cut would vary from approximately 100 metres (m) in the west to 250 m in the east (i.e. 190 m Australian Height Datum [AHD] in the west to 70 m AHD in the east).

The open cut would commence in the west and be developed towards the east, with waste rock progressively emplaced behind the advancing open cut face once sufficient space is available.

2.2.1 Overburden/Interburden Drill, Blast and Removal by Excavator

Drill and blast techniques would be used for the removal of competent overburden and interburden material for the open cut.

A mixture of ammonium nitrate and fuel oil (dry holes) and emulsion blend (wet holes) explosives would be used.

Blast sizes would typically range between:

- intermediate interburden blasts with a maximum instantaneous charge (MIC) of approximately 1,365 kilograms (kg); and
- deep overburden/interburden blasts with a MIC of approximately 2,275 kg.

The number of blasts per week would typically be five; however, up to six blasts per week may occur on some occasions.

Blast designs and sizes would vary over the life of the Project and would depend on factors such as the depth of coal seams and the design of benches. Following blasting, overburden and interburden would be removed by excavator and haul truck for placement in out-of-pit mine waste rock emplacements, or as infill in the mine void.

2.2.2 Coal Mining and Run-of-Mine Coal Handling

Up to 126 Mt of ROM coal would be mined from the open cut extent during the life of the Project.

Coal mining would involve excavators loading ROM coal into haul trucks for haulage to the ROM coal handling area at the Mine Infrastructure Area via internal haul roads. ROM coal would be either dumped directly into a hopper feeding the crushing and screening facility, or dumped on an adjacent ROM coal stockpile for later re-handling.

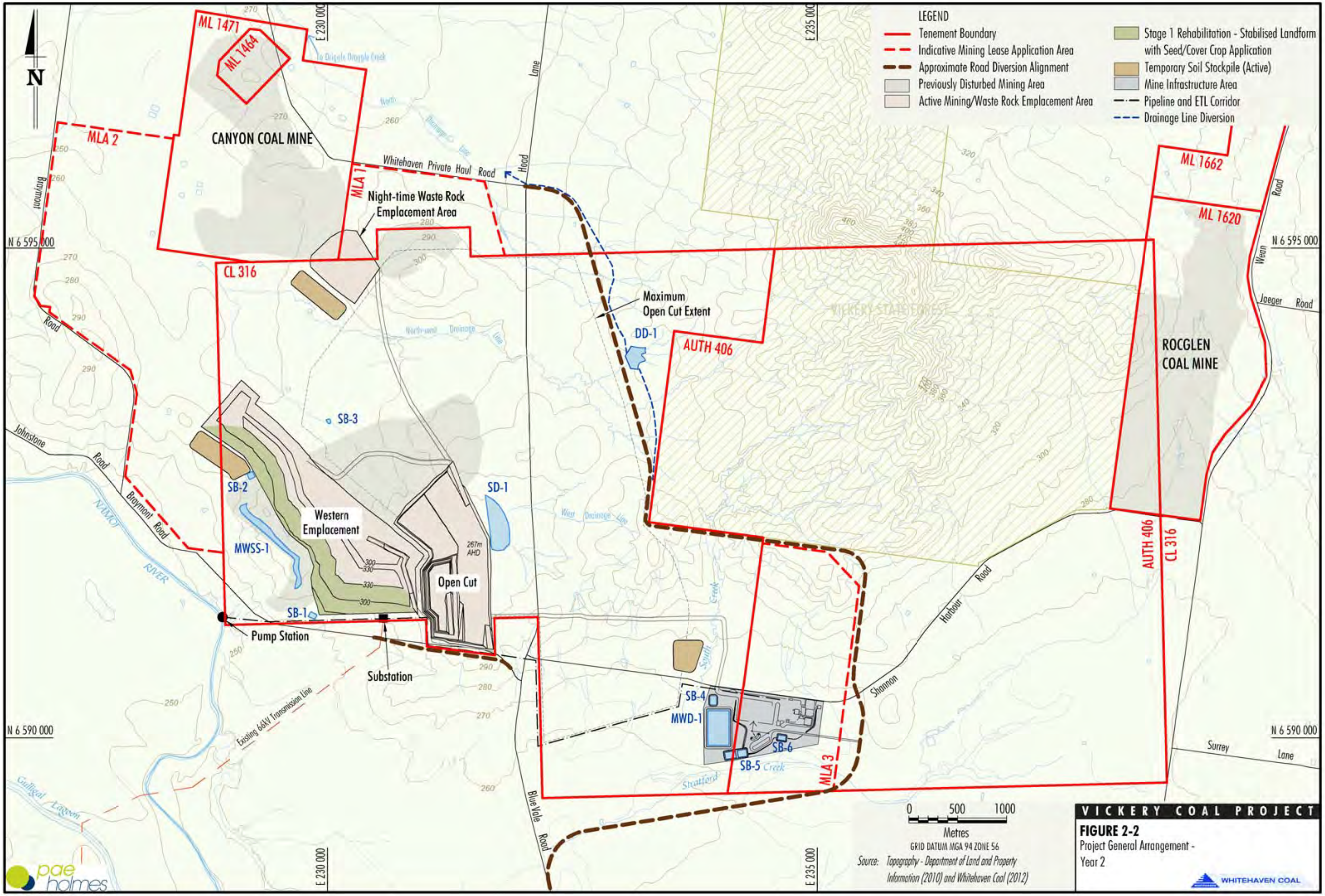

FIGURE 2-2
Project General Arrangement - Year 2

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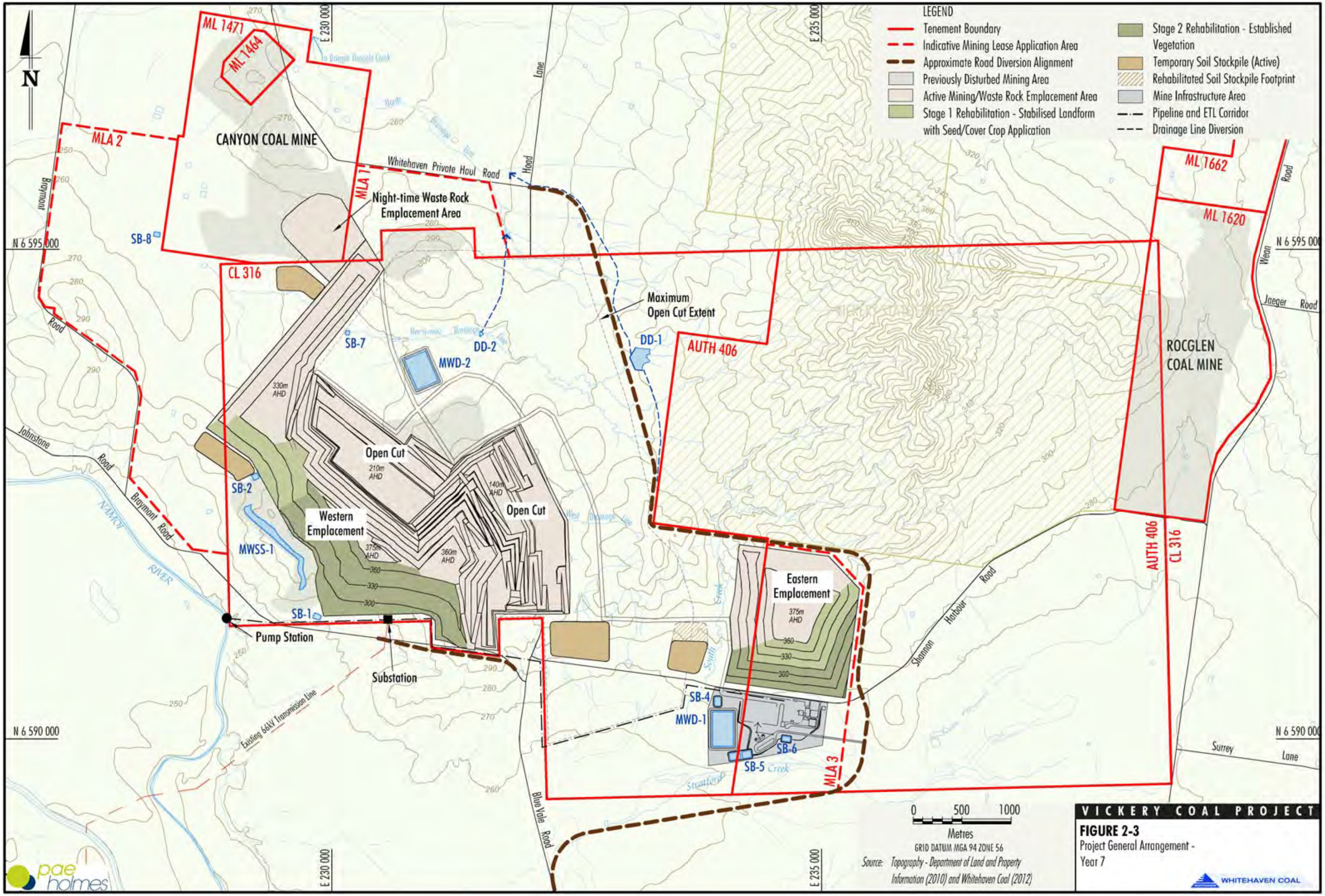

FIGURE 2-3
Project General Arrangement - Year 7

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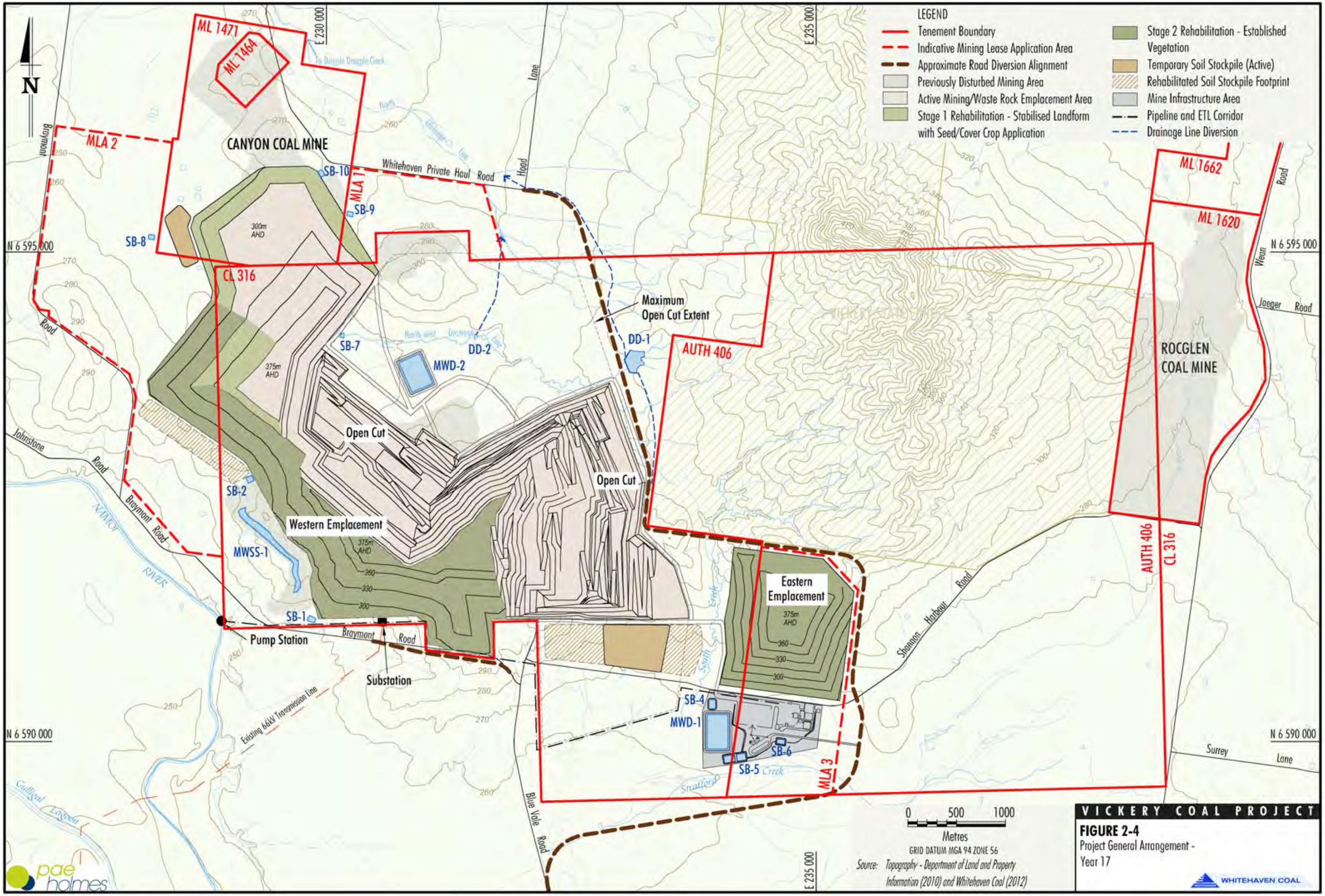

FIGURE 2-4
Project General Arrangement - Year 17

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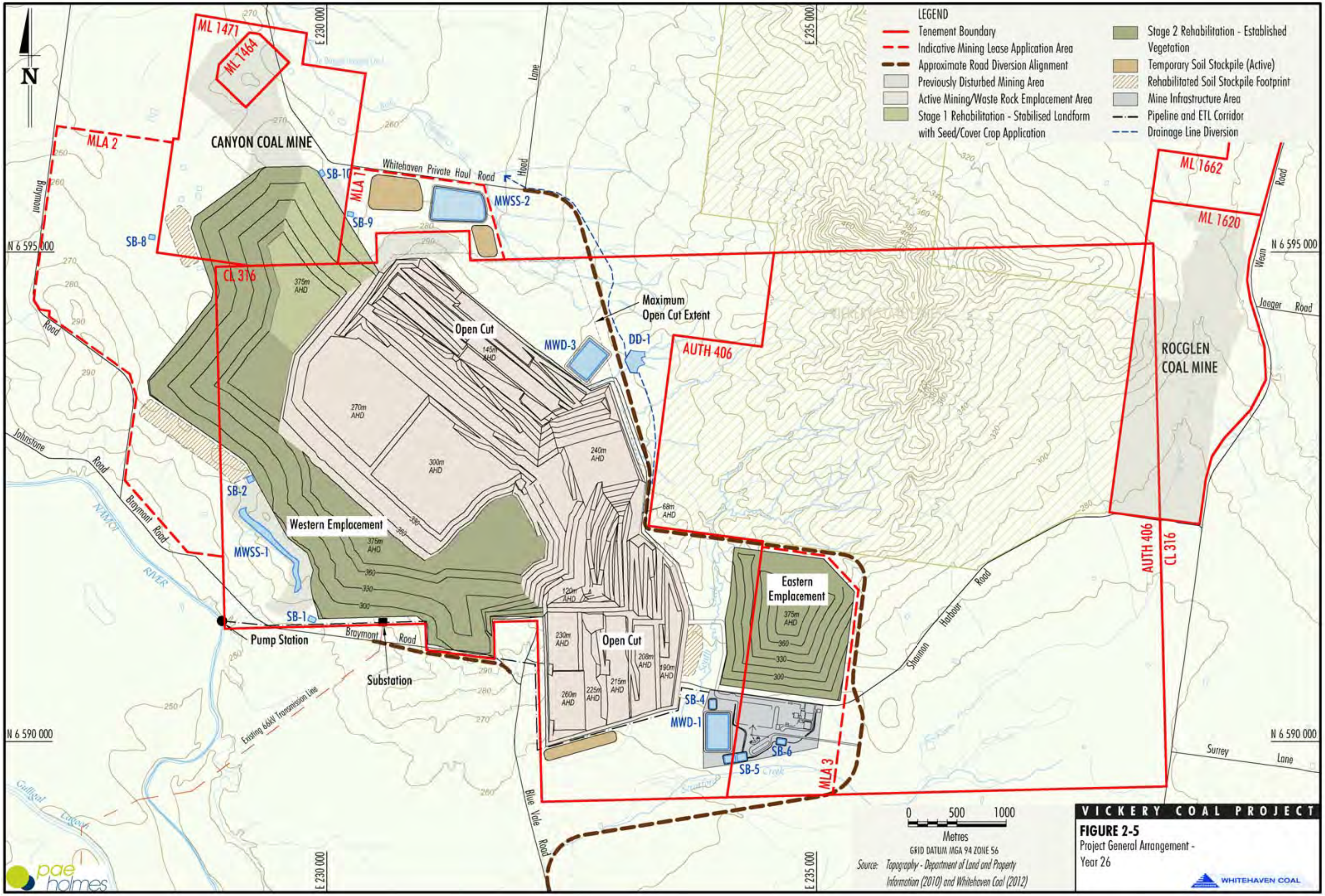

VICKERY COAL PROJECT

FIGURE 2-5
Project General Arrangement - Year 26

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2.2.3 On-site Production of Domestic Coal

Up to 150,000 t of ROM coal per annum would be selectively hauled to the on-site mobile crusher at the Mine Infrastructure Area for crushing and screening to produce domestic specification (15 to 35 millimetres [mm]) coal. The mobile crusher would be operated during daytime hours only (i.e. 7.00 am to 6.00 pm).

2.2.4 On-site Production of Gravel Materials

Up to 90,000 cubic metres (m^3) per annum of gravel material would be produced by crushing and screening of suitable overburden (excavated from within the open cut extent) in the on-site mobile crusher at the Mine Infrastructure Area.

On-site gravel crushing and screening operations would be conducted during daytime hours only (i.e. 7.00 am to 6.00 pm).

2.2.5 Mine Infrastructure Area

A Mine Infrastructure Area would be constructed to the south of the Eastern Emplacement (**Figures 2.2** to **2.5**). The Mine Infrastructure Area would consist of ROM coal stockpiles and handling and crushing equipment, workshops, offices, water management structures and car parks.

An existing infrastructure area associated with the historical mining activities including laydown areas, electricity substation, workshops and sheds is located within the southern portion of the proposed Western Emplacement area. These facilities would be used during the first 12 to 18 months of the Project while the new Mine Infrastructure Area is constructed. Once the new facilities are commissioned, the existing infrastructure area would be decommissioned.

2.2.6 Mine Fleet

The mine fleet for the Project would vary according to the equipment requirements associated with the open cut mining operations.

The mining fleet would typically consist of hydraulic excavators and dump trucks, with a support fleet of dozers, scrapers, graders, front end loaders, drill rigs and water trucks.

2.2.7 Indicative Mine Schedule

An indicative mine schedule for the Project is provided in **Table 2.1**. The mining years shown in bold are assessed in this report, chosen on the basis of potential for worst case air quality impacts (refer **Section 5.4**).

The staging of the open cut mining operations would be determined by the requirements of the coal market, product specification and/or blending requirements. As these requirements are likely to vary over the life of the Project, the development sequence of the open cut and coal extraction rates may also vary.

2.2.8 Run-of-Mine Coal Transport

Sized ROM coal would be transported from the Mine Infrastructure Area to the Whitehaven CHPP by a haulage contractor using on-highway haulage trucks. Sized ROM coal transportation would occur 24-hours per day, seven days per week.

The sized ROM coal would be transported from the Mine Infrastructure Area along the Blue Vale Road diversion to Blue Vale Road. The haulage trucks would then travel approximately 20 km along Blue Vale Road and then via the Kamilaroi Highway overpass to the Whitehaven CHPP.

Table 2.1: Indicative Mine Schedule

Project Year	ROM Extraction (Mtpa)	Overburden Removed (Mbcm)
Year 1*	0	16
Year 2	**1.5**	**25**
Year 3	3.8	38
Year 4	4.1	48
Year 5	4.1	47
Year 6	4.2	44
Year 7	**4.5**	**44**
Year 8	4.5	43
Year 9	4.5	42
Year 10	4.5	45
Year 11	4.5	41
Year 12	4.5	47
Year 13	4.5	44
Year 14	4.5	47
Year 15	4.5	47
Year 16	4.5	43
Year 17	**4.5**	**45**
Year 18	4.5	38
Year 19	4.5	45
Year 20	4.5	45
Year 21	4.5	49
Year 22	4.5	45
Year 23	4.5	45
Year 24	4.5	49
Year 25	4.5	40
Year 26	**4.5**	**51**
Year 27	4.5	39
Year 28	4.5	39
Year 29	4.5	39
Year 30	4.5	39

* Assumed Project commencement is 2014.

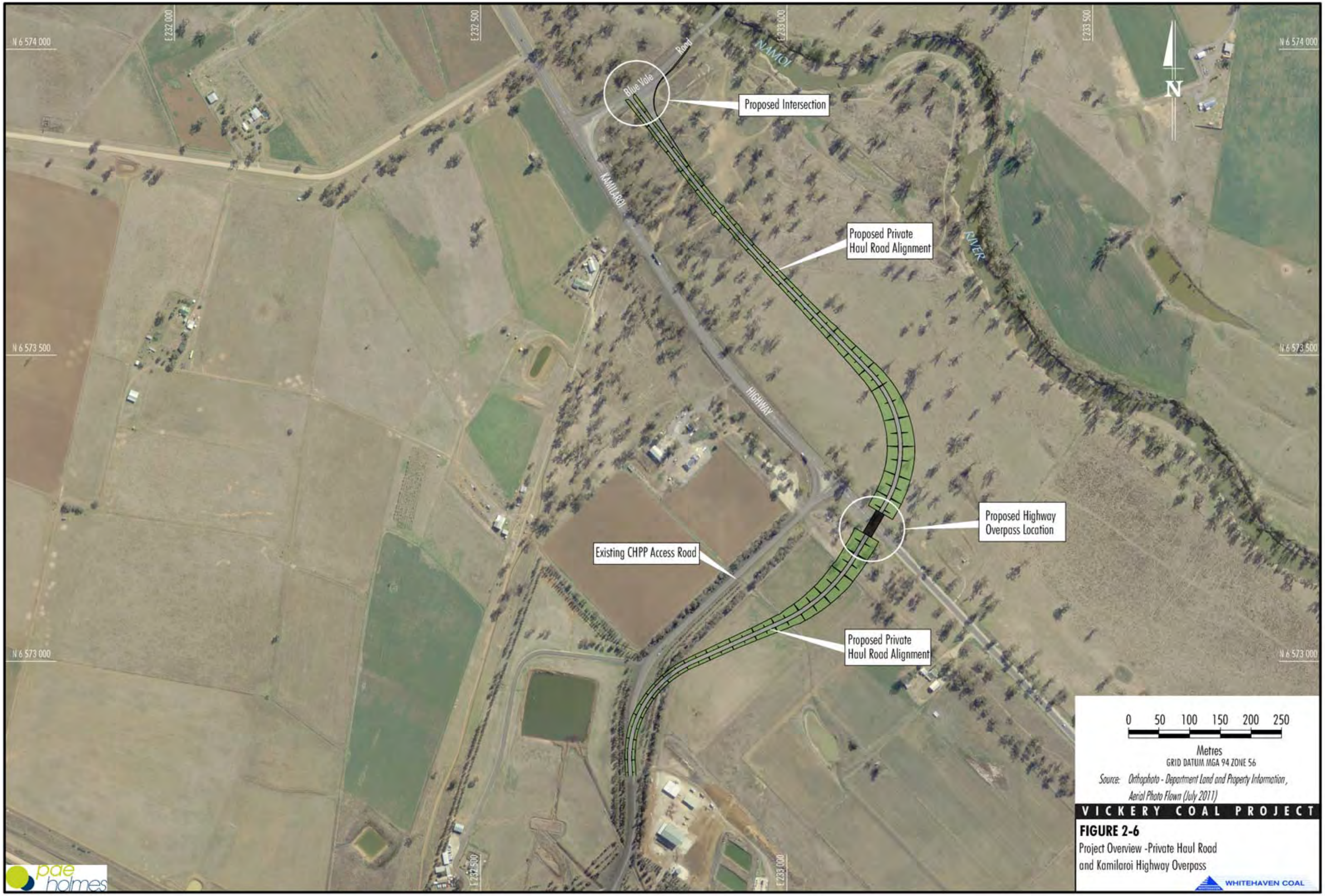
2.2.9 Private Haul Road and Highway Overpass

Whitehaven would construct the private haul road and Kamilaroi Highway overpass between Blue Vale Road and the Whitehaven CHPP prior to the combined ROM coal transport rate along the Whitehaven ROM coal transport route (from all Whitehaven mines) exceeding 3.5 Mtpa (**Figure 2.6**). The private haul road and Kamilaroi Highway overpass would intersect with Blue Vale Road between the bridge across the Namoi River and its intersection with the Kamilaroi Highway. The private haul road would run parallel to the Kamilaroi Highway and the Namoi River before crossing the highway adjacent to the existing CHPP access road.

The private haul road and Kamilaroi Highway overpass would allow haulage trucks to travel between Blue Vale Road and the Whitehaven CHPP without the need to travel along, and turn across the Kamilaroi Highway.

Associated benefits of the private haul road and Kamilaroi Highway overpass would also include a reduction in heavy vehicle interaction with other vehicles on the CHPP roads and improved ROM coal transport efficiency through a reduction in travel time between the Project and the Whitehaven CHPP.

Access to the road would be restricted to contractor haulage trucks. Appropriate signs and gates would be installed to prevent unauthorised access to the private haul road and Kamilaroi Highway overpass.



VICKERY COAL PROJECT

FIGURE 2-6

Project Overview -Private Haul Road and Kamilaroi Highway Overpass

WHITEHAVEN COAL

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2.2.10 Run-of-Mine Coal Processing

Whitehaven currently operates a CHPP and rail load out facility approximately 5 km west of Gunnedah, which processes ROM coal from the surrounding Whitehaven coal mining operations (Tarrawonga, Rocglen and Sunnyside Coal Mines).

Sized ROM coal from the Project would be loaded onto trains (i.e. bypass) or crushed, screened and washed at the existing Whitehaven CHPP before being loaded onto trains for rail transport to Newcastle and export markets.

It should be noted that the operation of the existing approved Whitehaven CHPP is not part of the Project.

2.2.11 Rail Movements

No change to the approved capacity of the Whitehaven CHPP would be required as a result of the Project, and therefore, no change to the existing Whitehaven CHPP rail movements would be required for the Project.

2.2.12 Domestic Coal and Gravel Materials Transport

Up to 150,000 t of domestic specification coal and 90,000 m^3 of gravel would be directly collected at the mine facilities area by customers.

On-site domestic coal and gravel transportation would be conducted during daytime hours only (i.e. 7.00 am to 6.00 pm).

2.3 Local Setting

The location of the existing VCM and surrounding areas is shown in **Figure 1.1**. The site is located approximately 25 km north of Gunnedah and 15 km southeast of Boggabri in the Gunnedah coalfields of the Namoi River Valley, NSW.

Land use in the local area is dominated by agricultural operations and open cut coal mining.

Land use within the Project site includes areas of native woodland vegetation, cleared grazing land on unimproved pastures and previously disturbed mining areas.

State-owned forestry (Vickery State Forest and Kelvin State Forest) and another coal mining operation (Rocglen Coal Mine) occur to the east of the VCM. Canyon Coal Mine which ceased operation in 2009 is located north of the Project boundary. Additionally, the Vickery South Coal Exploration Project is situated immediately south of the Project.

There are a number of receivers (e.g. dwellings) in the vicinity of the Project, as shown in **Figure 2.7** and listed in **Table 2.2.**

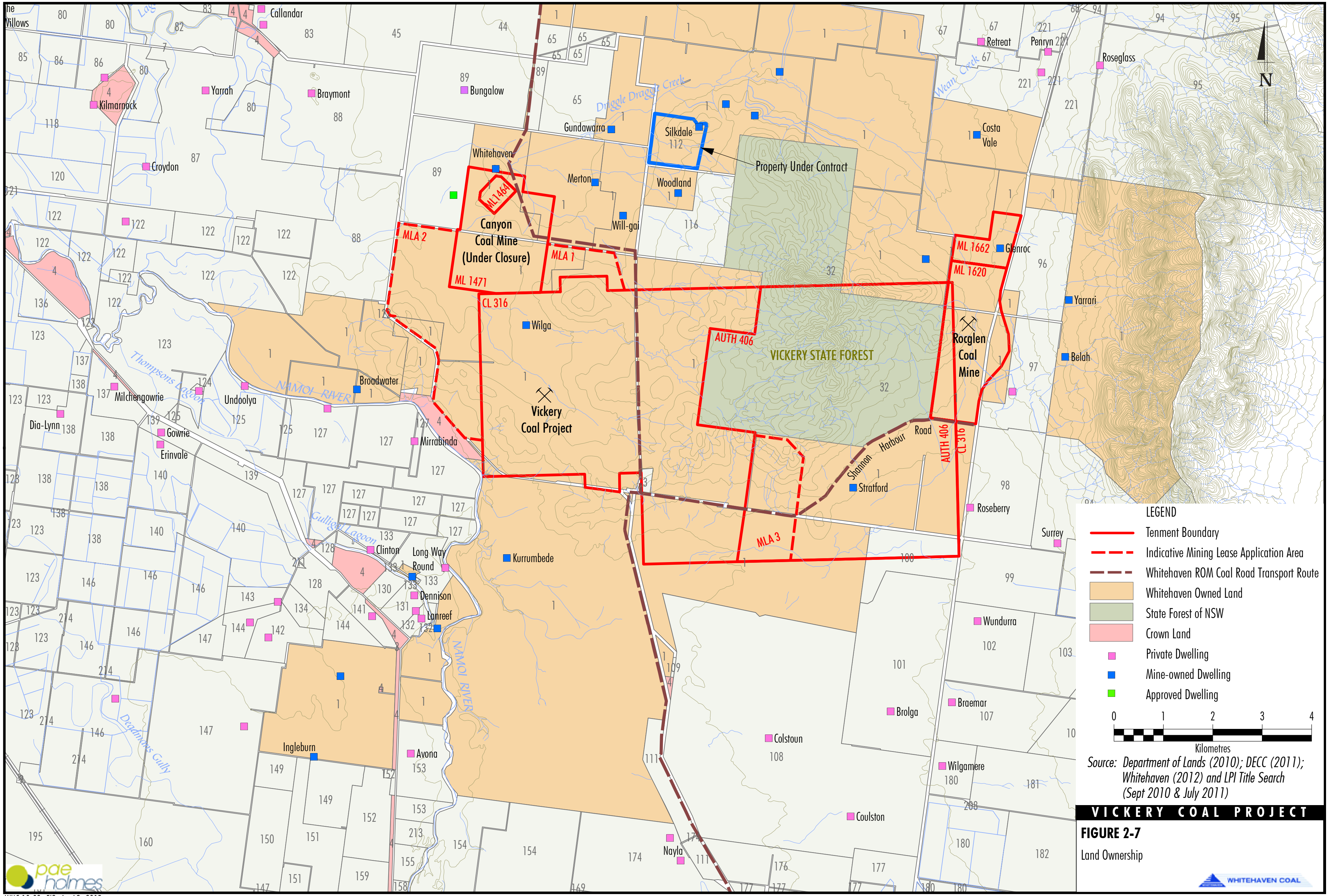

FIGURE 2-7
Land Ownership

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Table 2.2: Relevant Land Ownership List

Receiver ID	Dwelling Name	Ownership	Easting (m)	Northing (m)
67	Retreat	Richard Lindsay Penrose, Katriona Ann Penrose (Joint tenants)	239020	6599961
83a	Callandar	Robert Peter McGregor	224469	6600621
83b	-	Robert Peter McGregor	224507	6600300
86	-	Peter J Watson Holdings Pty Ltd	221297	6599230
87a	Croydon	David Sinclair Riley	222139	6597432
87b	Yarrah	David Sinclair Riley	223342	6598974
88	Braymont	Michael John Maunder, Jodie Helen Maunder (Joint tenants)	225481	6598912
89a	Bungalow	Keith Alexander Blanch, Cormaree Blanch (Joint tenants)	228572	6598981
89b	-	Keith Alexander Blanch, Cormaree Blanch (Joint tenants)	228412	6596679
94	Surrey	Rodney James Barnes, Angela Barnes (Tenants in common, Equal shares)	240572	6589817
95	Roseglass	Christiaan Wynand Harmse, Maria Jacomina Harmse (Joint tenants)	241425	6599480
98	Rosebury	Ronald Stanley Rennick	238777	6590513
99	Carlton	Wallace Noel Sales, Kaye Elizabeth Sales (Joint tenants)	241599	6588816
101	Brolga	Warren Franklin Nicholls, Susan Elizabeth Nicholls (Joint tenants)	237192	6586408
102	Wundurra	James Christopher Meyers, Jeanette Elizabeth Meyers (Joint tenants)	238969	6588240
103	-	Keith Gascoyne Perrett	241327	6586074
107	Braemar	John Charles Wise, Linda Dorothy Miller (Joint tenants)	238433	6586589
108a	Coulston	Anthony Charles Wannan, Pauline May Winter (Joint tenants)	234749	6585833
108b	Coulston	Anthony Charles Wannan, Pauline May Winter (Joint tenants)	236383	6584213
112*	Silkdale	Neil Phillip Jackson, Sharon Ann Jackson (Joint tenants)	233318	6598234
118	Kilmarnock	Andrew David Watson	221075	6598682
122	-	Nandewar Pty Limited	221722	6596321
124	-	John Peter Carrigan	223205	6592888
125	Undoolya	Stephen Maunder, Anita Jane Maunder (Joint tennants)	224131	6592990
127a	-	James Karl Barlow	225798	6592545
127b	Mirrabinda	James Karl Barlow	227605	6591919
127c	-	James Karl Barlow	228176	6589289
131a	Dennison	Brian John Keeler, Denise Patricia Keeler (Joint tenants)	227557	6588760
131b	-	Brian John Keeler, Denise Patricia Keeler (Joint tenants)	227591	6588442
132	Lanreef	Eric James Hannan, Carol Anne Hannan (Joint tennants, Estate perpetual lease)	227712	6588287
133a	Clinton	Grant Archie McIlveen	226673	6589692
137	Milchengowrie	Anthony Clarence Carrigan, Georgina Therese Carrigan (Tenants in common, Equal shares)	221496	6592978
138	Dia-Lynn	Anthony Clarence Carrigan	220402	6592427
139	Gowrie	Kenneth Leslie Crawford, Susan Ruth Crawford (Tenants in common, Equal shares)	222442	6592051
140	Erinvale	David Alexander Watt, Janet Elizabeth Watt (Tenants in common, Equal shares)	222425	6591809
141	-	Dee Micheal Heinemann, Amanda Maree Heinemann (Joint tenants)	226706	6588335
142	-	Timothy Bligh Roberts, Anne Roberts (Joint tenants)	224612	6587903
143	-	Scott Llewellyn Johns	224798	6588624
144	-	Errol Frederick Darley, Jennifer Therese Darley (Joint tenants)	224237	6588209
146	-	Graeme Charles Carrigan	221518	6586661
147	-	Trevor John Loveridge, Colleen Loveridge (Tenants in common, Equal shares)	224118	6586104
153	Avona	Robert George Mansfield, Heather Kaye Mansfield (Joint tenants)	227491	6585556
174b	-	Selkirk Pastoral Co Pty Limited	233060	6583473
180	Wilgamere	Richard James Fitzpatrick, Pamela Frances Fitzpatrick (Joint tenants)	238238	6585305
221a	Penryn	Margaret Eleanor Geddes	240378	6599756
221b	-	Margaret Eleanor Geddes	240241	6599341
1f	Whitehaven	Whitehaven Coal Mining Pty Limited	229210	6597383
1g	-	Whitehaven Coal Mining Pty Limited	237902	6595557
1i	Costa Vale	Whitehaven Coal Mining Pty Limited	238936	6598071
1l	Stratford	Whitehaven Coal Mining Pty Limited	236482	6590901
1m	Belah	Whitehaven Coal Mining Pty Limited	240613	6593728
1n	Yarrari	Whitehaven Coal Mining Pty Limited	240813	6594725
1o	Glenroc	Whitehaven Coal Mining Pty Limited	239390	6595641
1t	Gundawarra	Whitehaven Coal Mining Pty Limited	231547	6598184
1u	Broadwater	Whitehaven Coal Mining Pty Limited	226463	6592907
1v	Kurrumbede	Whitehaven Coal Mining Pty Limited	229423	6589512
1w	-	Whitehaven Coal Mining Pty Limited	228029	6588088
1x	Will-Gai	Whitehaven Coal Mining Pty Limited	231783	6596438
1y	-	Whitehaven Coal Mining Pty Limited	226067	6587121
1z	Long Way Round	Whitehaven Coal Mining Pty Limited	227515	6589145
1aa	-	Whitehaven Coal Mining Pty Limited	233861	6598699
1ab	-	Whitehaven Coal Mining Pty Limited	234447	6598461
1ac	-	Whitehaven Coal Mining Pty Limited	234948	6599352
1ad	Merton	Whitehaven Coal Mining Pty Limited	231215	6597109
1ae	Woodland	Whitehaven Coal Mining Pty Limited	232894	6596895
1af	Ingleburn	Whitehaven Coal Mining Pty Limited	225528	6585491

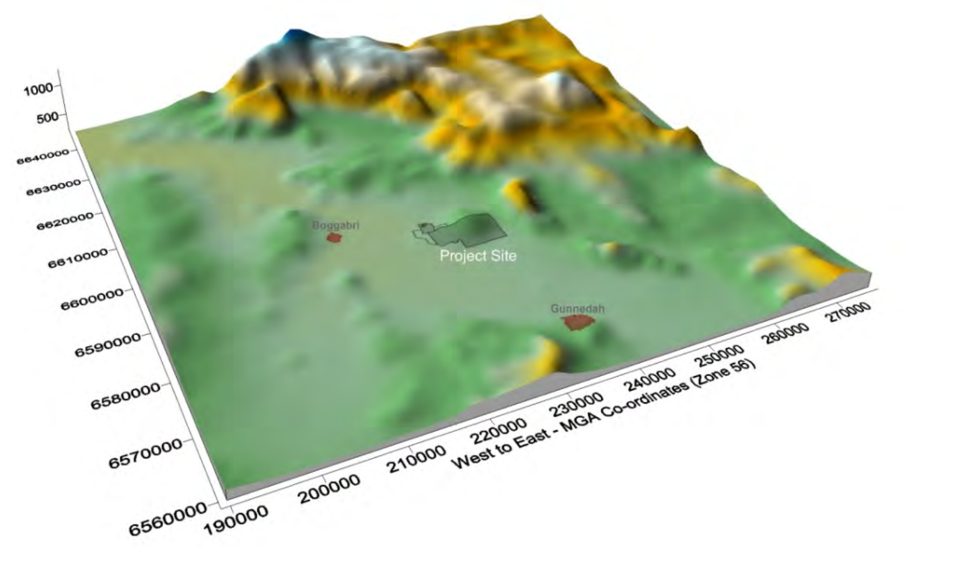
* Property under contract for purchase by Whitehaven.

Topography plays an important role in steering winds, generating turbulence and large scale eddies, and in generating drainage flows at night and upslope flows in the day. Regional topography in the Namoi River Valley has a strong influence on prevailing meteorology. The major regional topographical features that would be expected to influence air movements are displayed in **Figure 2.8** (vertical exaggeration applied to emphasise terrain features). The topography of the area in and immediately around the Project is characterised by the elevated areas of the Vickery State Forest and Kelvin State Forest to the east, and undulating lowlands and valley floor floodplains towards the west, which form part of the Namoi River Valley. The main local drainages are the Namoi River to the west and Driggle Draggle Creek to the north. **Figure 2.8** also shows a pseudo three-dimensional (3D) representation of the local topography (vertical exaggeration applied to emphasise terrain features).

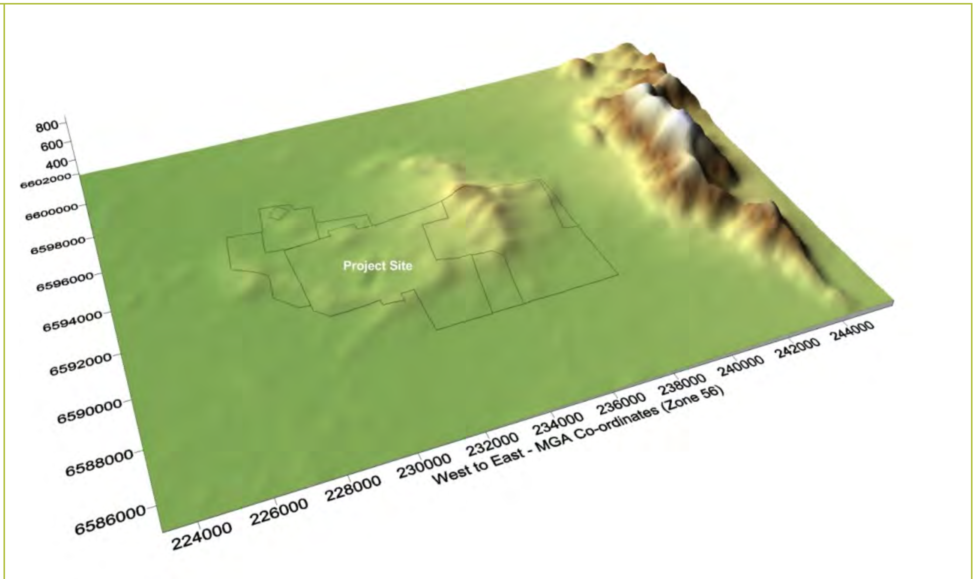
In addition, the receivers shown in **Table 2.3** are located to the north of the Project (i.e. between the Project and the Tarrawonga Coal Mine). Potential cumulative impacts were evaluated at these receiver locations (**Section 8.3**).

Table 2.3: Additional Land Ownership

Receiver ID	Dwelling Name	Ownership	Easting (m)	Northing (m)
44a	Kyalla	R.R. and P.L. Crosby	229097	6602016
44b	Northam	R.R. and P.L. Crosby	224284	6601781



Regional Topography



Local Topography

Figure 2.8: Pseudo 3D Plot of the Regional and Local Topography

3 LEGISLATIVE SETTING

3.1 Introduction

Project mining activities described in **Section 2** have the potential to generate fugitive dust emissions in the form of particulate matter described as total suspended particulate matter (TSP), particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) or less (PM_{10}) and deposited dust emissions. In addition, the combustion engines of generators and vehicles release emissions through engine exhausts including emissions of carbon monoxide (CO), minor quantities of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2).

Diesel combustion also results in the emission of particulate matter. These emissions are accounted for in the estimates of fugitive emissions of particles, which include diesel particles as well as particles derived from the materials being handled. These emissions have, therefore, been quantitatively assessed in this report.

The low sulphur content of Australian diesel, in combination with the fact that mining equipment (including generators) is widely dispersed over mine sites; is such that the ambient air quality goals for SO_2 would not be exceeded, even in mining operations that use large quantities of diesel. For this reason, no detailed assessment is required to demonstrate that emissions of SO_2 from the Project would not significantly affect ambient SO_2 concentrations. Similarly, NO_2 and CO emissions from the diesel combustion are limited and too widely dispersed to require a detailed modelling assessment. For this reason these emissions are not considered further in this report.

Other emissions to air from the Project include GHGs such as fugitive methane (CH_4) from exposed coal, carbon dioxide (CO_2) from the combustion of fuel in combustion engines, blasting and indirect GHG emissions from the combustion of coal produced on-site. GHG emissions are assessed in **Section 9**.

The following sections provide information on the air quality criteria used to assess the impact of dust and particulate emissions. To assist in interpreting the significance of predicted concentration and deposition levels some background discussion is also provided.

3.2 Particulate Matter and its Health Significance

Particulate matter has the capacity to affect health and to cause nuisance effects, and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both. The particulate size ranges are commonly described as:

- TSP – refers to all suspended particles in the air. In practice, the upper size range is typically 30 µm to 50 µm.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters less than 10 µm and with a unit density. PM_{10} are a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 µm diameter (a subset of PM_{10}). These are often referred to as the fine particles (FP) and are a sub-component of PM_{10}.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as coarse particles (CM).

Evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems. The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 µm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air, this is referred to as TSP. In practice particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm.

Both natural and anthropogenic processes contribute to the atmospheric load of particulate matter. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal[1] materials from roads, farming, mining, dust storms, and so forth. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts. Mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation, and natural processes such as bush fires. Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. $PM_{2.5}$ may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles in this size range are more harmful than the coarser component of PM_{10}.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. This is demonstrated in **Figure 3.1**, which shows the relative deposition by particle size within various regions of the respiratory tract. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air, which are key considerations in assessing exposure.

1 Crustal dust refers to dust generated from materials derived from the earth's crust.

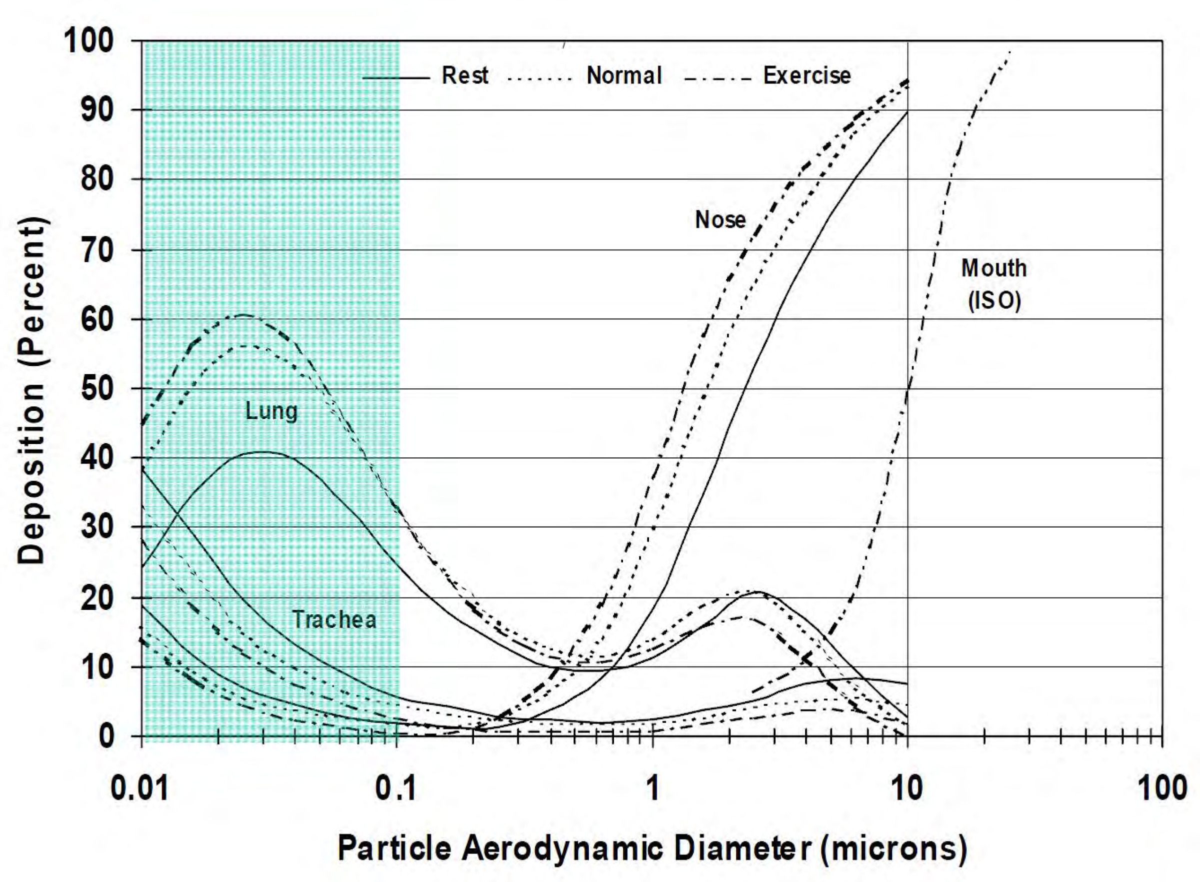


Figure 3.1: Particle Deposition within the Respiratory Track (Source: Chow, 1995)

The health-based assessment criteria used by the EPA have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion (**EPA**, **1998**; **National Environment Protection Council** [**NEPC**], **1998a**; **NEPC**, **1998b**). This means that, in contrast to dust of crustal origin, the particulate matter from urban areas would be composed of smaller particles and would generally contain acidic and carcinogenic substances that are associated with combustion.

3.3 Environmental Protection Authority Criteria

The Approved Methods specifies air quality assessment criteria relevant for assessing impacts from air pollution (**DEC, 2005**). The air quality goals relate to the total dust burden in the air and not just the dust from the Project. In other words, consideration of background dust levels needs to be made when using these goals to assess potential impacts. These criteria are health-based (i.e. they are set at levels to protect against health effects).

These criteria are consistent with the *National Environment Protection Measure for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). However, the EPA's criteria include averaging periods, which are not included in the Ambient Air-NEPM, and also references other measures of air quality, namely dust deposition and TSP.

Table 3.1 summarises the air quality goals for concentrations of particulate matter that are relevant to this study.

Table 3.1: Environmental Protection Authority Air Quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Averaging period	Standard/Goal	Agency
TSP	Annual mean	90 µg/m³	National Health and Medical Research Council.
PM_{10}	24-hour maximum	50 µg/m³	EPA impact assessment criteria; Ambient Air-NEPM reporting goal, allows five exceedances per year for bushfires and dust storms.
	Annual mean	30 µg/m³	EPA impact assessment criteria.
$PM_{2.5}$	Annual Mean	8 µg/m³	Ambient Air-NEPM Advisory Reporting Standard.
	24-hour average	25 µg/m³	

µg/m³ – micrograms per cubic metre

In May 2003, the NEPC released a variation to the Ambient Air-NEPM (**NEPC, 2003**) to include advisory reporting standards for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$). The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for $PM_{2.5}$ particles. It is noted that the Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria.

Notwithstanding the above, in the absence of any other relevant standard/goal, and because the requirement to consider $PM_{2.5}$ is included in the DGRs, the advisory reporting standards have been used in this report for comparison against dispersion modelling results (**Section 8**).

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and would fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts.

Table 3.2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 3.2: Environmental Protection Authority Criteria for Dust (Insoluble Solids) Fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

g/m²/month – grams per square metre per month.

4 EXISTING ENVIRONMENT

Air quality and meteorological monitoring equipment has been installed for the Project at the locations shown on **Figure 4.1**.

Five dust deposition gauges were installed around the Project area in October 2011 and a Tapered Element Oscillating Microbalance (TEOM) (measuring PM_{10} and $PM_{2.5}$) was installed in March 2012. Available monitoring data (i.e. to July/August 2012) from the dust deposition gauges and TEOM are provided in **Section 4.2**.

The Project meteorological station was installed in March 2012, and as such sufficient data was not available for use in the air quality dispersion modelling (which commenced in March 2012).

4.1 Meteorology

4.1.1 Local Wind Data

There are a number of automatic weather stations (AWS) located in the region. The closest AWS to the Project are the Rocglen Coal Mine AWS, located approximately 8 km northeast and the Vickery South Coal Exploration Project AWS, located approximately 3.5 km south. **Figure 4.1** shows the locations of these two meteorological stations.

The Vickery South Coal Exploration Project AWS and the Rocglen AWS collect 5-minute and 10-minute averages of wind speed, wind direction, temperature, solar radiation, relative humidity, sigma-theta and rainfall. The Vickery South Coal Exploration Project AWS was installed relatively recently and has data available from August 2011. The Rocglen AWS was established in April 2009.

A review of the available meteorological data from these sites has been conducted. In choosing a representative dataset for modelling, reference is made to seasonal wind patterns, average wind speeds, percentage occurrence of calm conditions and data recovery rates.

Based on this review, and an understanding of the local terrain, the Vickery South Coal Exploration Project AWS is considered to be more representative, as the Rocglen AWS is located within a (north-south aligned) valley and meteorological conditions are heavily influenced by local scale topography. Therefore, a period from March 2011 to February 2012 was chosen as the modelling year, to incorporate as much data as possible from the Vickery South Coal Exploration Project AWS.

Reference is also made to meteorological data collected at the Commonwealth Bureau of Meteorology (BoM) AWS at Gunnedah Airport (located approximately 19 km south of the Project) (**BoM, 2012a**). Comparative windroses for the Vickery South Coal Exploration Project AWS, Rocglen and BoM Gunnedah Airport AWS are presented in **Figure 4.2**.

Similar patterns occur at the Vickery South Coal Exploration Project AWS compared to the BoM Gunnedah Airport AWS, with a greater occurrence of east-southeast winds. On an annual basis, the dominant wind direction characteristic of the area is from the southeast. The annual percentage of calms at the BoM Gunnedah Airport AWS (winds less than 0.5 metres per second [m/s]) is 5% and the annual average wind speed is 3.6 m/s.

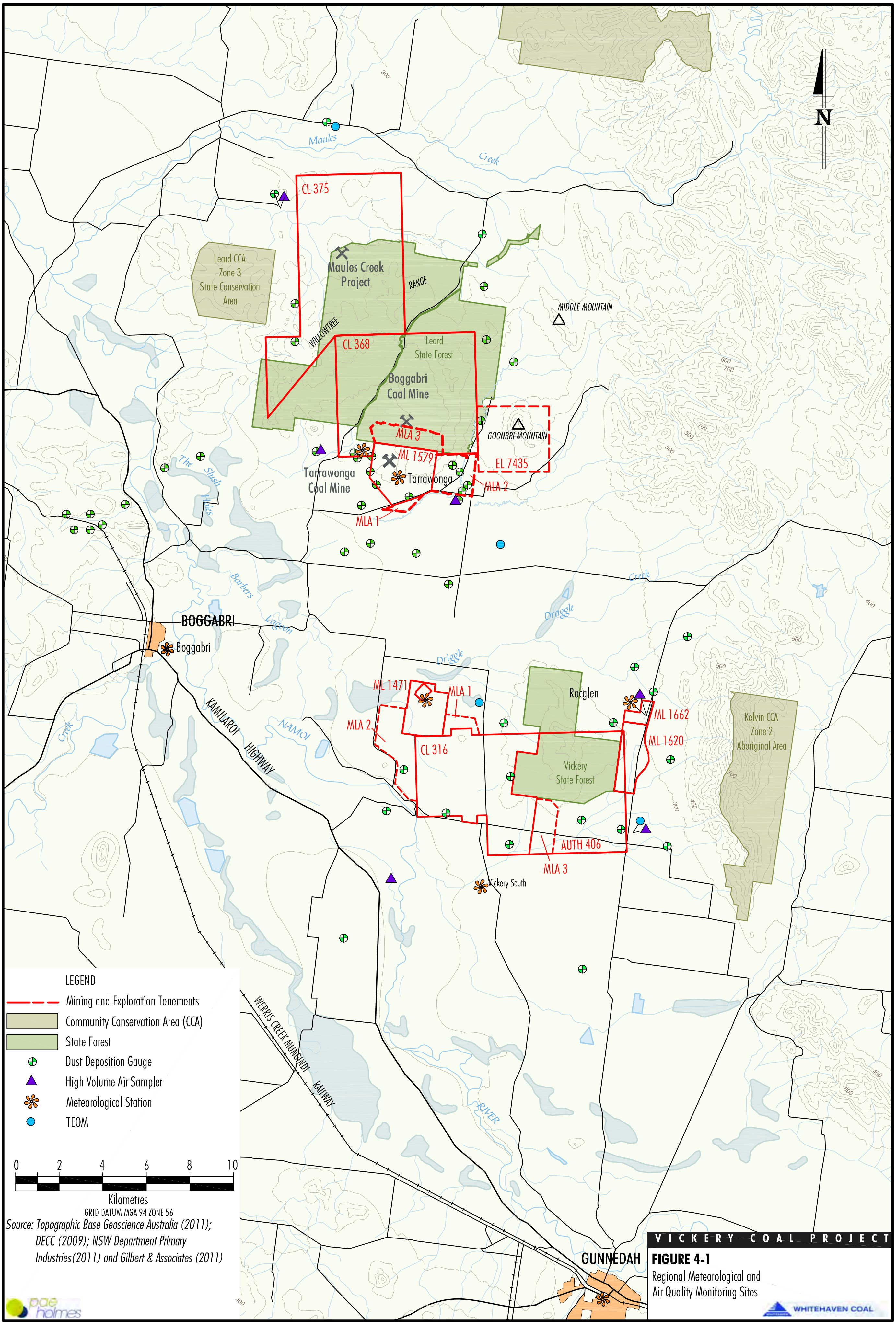


FIGURE 4-1 Regional Meteorological and Air Quality Monitoring Sites

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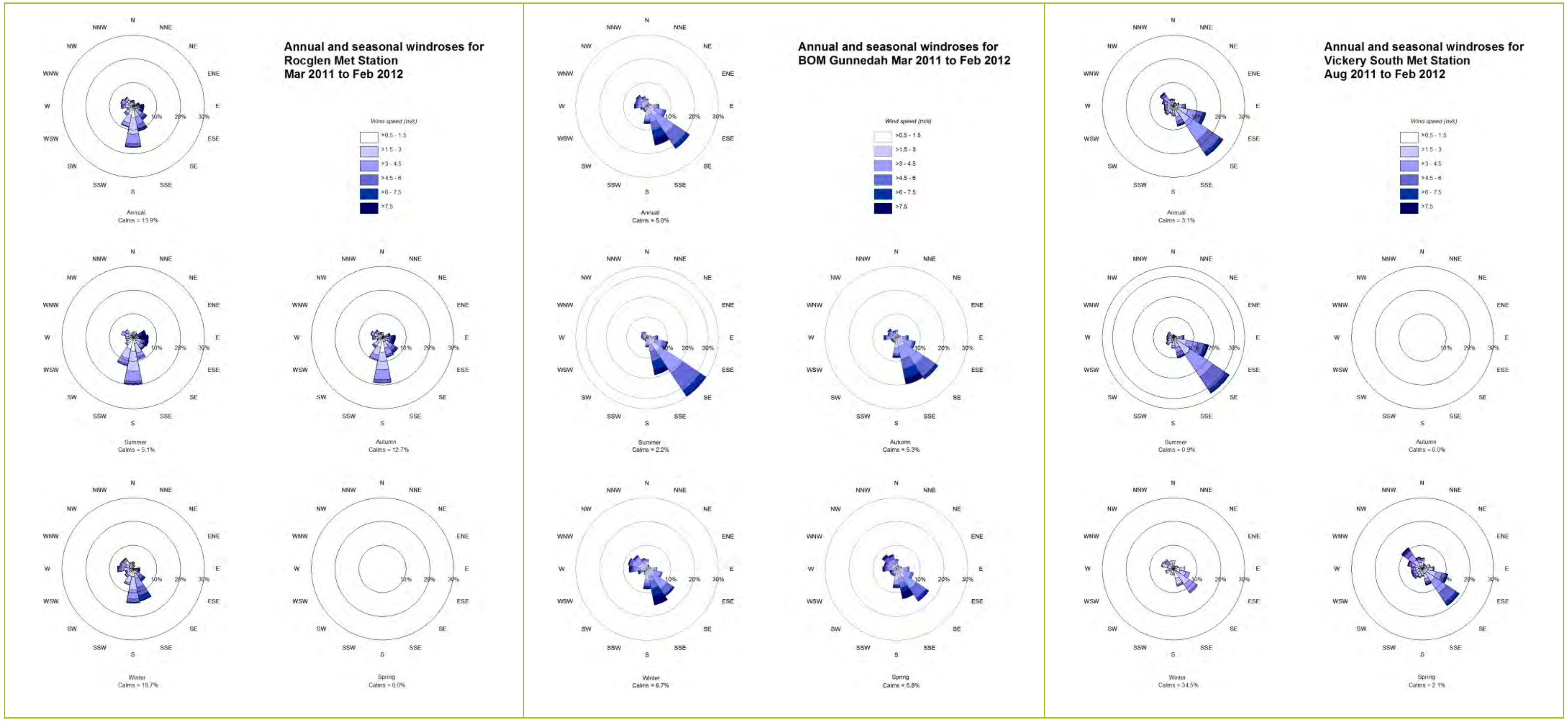


Figure 4.2: Annual and Seasonal Windroses for Rocglen, Bureau of Meteorology Gunnedah and Vickery South Coal Exploration Project

The differences in the wind patterns at Rocglen can be explained by the topographical features surrounding the Rocglen site. The Rocglen site is located in the valley with a north-south orientation, between the Vickery State Forest and Kelvin State Forest. The regional southeast winds are steered by the topography and the dominant wind direction shifts to the south. This local steering is shown in an hourly snapshot of the CALMET generated wind field, shown in **Figure 4.3**.

Data available from the Tarrawonga Coal Mine AWS, the Boggabri Coal Mine AWS and the proposed Maules Creek Coal Project AWS were also reviewed. Data recorded at these sites tend to be influenced strongly by local scale topography and were not considered in this assessment.

4.1.2 Local Climatic Conditions

Long-term meteorological data for the region are available from the BoM Gunnedah Pool AWS located in Gunnedah (**Table 4.1**) (**BoM, 2012a**). The site provides information on the long-term average values of climatic elements such as temperature, humidity, rainfall, the number of raindays per year etc. The station at Gunnedah airport has been in operation since 1876.

Table 4.1 presents temperature, humidity and rainfall data collected at Gunnedah Pool (**BoM, 2012a**). Temperature and humidity data consist of monthly means of 9.00 am and 3.00 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of raindays per month.

The annual mean daily maximum and minimum temperatures experienced at Gunnedah Pool are 25.9 degrees Celsius (°C) and 10.9°C respectively. On average January is the hottest month with an average maximum temperature of 34.0°C. July is the coldest month, with average minimum temperature of 3.0°C.

The annual mean relative humidity reading collected at 9.00 am at Gunnedah Pool is 67%, and at 3.00 pm the annual mean is 46%. The month with the highest humidity on average is June with a 9.00 am average of 79%, and the lowest is November and December with a 3.00 pm average of 40%.

Rainfall data collected at the Gunnedah Pool AWS shows that January is the wettest month, with a mean rainfall of 71.3 mm over 6.5 days. The mean annual rainfall is 622.4 mm with a mean of 72 raindays.

Table 4.1: Temperature, Humidity and Rainfall Data for the Gunnedah Pool AWS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	25.0	23.8	22.1	18.3	13.3	9.8	8.8	10.9	15	19.1	22.1	24.4	17.7
Wet-bulb	19.7	19.3	17.7	14.6	11.1	8.2	7.1	8.4	11.7	14.6	16.8	18.8	14.0
Humidity	61	65	65	67	73	79	77	71	65	61	59	58	67
3pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	31.2	30.3	28.7	24.9	20	16.7	15.8	17.7	21.3	24.5	27.7	30.2	24.1
Wet-bulb	21.6	21.4	20	17.3	14.3	12	11	11.9	14.3	16.4	18.3	20.2	16.6
Humidity	43	45	44	46	51	55	53	48	44	43	40	40	46
Daily Maximum Temperature (°C)													
Mean	34.0	32.7	30.1	26.4	21.8	18	17.1	19.5	23.2	27	30	31.4	25.9
Daily Minimum Temperature (°C)													
Mean	18.4	18.1	15.8	11.4	7.1	4.3	3	4.2	7	10.8	14.2	16.8	10.9
Rainfall (mm)													
Mean	71.3	67.3	47.7	37.5	42.5	43.6	42.4	41.5	40.3	55.5	62.6	70.1	622.4
Raindays (Number)													
Mean	6.5	6.1	4.7	4.3	5.1	6.3	6.2	6.2	5.8	6.9	6.8	7.1	72.0

Station number 055023; Commenced: 1876, Latest record: 2012; Latitude (deg S): -30.98; Longitude (deg E): 150.25.
Source: ***BoM (2012)***

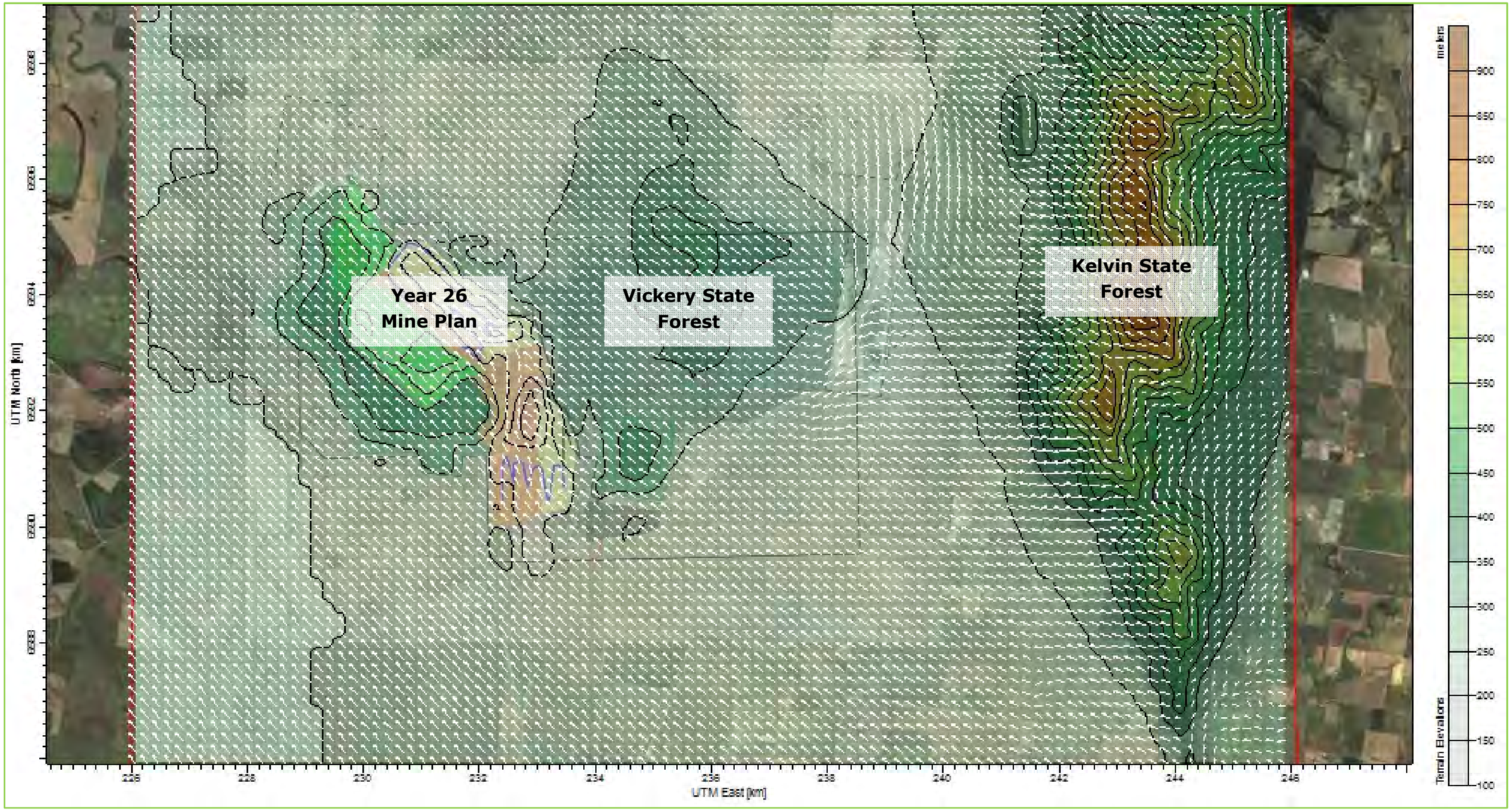


Figure 4.3: Wind Field for Year 26 Generated by CALMET – 1/02/2012 3am

4.2 Existing Air Quality

The existing air quality conditions (that is, background conditions) are influenced by existing mining operations from both a local and regional perspective.

The nearest existing air quality monitoring sites to the Project are the Whitehaven owned Rocglen Coal Mine and the Vickery South Coal Exploration Project. Rocglen and Vickery South both have current monitoring networks, and data from these networks have been made available for this report. Canyon monitoring ceased in early 2010 (coinciding with closure of the site), and only included dust deposition data. Because these results are sporadic and ceased in 2010, Canyon data area has not been considered further.

Further north, air quality monitoring networks are operated by the Tarrawonga Coal Mine, the Boggabri Coal Mine and the proposed Maules Creek Coal Project. In addition, the EPA operates a monitoring site at Tamworth, which can be considered to be representative of regional PM_{10} concentrations.

An overview of these monitoring networks, and when they commenced, is provided in **Table 4.2**, which includes dust deposition gauges, High Volume Air Samplers (HVAS) and TEOM.

Table 4.2: Summary of Dust Monitoring

Monitoring Site	Monitoring Method	Monitoring Commenced
The Project	1 x TEOM (measuring PM_{10} and $PM_{2.5}$)	March 2012
	5 x DDG	October 2011
Rocglen Coal Mine	1 x TEOM (measuring PM_{10} and $PM_{2.5}$[(a)])	March 2012
	7 x DDG	June/July 2007
	2 x HVAS	
Vickery South Coal Exploration Project	3 x DDG	August 2011
	1 x HVAS	
Tarrawonga Coal Mine	1 x TEOM (measuring PM_{10} and $PM_{2.5}$[(a)])	March 2012
	14 x DDG	December 2005
	1 x HVAS	June 2006
Boggabri Coal Mine	15 x DDG	2005
	1 x HVAS	November 2005
Maules Creek Coal Mine	4 x DDG	August 2010
	1 x HVAS	October 2010
	1 x TEOM (measuring PM_{10} and $PM_{2.5}$)	September 2011
EPA – Tamworth	1 x TEOM (measuring PM_{10})	2000

(a) $PM_{2.5}$ monitoring data unavailable
DDG = dust deposition gauge

4.2.1 PM_{10} Monitoring Data

A summary of the annual average PM_{10} concentrations recorded across the local HVAS monitoring sites for the previous 6 years are presented in **Table 4.3**. Local and regional monitoring at the TEOM sites is summarised in **Table 4.4**. It is noted that PM_{10} concentrations at some sites would be more influenced by local mining activity (i.e. the Rocglen, Tarrawonga and Boggabri Coal Mines) while others would be influenced more strongly by vehicle traffic and wood fires during winter (i.e. Tamworth).

The annual average PM_{10} concentration since the start of 2010 across all sites is between 10 $\mu g/m^3$ and 12 $\mu g/m^3$. These concentrations are consistent with levels recorded at areas outside the influence of local mining or other sources (i.e. Vickery South Coal Exploration Project and Maules Creek).

The day-to-day variability in ambient levels of 24-hour PM_{10} concentrations across the region is shown in **Figure 4.4** to **Figure 4.7**. Many of the elevated 24-hour concentrations coincide with periods of regional dust storms or bushfires (**BoM, 2012b**). PM_{10} levels across all sites have been consistently lower than the 24-hour PM_{10} impact assessment criterion since the start of 2010.

It is also noted that higher PM_{10} concentrations during 2009 (both in annual averages and peak 24-hour concentrations) are a result of the generally drier conditions experienced across NSW during 2009, which was the warmest year on record for the state of NSW and had low annual average rainfall. A record number of regional dust storms also occurred in that year, particularly between October 2009 and January 2010 (**BoM, 2012b**). The spike in PM_{10} concentrations from regional dust storms in 2009 is clearly shown at the EPA Tamworth monitor (refer to **Figure 4.7).**

Table 4.3: Summary of Annual Average PM_{10} at Local High Volume Air Samples

Monitoring Period	Rocglen Coal Mine		Vickery South Coal Exploration Project	Boggabri Coal Mine	Tarrawonga Coal Mine	Maules Creek Coal Mine	Average
	Glenroc	Roseberry					
2007	-	-	-	14 [(a)]	16	-	**15**
2008	23	13	-	11	13	-	**15**
2009	24	20	-	20	21	-	**22**
2010	12	9	-	12	13	10 [(d)]	**11**
2011	13	11	11 [(b)]	14 [(c)]	16	11 [(e)]	**12**
2012 [(f)]	17	8	8	-	11	-	**11**

(a) data from July 2007
(b) data from July 2011
(c) data to July 2011
(d) data from Oct 2010
(e) data to August 2011
(f) data to May/June 2012

Table 4.4: Summary of Annual Average PM_{10} at Local and Regional Tapered Element Oscillating Microbalance

Monitoring Period	Project	Tarrawonga Coal Mine	Rocglen Coal Mine	Maules Creek Coal Mine	EPA Tamworth	Average
2007	-	-	-	-	16	**16**
2008	-	-	-	-	16	**16**
2009	-	-	-	-	27	**27**
2010	-	-	-	-	12	**12**
2011	-	-	-	8 [(a)]	13	**11**
2012	11 [(b)]	11 [(b)]	11 [(b)]	6 [(c)]	13 [(d)]	**10**

(a) data from November 2011
(b) data from April 2012 to July 2012
(c) data missing from March 2012 to mid-April 2012 and data available to May 2012
(d) data to July 2012

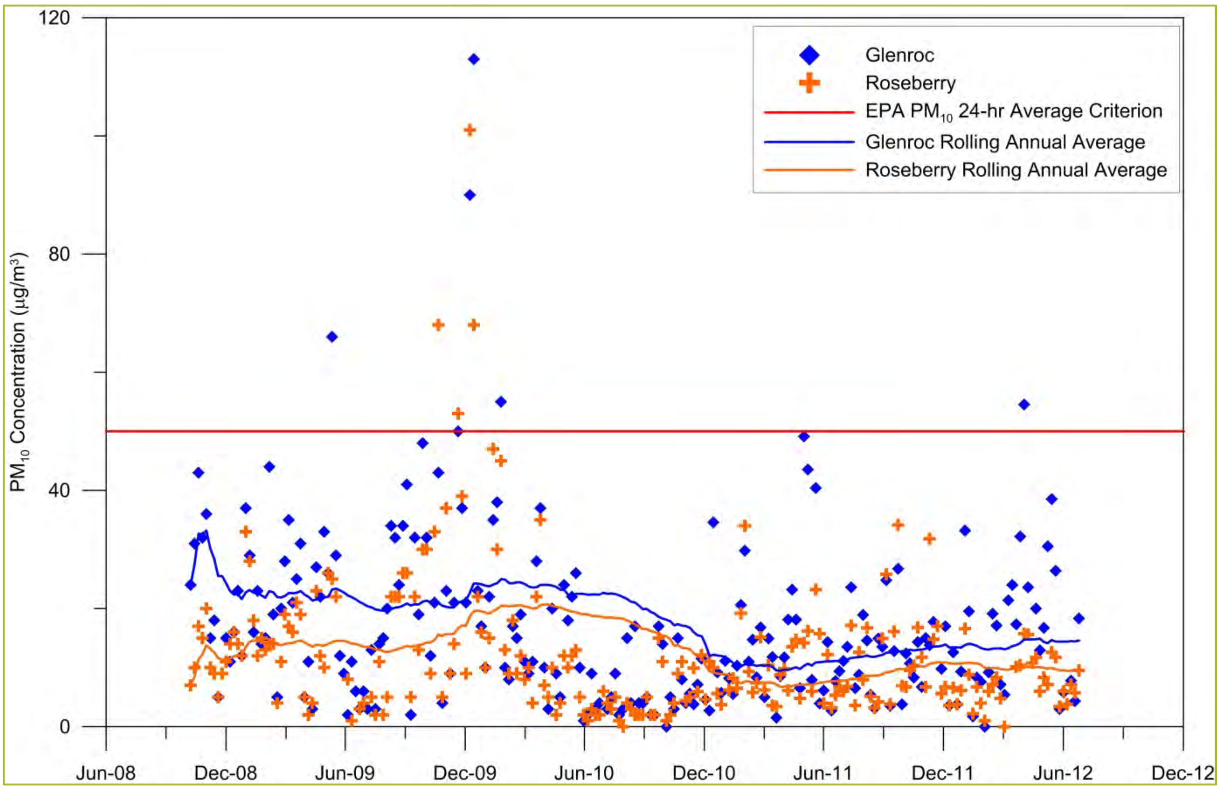


Figure 4.4: Rocglen 24-hour PM_{10} Concentrations - µg/m^3

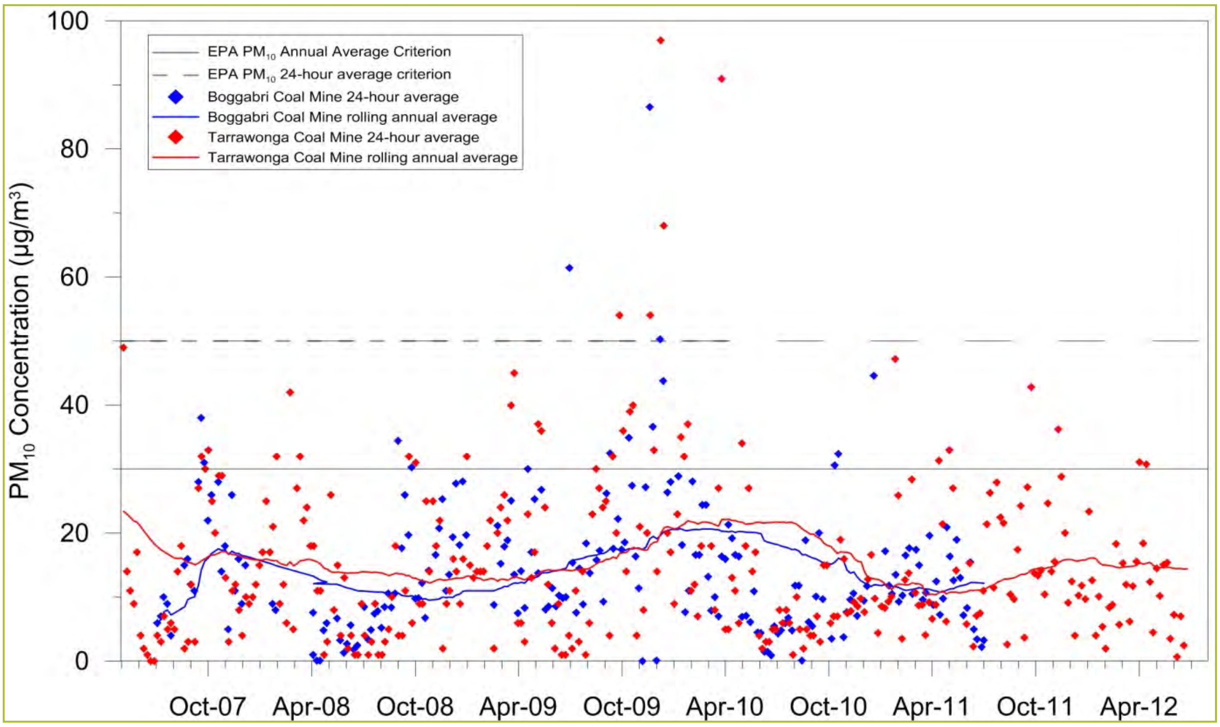


Figure 4.5: Boggabri and Tarrawonga 24-hour Average PM_{10} Concentrations – µg/m^3

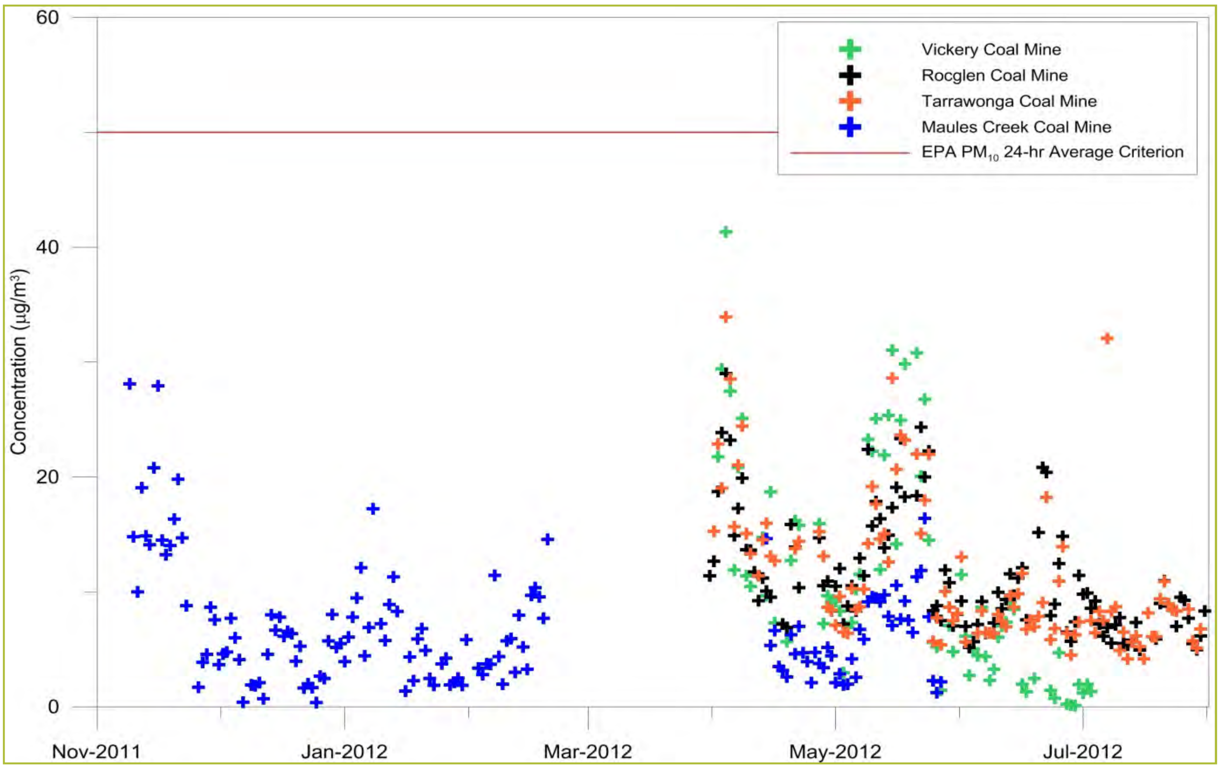


Figure 4.6: 24-hour PM_{10} Concentrations at Local Tapered Element Oscillating Microbalance – µg/m^3

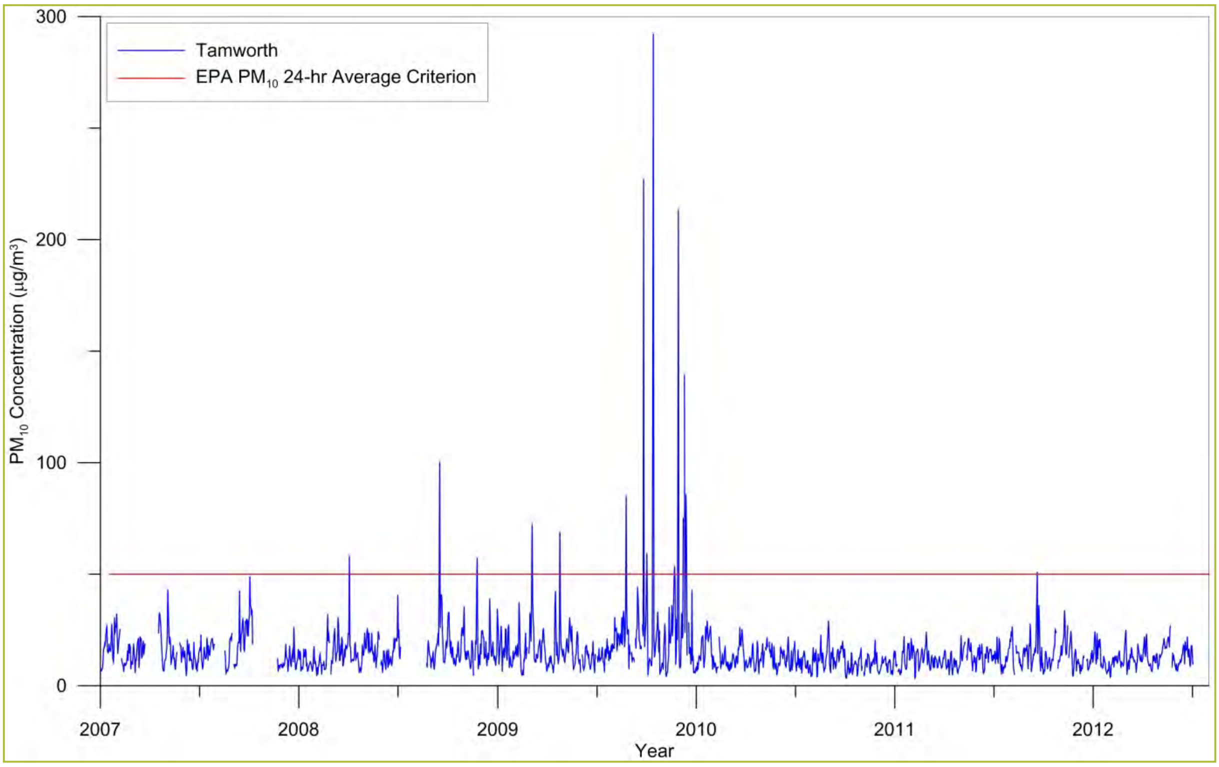


Figure 4.7: Environmental Protection Authority Tamworth 24-hour PM_{10} Concentrations

4.2.2 Dust Deposition

A summary of the annual average dust deposition recorded across all monitoring sites, for the previous 8 years, is presented in **Table 4.5**. Data above the impact assessment criteria are shown in bold.

As noted in **PAEHolmes** (**2012**), dust deposition at some sites is influenced by local mining activity. A number of Tarrawonga Coal Mine dust gauges including EB-8, EB-11, EB-14 and EB-15 are located within the existing Tarrawonga Coal Mine ML. These gauges are often in close proximity to active mining operations, therefore these data provide diagnostic data only. Site EB-13 exhibits consistently higher dust deposition levels relative to the adjacent sites EB-4 and EB-5. This is likely to be due to a localised dust source on the Bollol Creek Station property, rather than a larger scale effect.

Dust deposition levels at distances further from active mining (i.e. Vickery South Coal Exploration Project, Maules Creek) are generally lower than the impact assessment criteria, and at Maules Creek and the Vickery South Coal Exploration Project, are generally less than 2 g/m^2/month.

Table 4.5: Summary of Dust Deposition Data (g/m^2/month)

Site		2005	2006	2007	2008	2009	2010	2011	2012[(c)]	Ave
Vickery South	DG1	-	-	-	-	-	-	0.3 [(a)]	1.2	0.8
	DG2	-	-	-	-	-	-	2	2.2	2.1
	DG3	-	-	-	-	-	-	1.1	1.7	1.4
Rocglen	BD1	-	-	1.8	1.3 [(b)]	-	-	-	-	1.6
	BD2	-	-	1.5	0.9	2.3	1.5	1.3	1.6	1.5
	BD3	-	-	1.2	1.2	1.7	1.2	1.3	1.0	1.3
	BD4	-	-	1.5	1.2	1.7	0.8	0.9	1.1	1.2
	BD5	-	-	0.7	0.7	2.4	1.0	0.7	0.8	1.1
	BD6	-	-	1.1	1.1	1.7	1.1	1.7	0.7	1.2
	BD7	-	-	1.4	1.1	1.7	1.4	0.9	2.2	1.5
	BD8	-	-	1.3	1.1	2.0	1.0	1.1	0.9	1.2
Tarrawonga	EB-3[c]	-	1.6	2.6	**4.2**	-	-	-	-	2.8
	EB-4	1.4	1.4	1.4	2	3.2	2.6	**5.7**	3.3	2.5
	EB-5	**5.8**	1.6	2.2	2.3	**4.4**	2.9	3.4	0.7	2.9
	EB-6	1.3	1.1	1	1.3	2.1	1	0.7	0.9	1.2
	EB-7	0.8	1.1	1.1	1.2	2.3	1	0.7	0.7	1.1
	EB-8	1.3	1	1.1	2.5	**4.7**	2.1	**4.1**	**4.9**	2.7
	EB-9	1.2	0.9	1.2	1	2.3	0.8	0.6	0.9	1.1
	EB-10	-	-	1	2.9	3.1	**4.5**	1.8	**4.8**	3.0
	EB-11	-	-	1.4	1.4	3.2	2	1.8	1.2	1.8
	EB-12	-	-	1	1.7	3.1	2.1	1.3	1.2	1.7
	EB-13	-	-	-	**12.9**	**7.3**	**4.7**	2.3	2.9	**6.0**
	EB-14	-	-	-	2.7	**4.8**	3.3	1.6	3.5	3.2
	EB-15	-	-	-	2.7	**6.5**	**4.3**	**4.7**	**4.9**	**4.6**
	EB-16	-	-	-	-	-	1.6	1.6	3.1	2.1
Boggabri	D1	0.7	0.9	1.8	2.6	2.6	**4.3**	1.4	-	2.0
	D2	0.7	1.5	2	2.4	2.1	2.7	1.4	-	1.8
	D3	2.1	1.6	2.9	**5.6**	**4.1**	**9.1**	**5.5**	-	**4.4**
	D4	2.2	1.5	2.3	3.9	2.2	2.9	**4.2**	-	2.7

Site		2005	2006	2007	2008	2009	2010	2011	2012(c)	Ave
	D5	1.4	1.3	1.7	1.4	2.2	0.8	0.9	-	1.4
	D6	1.5	1	1.7	1.9	2.6	0.9	1.1	-	1.5
	D7	0.8	1.2	1.5	1.6	2.4	0.8	1	-	1.3
	D8	1.1	1.1	1.3	1.2	2	0.9	1.1	-	1.2
	D9	1.1	1.3	1	2.3	2.3	1.5	**4.4**	-	2.0
	D10	1.1	0.8	1.1	1.1	2	0.4	0.5	-	1.0
	D11	1.5	1.2	1	1.4	2.6	0.7	0.4	-	1.3
	D12	1.1	1.6	1.9	2.9	**4.8**	**5**	1.6	-	2.7
	D13	1.5	1.8	2.2	2.4	2.9	1.6	0.4	-	1.8
	D14	0.9	0.9	1.6	**7.4**	**4.7**	**5.7**	1	-	3.2
	D15	-	-	-	1.1	**22.4**	1.1	1.8	-	**6.6**
Maules Creek	MC01	-	-	-	-	-	-	1	-	1.0
	MC02	-	-	-	-	-	-	1.3	-	1.3
	MC03	-	-	-	-	-	-	2.2	-	2.2
	MC04	-	-	-	-	-	-	1.3	-	1.3
Vickery (d)	V1	-	-	-	-	-	-	0.6	0.6	0.6
	V2	-	-	-	-	-	-	0.6	0.6	0.6
	V3	-	-	-	-	-	-	0.7	**4.1**	2.4
	V4	-	-	-	-	-	-	0.6	2.1	1.4
	V5	-	-	-	-	-	-	0.6	0.8	0.7

(a) data from August 2011.
(b) data to November 2008.
(c) data available to May/June 2012.
(d) data from October 2011 to August 2012.
Bold font indicates data above impact assessment criteria.

4.3 Total Suspended Particulate Matter Concentrations

No TSP concentration data are available in the vicinity of the Project. However, annual average TSP concentrations can be estimated from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**).

Since the start of 2010, annual average PM_{10} concentrations have been 10 to 12 µg/m^3 across all sites (refer **Section 4.2.1**). As such, the background annual average TSP concentration for this period is estimated as 30 µg/m^3.

4.4 $PM_{2.5}$ Concentrations

$PM_{2.5}$ concentrations are measured for the Project and the proposed Maules Creek Coal Project. Data has been collected for the Project and Maules Creek since April 2012 and November 2011, respectively. A plot of the 24-hour $PM_{2.5}$ concentrations is shown in **Figure 4.8**.

The average $PM_{2.5}$ concentration based on the available validated data for the Project and at Maules Creek is 4.6 µg/m^3 and 4.5 µg/m^3, respectively.

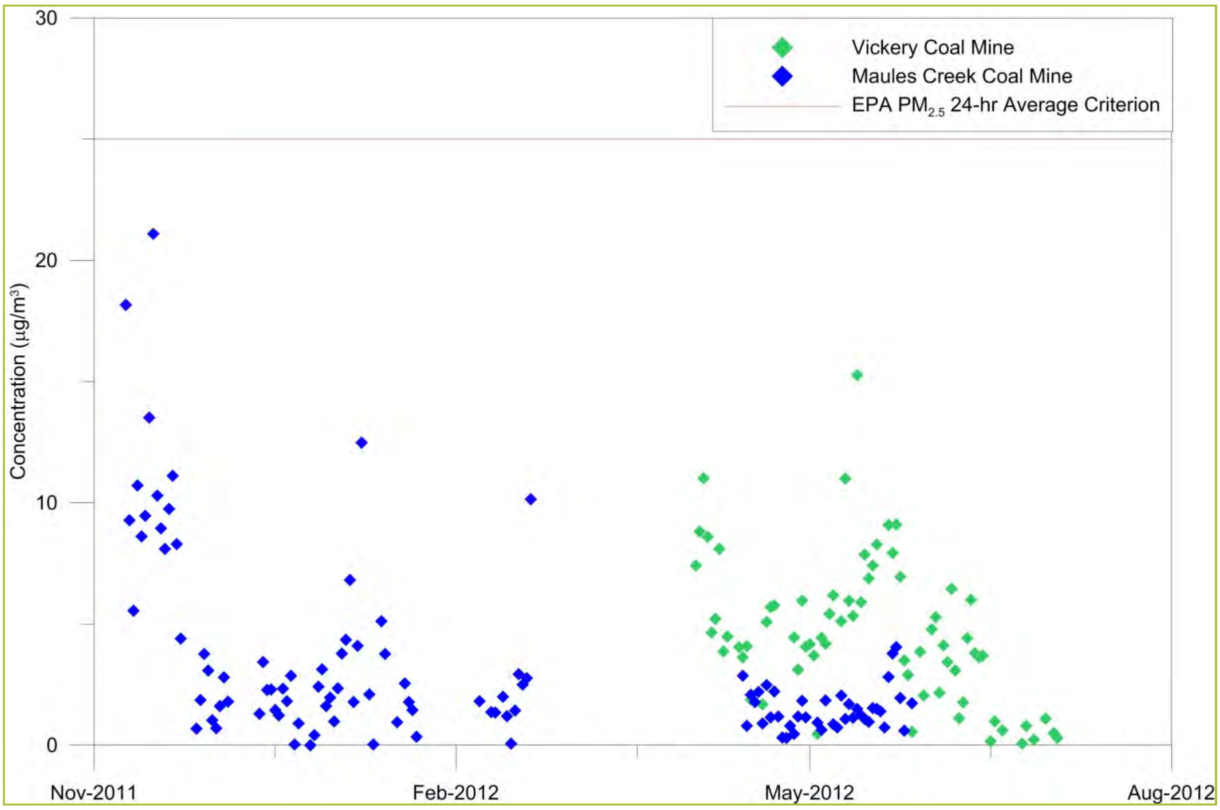


Figure 4.8: Project and Maules Creek 24-hour Average $PM_{2.5}$ Concentrations – µg/m^3

4.5 Background Air Quality for Assessment Purposes

To assess impacts against the relevant air quality standards and goals it is necessary to consider the existing dust concentration and deposition levels for the area in which the Project would contribute. The existing background levels account for distant mines and other sources that are not modelled in the assessment.

As described in **Section 4.2.1**, a number of dust storms occurred between October 2009 and January 2010, resulting in elevated annual average PM_{10} concentrations.

Based on the review of air quality data available since the start of 2010 (**Section 4.2**), the following background levels are adopted for this assessment:

- annual average PM_{10} concentration of 12 µg/m^3;
- annual average $PM_{2.5}$ concentration of 4.5 µg/m^3;
- annual average TSP concentration of 30 µg/m^3; and
- annual average dust deposition of 2 g/m^2/month.

5 MODELLING APPROACH

The assessment follows a conventional approach commonly used for air quality assessment in Australia and outlined in the Approved Methods (**DEC, 2005**).

5.1 Modelling System

The CALMET/CALPUFF modelling system was chosen for this study. CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the 3D meteorological fields that are utilised in the CALPUFF dispersion model. CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region. CALPUFF is a multi-layer, multi-species non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal (**Scire *et al.*, 2000**). The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff, and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

The CALPUFF dispersion model is endorsed by the United States Environment Protection Agency (US EPA) and is an approved modelling system in accordance with the Approved Methods.

In March 2011 the NSW Office of Environment and Heritage published generic guidance and optional settings for the CALPUFF modelling system for inclusion in the Approved Methods (**TRC Environmental Corporation, 2011**). The model set up for this study has been conducted in consideration of these guidelines (**Appendix A)**.

5.2 Model Set Up

CALMET was initially run for a coarse outer grid domain of 90 km x 90 km, centred near the Project site, with a 2 km grid resolution. This coarse outer grid was used as input to the initial guess field for a finer resolution inner grid domain of 20 km x 15 km with a 0.2 km grid resolution, also centred over the Project site. The rationale for modelling an outer meteorological domain was to capture significant regional features, for example Mount Kaputar, and to allow cloud data from BoM monitoring sites to be incorporated.

Upper air information was incorporated through the use of prognostic 3D data extracted from The Air Pollution Model (TAPM)[2].

[2] The Air Pollution Model, or TAPM, is a 3D meteorological and air pollution model developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Atmospheric Research. Detailed description of the TAPM model and its performance is provided in Hurley (2008) and Hurley *et al*. (2009).

The inner grid modelling was used to create a fine resolution 3D meteorological field for the area around the Project site. Observed hourly data from the Vickery South Coal Exploration Project AWS, Rocglen Coal Mine AWS and the BoM site located at Tamworth Airport were used as input for CALMET. Cloud cover and cloud heights were sourced from observations at Tamworth Airport AWS. Detailed mine plan terrain data were incorporated into the modelling and a separate CALMET wind field generated for each mine plan scenario. Further details on model set up are provided in **Appendix A**.

5.3 Dispersion Meteorology

The CALMET generated winds are compared with the measured data from the Vickery South Coal Exploration Project AWS and presented in **Figure 5.1**. The Vickery South Coal Exploration Project meteorological data were available from August 2011 to February 2012.

The CALMET windrose is extracted for a single point at the approximate location of the Vickery South Coal Exploration Project site. The CALMET windrose displays very similar characteristics to the measured data with dominant winds from southeast. The average wind speed from CALMET and the Vickery South Coal Exploration Project AWS is 2.7 m/s and 3.0 m/s, respectively. The percentage occurrence of calm conditions (defined as wind speeds <0.5m/s) is similar, being 3.7% and 3.1%.

5.4 Modelling Scenarios

Four years have been chosen for dispersion modelling. These years along with their rationale for selection are provided below:

- Year 2 – Representative of initial mining and of western-most operations during the Project.
- Year 7 – Includes placement of waste rock at the Eastern Waste Emplacement area (at its maximum elevation) and is the first year that a mining rate of 4.5 Mtpa ROM coal extraction occurs from the open cut pit.
- Year 17 – Includes placement of waste rock at northern-most emplacement and large portion of exposed area (pit and overburden areas).
- Year 26 – Maximum Project ROM coal and waste rock production rates.

Dispersion modelling results for the above years are considered to represent the worst case for the Project at any particular residential receiver.

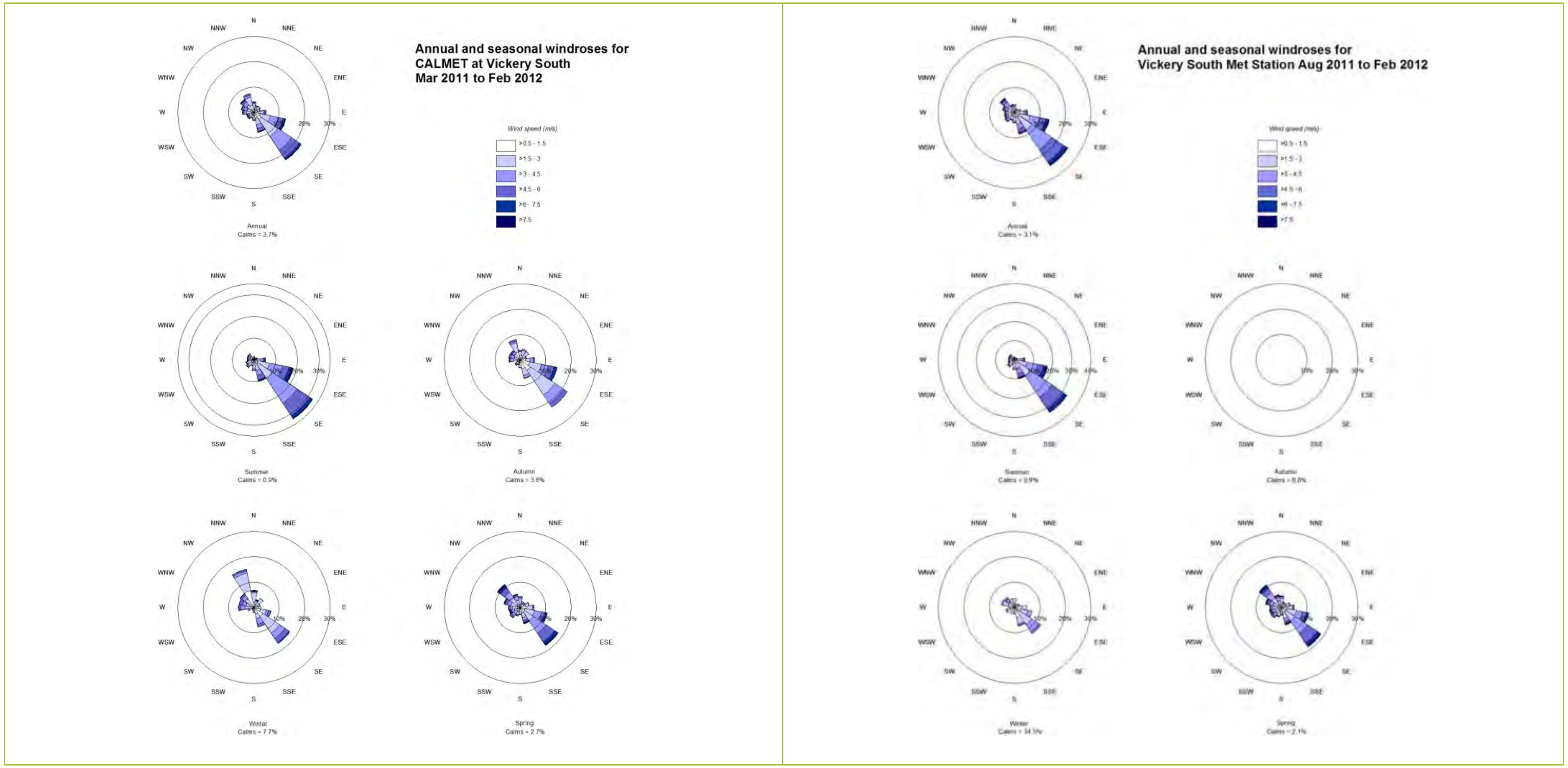


Figure 5.1: Annual and Seasonal Windroses for the Vickery South Coal Exploration Project and CALMET

6 OVERVIEW OF BEST PRACTICE DUST CONTROL

This section describes the best practice air quality mitigation measures to be implemented for the Project with reference to the recommendations of the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (**Donnelly *et al.*, 2011**) (the Best Practice Report), a study that was commissioned by the EPA.

As an outcome of the Best Practice Report, the EPA developed a Pollution Reduction Programme (PRP) that requires each mining company to prepare a report on the practicability of implementing best practice measures to reduce particle emissions. PRP requirements were included in the nearby Whitehaven-owned Rocglen and Tarrawonga Coal Mine Environment Protection Licence. As such, the dust management measures for the Project have been developed in consideration of existing dust management practices at the Tarrawonga and Rocglen Coal Mines, as well as the measures detailed in the Tarrawonga PRP (**PAEHolmes, 2012**).

Table 6.1 provides an overview of the best practice air quality mitigation measures to be implemented for the Project. These are targeted at the main sources of air quality emissions identified in the Best Practice Report (**Donnelly *et al.*, 2011)**. Measures to be employed for the Project include:

- Use of water carts/trucks to control emissions from haul roads.
- Use of additional water application (i.e. level 2 water) on haul roads.
- The use of large vehicles (reducing the number of trips required).
- Progressive rehabilitation.
- Watering of trafficked areas for bulldozing.
- Minimisation of travel speed and distance travelled for bulldozing.
- Delay of blasts if unfavourable weather prevails.
- Minimisation of blast area.
- Use of water sprays or curtains for drilling operations.
- Minimisation of drop heights for dumping of overburden and ROM coal.
- Enclosure of the crushing/screening facility.

6.1 Other Potential Best Practice Controls Considered for the Project

Whitehaven has investigated other best practice controls including water sprays at the ROM pad and other infrastructure areas. Water sprays on activities handling ROM coal was considered to be impractical as it affects the moisture content of the coal, which is considered to be disadvantageous given that some ROM coal is directly sold to customers (i.e. domestic coal). Preliminary air dispersion modelling of water sprays on the ROM pad and ROM hopper indicated that the effect of the control measures on dust impacts at the sensitive receivers is not significant. Direct water spraying of overburden loading and dumping is not considered to be operationally feasible due to the dispersed nature of potential overburden loading/unloading locations (i.e. multiple loading and unloading locations are typically used). Water carts/trucks are used on active haul roads as described above.

Table 6.1: Overview of Best Practice Emission Reduction Measures Described in the Best Practice Report

Air Quality Emission Source	Emission Reduction Measure	To be used for Project	Comments	Effectiveness of reduction in Emissions Inventory
Haul Trucks travelling on Unpaved Roads	Use of water carts/trucks to control emissions	Yes	Water carts used plus a water truck.	75% haul road control of emissions.
	Additional water application and/or use of surfactants	Yes	Additional/extended water truck shifts to be undertaken when necessary. Whitehaven would also undertake an education campaign with water cart/truck drivers to facilitate targeted application of additional watering.	
	Use of larger vehicles	Yes	195 t and 240 t capacity vehicles used for overburden and coal.	The emission factor is based on the size of the vehicles, so no addition reduction to the emissions inventory is necessary.
Wind Erosion of Overburden	Progressive Rehabilitation	Yes	Rehabilitation to occur as described in Section 5 in the Main Text of the EIS.	Partially rehabilitated areas are assumed to be 99% effective in terms of dust control as they are not trafficked and would therefore be subject to surface 'crusting' and progressive establishment of groundcover/grasses. Rehabilitated areas are 100% effective in terms of dust control.
ROM Coal Handling	Minimisation of drop heights	Yes	Whitehaven would undertake an education campaign with truck drivers to minimise drop heights.	30% control of unloading ROM coal at ROM pad emissions.
Bulldozing	Watering of trafficked areas	Yes	Application rates would be as per unpaved roads.	Emission factor based on hours used, so no reduction to the emissions inventory is necessary, however there would be a marginal reduction in practice.
	Minimisation of travel speed and distance travelled	Yes	Whitehaven would undertake an education campaign with dozer drivers to encourage appropriate speeds and routes are used.	
Blasting	Delay of blasts if unfavourable weather prevails	Yes	Whitehaven would delay blasting during unfavourable conditions, including strong winds and temperature inversions.	Emission factor does not consider weather conditions, so no reduction to the emissions inventory is necessary, however there would be a material reduction in short-term emissions in practice.
	Minimisation of blast area	Yes	Appropriate blast design, including minimisation of blasting area is an objective of blasting operations.	Blasting area assumed to be 6,000 square metres (m^2).
Drilling	Water Sprays or curtains	Yes	Drilling typically uses water injection.	70% control of drilling emissions.
Loading and dumping of Overburden	Minimisation of drop heights	Yes	Whitehaven would undertake an education campaign with truck drivers to minimise drop heights.	30% control of loading and unloading of overburden emissions.

Air Quality Emission Source	Emission Reduction Measure	To be used for Project	Comments	Effectiveness of reduction in Emissions Inventory
	Use of water sprays	No	Direct water spraying of overburden loading and dumping is not considered to be operationally feasible by Whitehaven due to the dispersed nature of potential overburden loading/unloading locations (i.e. multiple loading and unloading locations are typically used). Water carts/trucks are used on active haul roads as described above.	N/A
Crushing/Screening	Enclosure	Yes	Crushing and screening of ROM coal undertaken within an enclosed building.	100% control of ROM coal crushing and screening emissions.
ROM Coal Stockpile	Water sprays	No	Water sprays on activities handling ROM coal was considered to be impractical as it affects the moisture content of the coal, which is considered to be disadvantageous given that some ROM coal is directly sold to customer (i.e. domestic coal). Preliminary air dispersion modelling of water sprays on the ROM pad and ROM hopper indicated that the effect of the control measures on dust impacts at the sensitive receivers is not significant.	N/A

6.2 Description of Real Time Air Quality Management

Whitehaven is committed to leading practice dust management at the site through the use of a real-time and proactive dust management system. A network of real-time dust monitors in the vicinity of the Project would continuously log short-term particulate concentrations and report the data to a web based recording system.

When certain short-term trigger levels are reached or exceeded, a message would be delivered to a Whitehaven representative, alerting them to the elevated short-term dust levels. The on-site weather station would report wind conditions at the time, allowing appropriate personnel to determine the potential origin of the elevated dust levels. The short-term trigger levels (e.g. 1-hour average) would be set at a level where a few consecutive readings at these high levels risks a breach of the 24-hour PM_{10} impact assessment criteria.

An additional potential component of the dust management system would be a meteorological forecasting system to predict, in advance, what the meteorological conditions would be. This would allow the appropriate personnel to manage the intensity of activities for that day, increase controls or limit activity to various areas of the Project.

It is anticipated that real-time air quality monitoring and controls would be particularly effective in controlling the potential short-term emissions which are predicted in **Section 8.2**. The real-time air quality monitoring would complement the existing monitoring systems for other mining operations in the area (e.g. the Tarrawonga, Rocglen and Boggabri Coal Mines and the Maules Creek Coal Project).

7 EMISSIONS TO AIR

The operation of the Project has been analysed and estimates of dust emissions for the key dust generating activities have been made. Emission factors developed both locally and by the US EPA, have been applied to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most reliable, contemporary methods for determining dust generation rates.

The mining plans for the Project have been analysed and detailed emissions inventories have been prepared for four key operating scenarios, being Project Years 2, 7, 17 and 26. These modelled years are considered to be representative of worst-case operations; for example where coal and waste production are highest, where extraction or wind erosion areas are largest, or where operations are located closest to receivers (**Section 5.4**).

Detailed calculations are provided in **Appendix B** which provides information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content, etc.), information on the way in which equipment would be used to undertake different mining operations and the quantities of materials that would be handled in each operation.

7.1 Particle Size Categories

Emission rates of TSP, PM_{10} and $PM_{2.5}$ have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix B**). Modelling of PM_{10} and $PM_{2.5}$ was undertaken using the particle size specific inventories and was assumed to emit and deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mass of the particle size range.

TSP and dust deposition modelling was undertaken by splitting the TSP inventory into three particle size categories. The distribution of particles in each particle size range for TSP and dust deposition modelling is as follows (**State Pollution Control Commission, 1986**):

- $PM_{2.5}$ (FP) is 0.0468 of the TSP.
- $PM_{2.5-10}$ (CM) is 0.3440 of TSP.
- PM_{10-30} (Rest) is 0.6090 of TSP.

7.2 Emission Estimates

Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. Dust generating activities were represented by a series of volume sources situated according to the location of activities for the modelled scenarios.

To model the effect of pit retention for emissions within the open cut pits and the effects of other mine landforms, detailed mine terrain has been incorporated into the modelling for each modelled mine year.

The information used for developing the inventories has been based on the operational descriptions and mine plan drawings and used to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions. **Table 7.1** to **Table 7.4** summarises the quantities of TSP, PM_{10} and $PM_{2.5}$ estimated to be released by each activity of the Project.

Table 7.1: Estimated Particulate Emissions in Year 2

Activity	TSP emissions (kg/y)	PM_{10} emissions (kg/y)	$PM_{2.5}$ emissions (kg/y)
OB - Drilling Pit	9,462	4,920	284
OB - Blasting Pit	8,627	4,486	259
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	48,468	22,924	3,471
OB - Hauling OB from Open Cut to Main Emplacement	1,760,549	385,737	37,663
OB - Hauling OB from Open Cut to ROM pad for gravel	7,461	1,596	160
OB - Emplacing OB at Emplacement Area	48,468	22,924	3,471
OB - Dozers on OB (In-Pit)	177,693	41,993	18,658
OB - Dozers on OB (on emplacement)	266,540	62,989	27,987
OB - Crushing gravel (mobile crusher)	248	248	0
OB - Loading crushed gravel to trucks	249	118	18
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	303	138
Rh - Dozers on partial rehab area	81,443	19,247	8,551
Rh - Scrapers on partial rehab area (travel mode)	216,463	54,116	0
CL - Dozers ripping/pushing/clean-up (In-Pit)	268,177	77,280	5,900
CL - Sh/Ex/FELs Loading ROM to trucks Pit	71,748	10,319	1,363
CL - Hauling CL from Open Cut to ROM pad	54,065	11,566	1,157
CL - Unloading ROM at ROM pad	50,224	7,223	954
CL - Sh/Ex/FELs loading ROM to dump hopper	71,748	10,319	1,363
CL - Crushing ROM	0	0	0
CL - Screening ROM	0	0	0
CL - Loading crushed/screened ROM to trucks	71,748	10,319	1,363
CL - Hauling crushed ROM to site exit (sealed)	11,456	2,194	1,001
WE - Active Pit	78,840	39,420	5,913
WE - Waste Emplacement	132,977	66,488	9,973
WE - Waste Emplacement (adverse weather)	27,071	13,534	2,030
WE - Partially Rehab Area – Western	569	285	43
WE- Topsoil Stockpiles	876	438	66
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	42,574	21,287	3,193
Grading roads	75,481	26,373	2,340
Total emissions for Year 2 (kg/y)	**3,584,806**	**918,646**	**137,319**

OB = overburden; Rh = rehabilitation; CL = coal; Sh = shovel; EX = excavator; FEL = front-end loader; WE = wind erosion; kg/y = kilograms per year

Table 7.2: Estimated Particulate Emissions in Year 7

Activity	TSP emission (kg/y)	PM_{10} emissions (kg/y)	$PM_{2.5}$ emissions (kg/y)
OB - Drilling East Pit	6,308	3,280	189
OB - Blasting East Pit	10,122	5,264	304
OB - Drilling West Pit	3,154	1,640	95
OB - Blasting West Pit	5,061	2,632	152
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	56,870	26,898	4,073
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	28,435	13,449	2,037
OB - Hauling OB from Open Cut (East) to Main Emplacement	330,514	70,706	7,071
OB - Hauling OB from Open Cut (East) to Eastern Emplacement	1,870,571	400,165	40,017
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	8,322	1,780	178
OB - Hauling OB from Open Cut (West) to Emplacement	743,656	159,088	15,909
OB - Emplacing OB at Emplacement Area (East)	37,913	17,932	2,715
OB - Emplacing OB at Emplacement Area (Main)	47,391	22,415	3,394
OB - Dozers on OB (In-Pit)	444,233	104,982	46,644
OB - Dozers on OB (on emplacement)	355,386	83,986	37,316
OB - Crushing gravel (mobile crusher)	248	248	0
OB - Loading crushed gravel to trucks	249	118	249
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	303	138
Rh - Dozers on partial rehab area	81,443	19,247	8,551
Rh - Scrapers on partial rehab area (eastern)	108,232	27,058	0
Rh - Scrapers on partial rehab area (western)	108,232	27,058	0
CL - Dozers ripping/pushing/clean-up (In-Pit)	268,177	77,280	5,900
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	143,496	20,637	2,726
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	71,748	10,319	1,363
CL - Hauling CL from Open Cut (East) to ROM pad	120,607	25,801	2,580
CL - Hauling CL from Open Cut (West) to ROM pad	60,304	12,901	1,290
CL - Unloading ROM at ROM pad	150,671	21,669	2,863
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	30,956	4,090
CL - Crushing ROM	0	0	0
CL - Screening ROM	0	0	0
CL - Loading crushed/screened ROM to trucks	215,245	30,956	4,090
CL - Hauling crushed ROM to site exit (sealed)	34,367	6,581	3,002
WE - Active Pit	183,960	91,980	13,797
WE - Waste Emplacement (Main)	296,964	148,482	22,272
WE - Waste Emplacement (East)	82,081	41,041	6,156
WE - Partially Rehab Area – Western	362	181	27
WE - Partially Rehab Area – Eastern	323	161	24
WE- Topsoil Stockpiles	876	438	66
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	42,574	21,287	3,193
Grading roads	75,481	26,373	2,340
Total emissions for Year 7 (kg/y)	**6,210,402**	**1,555,292**	**244,811**

Table 7.3: Estimated Particulate Emissions in Year 17

Activity	TSP emission (kg/y)	PM_{10} emissions (kg/y)	$PM_{2.5}$ emissions (kg/y)
OB - Drilling East Pit	6,308	3,280	189
OB - Blasting East Pit	10,352	5,383	311
OB - Drilling West Pit	3,154	1,640	95
OB - Blasting West Pit	5,176	2,692	155
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	58,162	27,509	4,166
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	29,081	13,755	2,083
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 1)	528,165	127,894	11,299
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 2)	676,051	144,625	14,463
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	7,174	1,535	153
OB - Hauling OB from Open Cut (West) to Emplacement	884,801	167,223	18,928
OB - Emplacing OB at Emplacement Area (East)	58,162	27,509	4,166
OB - Emplacing OB at Emplacement Area (West)	29,081	13,755	2,083
OB - Dozers on OB (In-Pit)	355,386	83,986	37,316
OB - Dozers on OB (on emplacement)	355,386	83,986	37,316
OB - Crushing gravel (mobile crusher)	559	248	0
OB - Loading crushed gravel to trucks	249	118	18
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	303	138
Rh - Dozers on partial rehab area	81,443	19,247	8,551
Rh - Scrapers on partial rehab area (western)	216,463	54,116	0
CL - Dozers ripping/pushing/clean-up (In-Pit)	268,177	77,280	5,900
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	143,496	20,637	2,726
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	71,748	10,319	1,363
CL - Hauling CL from Open Cut (East) to ROM pad	103,972	22,242	2,224
CL - Hauling CL from Open Cut (West) to ROM pad	96,694	20,685	2,069
CL - Unloading ROM at ROM pad	150,671	21,669	2,863
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	30,956	4,090
CL - Crushing ROM	0	0	0
CL - Screening ROM	0	0	0
CL - Loading crushed/screened ROM to trucks	215,245	30,956	4,090
CL - Hauling crushed ROM to site exit (sealed)	34,367	6,581	3,002
WE - Active Pit	314,747	157,373	23,606
WE - Waste Emplacement	374,840	187,420	28,113
WE - Partially Rehab Area – Western	907	453	68
WE- Topsoil Stockpiles	876	438	66
WE - ROM Stockpiles (Wind Erosion & Maintenance)	42,574	21,287	3,193
Grading roads	75,481	26,373	2,340
Total emissions for Year 17 (kg/y)	**5,415,774**	**1,413,473**	**227,143**

Table 7.4: Estimated Particulate Emissions in Year 26

Activity	TSP emission (kg/y)	PM_{10} emissions (kg/y)	$PM_{2.5}$ emissions (kg/y)
OB - Drilling North Pit	6,308	3,280	189
OB - Blasting North Pit	11,503	5,981	345
OB - Drilling South Pit	3,154	1,640	95
OB - Blasting South Pit	5,751	2,991	173
OB - Sh/Ex/FELs loading OB to haul trucks North Pit	64,624	30,566	4,629
OB - Sh/Ex/FELs loading OB to haul trucks South Pit	32,312	15,283	2,314
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 1)	575,113	123,032	12,303
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 2)	868,538	185,803	18,580
OB - Hauling OB from Open Cut (South) to Emplacement	1,288,675	275,682	27,568
OB - Hauling OB from Open Cut (South) to ROM pad for gravel	4,591	982	98
OB - Emplacing OB at Emplacement Area	96,937	45,848	6,943
OB - Dozers on OB (In-Pit)	355,386	83,986	37,316
OB - Dozers on OB (on emplacement)	355,386	83,986	37,316
OB - Crushing gravel (mobile crusher)	559	248	0
OB - Loading crushed gravel to trucks	249	118	18
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	303	138
Rh - Dozers on partial rehab area	81,443	19,247	8,551
Rh - Scrapers on partial rehab area (western)	216,463	54,116	0
CL - Dozers ripping/pushing/clean-up (In-Pit)	268,177	77,280	5,900
CL - Sh/Ex/FELs Loading ROM to trucks North Pit	143,496	20,637	2,726
CL - Sh/Ex/FELs Loading ROM to trucks South Pit	71,748	10,319	1,363
CL - Hauling CL from Open Cut (North) to ROM pad	141,402	30,250	3,025
CL - Hauling CL from Open Cut (South) to ROM pad	33,271	7,118	712
CL - Unloading ROM at ROM pad	150,671	21,669	2,863
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	30,956	4,090
CL - Crushing ROM	0	0	0
CL - Screening ROM	0	0	0
CL - Loading crushed/screened ROM to trucks	215,245	30,956	4,090
CL - Hauling crushed ROM to site exit (sealed)	34,367	6,581	3,002
WE - Active Pit	297,840	148,920	22,338
WE - Waste Emplacement	297,840	148,920	22,338
WE - Partially Rehab Area – Western	3,162	1,581	237
WE- Topsoil Stockpiles	876	438	66
WE - ROM Stockpiles (Wind Erosion & Maintenance)	42,574	21,287	3,193
Grading roads	75,481	26,373	2,340
Total emissions for Year 26 (kg/y)	**6,234,577**	**1,653,679**	**255,454**

As described in **Section 2.1**, the Project would include the transportation of ROM coal using on-highway trucks to the Whitehaven CHPP for handling, processing and transportation to the Port of Newcastle via trains.

Potential air quality impacts associated with the transportation of ROM coal to the Whitehaven CHPP (i.e. via sealed roads in on-highway trucks which feature automated covers over the coal) and transportation by rail to the Port of Newcastle are described in **Section 8.24**.

It should be noted that there would be no increase in the approved processing rate at the Whitehaven CHPP. As such, assessment of potential impacts at the Whitehaven CHPP is not required.

7.3 Consideration of Cumulative Emissions

There are several other operating mines located in the vicinity of the Project, the closest being the Rocglen, Tarrawonga and Boggabri Coal Mines. The Rocglen Coal Mine is located adjacent to the northeast corner of the Project boundary, and Tarrawonga Coal Mine is located approximately 10 km north of the Project. The Boggabri Coal Mine is located approximately 15 km north and the proposed Maules Creek Coal Mine is located approximately 20 km northwest of the Project.

The Canyon Coal Mine is also located northwest of the Project boundary, however operations ceased in July 2009.

As described in **Section 4.2** existing dust monitoring would include potential impacts from existing mining operations, but would not include proposed or recently approved mining projects. Recently proposed or approved projects in the vicinity of the Project include the:

- Tarrawonga Coal Project;
- Rocglen Extension Project;
- Boggabri Coal Project; and
- the proposed Maules Creek Coal Project.

Further discussion regarding these projects, and their relevance in terms of potential cumulative air quality impacts with the Project, is provided below.

7.3.1 Tarrawonga Coal Project

The Tarrawonga Coal Mine has submitted an Environmental Assessment dated January 2012 to the DoP (now the DP&I) for the continuation and expansion of the current mining operations for a further 17 years commencing 2013 (Tarrawonga Coal Project) (**Tarrawonga Coal Pty Ltd [TCPL], 2012**). The continuation of mining would extract up to 3 Mtpa of ROM coal and would progress the operations to the east and the north of the current operations, towards the Boggabri Coal Project CL 368 boundary.

The air quality assessment for the Tarrawonga Coal Project (**PAEHolmes, 2012**) indicates that impacts to the south near the VCM are in the range of 1 $\mu g/m^3$ to 3 $\mu g/m^3$ for annual average PM_{10}, and 1 $\mu g/m^3$ to 5 $\mu g/m^3$ for TSP across the years modelled.

The annual average dust deposition from the Tarrawonga Coal Project is below 0.1 g/m^2/month in the vicinity of the Project and is not considered further.

7.3.2 Rocglen Extension Project

The Rocglen Coal Mine currently operates under existing approvals (DA 06_0198 and 10_0015) to extract up to 1.5 Mtpa of ROM coal. The Rocglen Coal Mine was granted approval for an extension of mining and changes to the pit and emplacement areas (i.e. the Rocglen Extension Project) on 27 September 2011. An air quality assessment was undertaken for the Rocglen Extension Project by PAEHolmes (**PAEHolmes, 2011a**).

The Rocglen Coal Mine is located within a small valley between the Vickery State Forest and the Kelvin State Forest. The air quality assessment for the extension project indicated that majority of the emissions from the operations would be contained within the valley.

The Rocglen Extension Project has been approved to extend mining operations until 2022. Year 1 of operation for the Rocglen Extension Project was scheduled to commence in 2011 and therefore concurrent emissions from the Rocglen extension project would occur from Year 1 (2013) to Year 10 (2022) of the Project.

7.3.3 Boggabri Coal Project

The Boggabri Coal Mine submitted an Environmental Assessment dated December 2010 to the DoP (now the DP&I) for the continuation and expansion of the current mining operations for a further 21 years (Boggabri Coal Project) (**Hanson Bailey, 2010**). The Project would extract up to 8.6 Mtpa of ROM coal which would progress the operations to the north-west of the current operations, towards the Maules Creek Coal Project boundary.

Project Approval for the Boggabri Coal Project was issued on 18 July 2012.

The air quality assessment for the Boggabri Coal Project (**PAEHolmes, 2010**) indicates that impacts to the south near the Project are in the range of 1 micrograms per cubic metre ($\mu g/m^3$) to 4 $\mu g/m^3$ for annual average PM_{10}, and 1 $\mu g/m^3$ to 5 $\mu g/m^3$ for TSP across the years modelled.

The annual average dust deposition from the Boggabri Coal Project is well below 0.1 g/m^2/month in the vicinity of the Project. Similarly, the predicted annual average $PM_{2.5}$ concentrations from the Boggabri Coal Project are less than 1 $\mu g/m^3$ at any residence in the vicinity of the Project. Dust deposition and $PM_{2.5}$ concentrations from Boggabri Coal Mine are not considered further in this assessment.

7.3.4 Maules Creek Coal Project

An Environmental Assessment for the Maules Creek Coal Project was submitted in July 2011 (**Hanson Bailey, 2011**). The Maules Creek Coal Project is located approximately 20 km to the north of the Project and is seeking approval for a 21 year Project extracting ROM coal up to 13 Mtpa.

An air quality impact assessment was undertaken for the Maules Creek Coal Project by **PAEHolmes** (**2011b**). Based on a review of **PAEHolmes** (**2011b**), ground level concentrations of particulate matter from the Maules Creek Coal Project at locations in the vicinity of the VCM are anticipated to be negligible. Cumulative impacts from the Maules Creek Coal Mine operations, in the vicinity of the Project are therefore not considered further in this assessment.

7.3.5 Quantitative Cumulative Impact Assessment

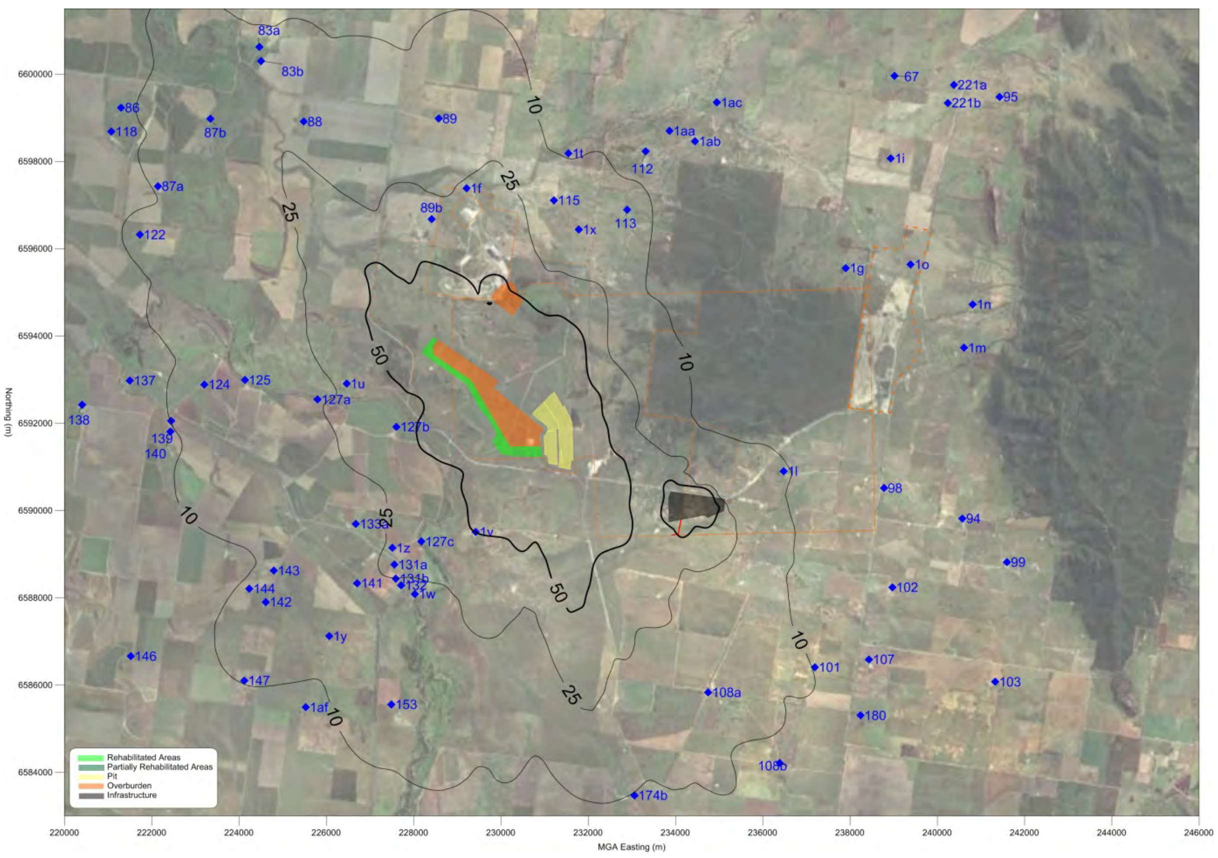
The quantitative assessment of potential cumulative impacts focuses on the Tarrawonga Coal Project, the Boggabri Coal Project and Rocglen Extension Project (in addition to existing background sources). Cumulative impacts from these projects are assessed in **Section 8**.

8 IMPACT ASSESSMENT

Dispersion model predictions have been made for Year 2, Year 7, Year 17 and Year 26 of Project mining operations. Contour plots (i.e. isopleths) of particulate concentrations and deposition levels show the areas that are predicted to be affected by dust at different levels. It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths would not always match exactly with predicted impacts at any specific location. The actual predicted particulate concentrations/levels at nearby receivers are presented in tabular form, with those that are predicted to experience levels above the EPA's impact assessment criteria highlighted in bold, where relevant.

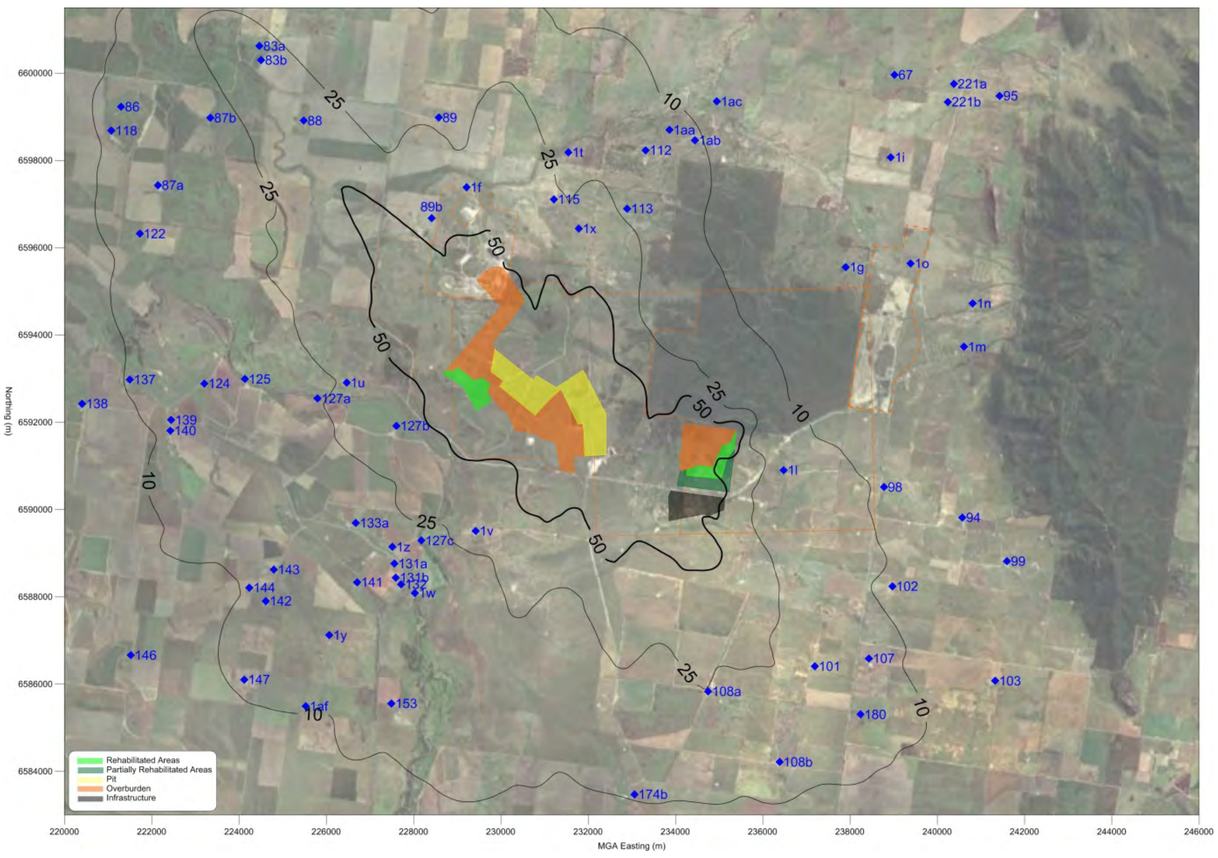
8.1 Project-only 24-hour Average PM_{10}

Figure 8.1 to **Figure 8.4** present contour plots for the predicted maximum 24-hour PM_{10} concentrations for the Project-only for each modelled scenario. The isopleth for the 24-hour average criterion of 50 µg/m^3 is shown in bold. The 24-hour PM_{10} contours presented in **Figure 8.1** to **Figure 8.4** do not represent a single worst case day, but rather represent the potential worst case 24-hour PM_{10} concentration that could be reached at any particular location across the entire modelling year.



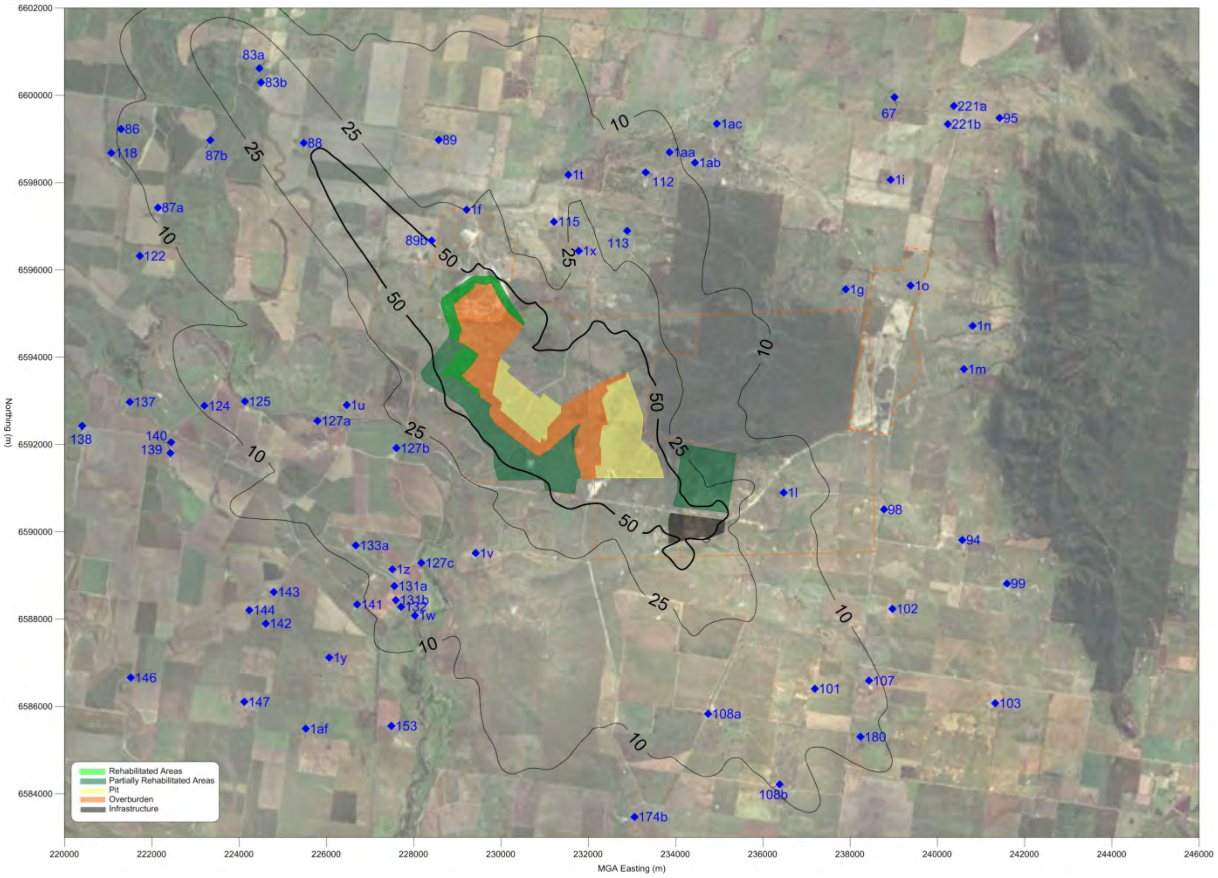
Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
PM_{10}	Vickery	Year 2	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	50 µg/m^3	CALMET	R. Kan

Figure 8.1: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 2



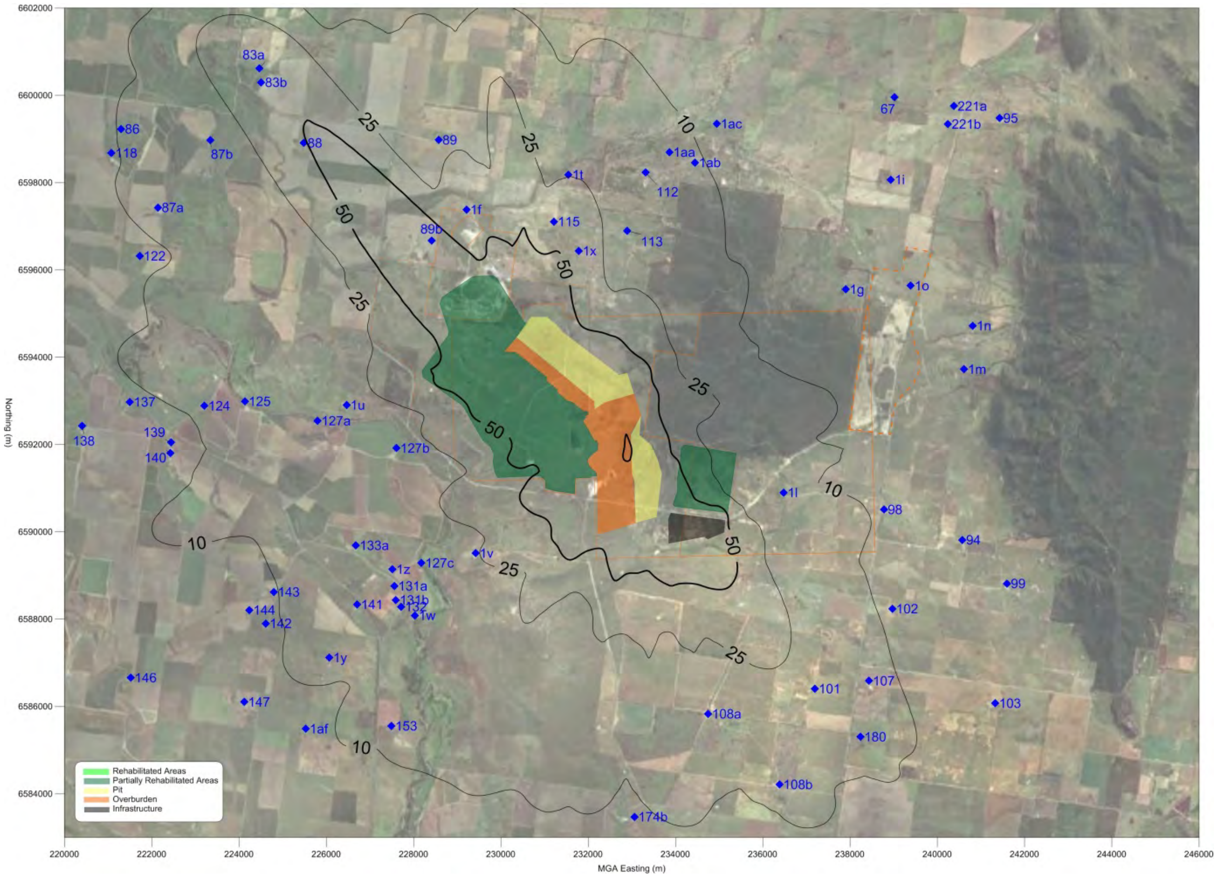
Species: PM_{10}	**Location:** Vickery	**Scenario:** Year 7	**Percentile:** Maximum	**Averaging Time:** 24-hour
Model Used: CALPUFF v6.42	**Units:** $\mu g/m^3$	**Guideline:** 50 $\mu g/m^3$	**Met Data:** CALMET	**Plot:** R. Kan

Figure 8.2: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 7



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 17	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	50 µg/m^3	CALMET	R. Kan

Figure 8.3: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 17



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 26	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	50 µg/m³	CALMET	R. Kan

Figure 8.4: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 26

8.2 Summary of 24-hour Average PM_{10} Results at Individual Receivers

A summary of the predicted particulate concentrations at each of the individual receivers is provided in **Table 8.1**. There is one privately owned receiver (89b) predicted to experience 24-hour average PM_{10} concentrations above the assessment criteria in Year 26, due to emissions from the Project-only. It is noted that receiver 89b is an approved dwelling location.

As described in the Section 4.6 of the Main Report of the EIS, Whitehaven is intending to enter into a private agreement or purchase agreement with the landowner of receiver 89b (and 89a).

No exceedances are predicted at mine-owned receivers, although the maximum 24-hour PM_{10} concentration at receiver 1v is predicted to be 50 µg/m³ in Year 2.

Table 8.1: Maximum Predicted Project-only 24-hour Average PM_{10} Concentrations ($\mu g/m^3$)

Receiver ID	Y2	Y7	Y17	Y26
	24-hour Average PM_{10} ($\mu g/m^3$) Assessment criteria = 50 $\mu g/m^3$			
67	1	2	2	2
83a	12	31	39	42
83b	13	34	42	43
86	9	13	10	10
87a	11	15	11	13
87b	14	20	15	15
88	18	40	49	49
89a	18	23	17	23
89b	30	40	43	**69**
94	2	4	3	3
95	1	1	1	1
98	4	9	5	8
99	2	3	2	3
101	10	18	16	19
102	5	8	6	8
103	2	4	4	4
107	6	13	11	13
108a	15	24	15	17
108b	8	15	11	15
112	8	15	14	14
118	8	12	9	9
122	11	14	8	9
124	13	14	10	11
125	16	17	12	13
127a	24	24	17	16
127b	47	40	20	20
127c	33	22	14	20
131a	27	19	12	17
131b	25	19	11	16
132	23	19	11	15
133a	21	19	11	14
137	8	10	8	8
138	5	7	5	5
139	10	11	8	9
140	10	11	7	9
141	22	17	10	15
142	13	12	7	9
143	12	12	7	10
144	11	10	6	9
146	6	6	3	5
147	10	11	6	8
153	15	13	7	12
174b	10	11	7	8
180	8	13	12	13
221a	1	2	1	2
221b	1	2	1	2
1f	26	30	23	36
1g	2	5	5	5
1i	1	3	2	3
1l	11	18	14	14
1m	1	2	2	2
1n	1	2	1	2
1o	1	3	2	3
1t	10	19	23	25
1u	30	27	20	20
1v	50	27	19	24
1w	22	19	12	14
1x	16	31	32	38
1y	15	15	8	12
1z	27	20	11	17
1aa	6	12	11	12
1ab	5	11	9	11
1ac	4	8	6	8
1ad	14	30	21	37
1ae	13	23	20	19
1af	8	10	7	8

Y = year
Note: Receivers with prefix "1" denote mine-owned receivers
Exceedances are bolded

8.3 Cumulative 24-hour Average PM_{10} Impacts

It is difficult to accurately predict cumulative 24-hour PM_{10} concentration using dispersion modelling due to the difficulties in resolving (on a day-to-day basis) the varying intensity, duration and precise locations of activities at mine sites, weather conditions at the time of the activity, or a combination of activities.

Difficulties in predicting cumulative 24-hour impacts are compounded by the day-to-day variability in ambient dust levels and the spatial and temporal variation in any other anthropogenic activity e.g. agricultural activity, or uncontrolled events such as bushfires. Experience shows that in many cases the worst-case 24-hour PM_{10} concentrations are strongly influenced by other sources in an area, such as bushfires and dust storms, which are essentially unpredictable. The variability in 24-hour average PM_{10} concentrations can be clearly seen in the data collected at the HVAS and TEOM monitors located surrounding the mine (see **Section 4.2.1**).

Due to the difficulties outlined above, cumulative air quality impacts have been evaluated using a statistical approach (Monte Carlo Simulation). This approach has been used to achieve the objectives of a Level 2 Assessment (see Section 11.2 of **DEC, 2005**). The cumulative assessment focuses on representative receivers in key areas in the vicinity of the mine.

8.3.1 Cumulative 24-hour PM_{10} Model Predictions and Analysis

The Monte Carlo Simulation is a statistical approach that combines the frequency distribution of one data set (in this case background 24-hour PM_{10} concentrations) with the frequency distribution of another data set (modelled impacts at a given point). This is achieved by repeatedly randomly sampling and combining values within the two data sets to create a third, 'cumulative' data set and associated frequency distribution.

Eight private and mine-owned receivers (receivers 1f, 1v, 1x, 1ad, 88, 89b, 127b and 127c) were selected for cumulative analysis based on their proximity to these operations and also the magnitude of their Project mine-only predictions (see **Section 8.2**).

Modelled PM_{10} concentrations due to Project at the selected receivers were analysed for one year (the 'model year'). The modelling predictions chosen were the Project year with the worst case predicted impact (Year 2 for receivers 1v, 127b and 127c to the southwest and Year 26 for receivers 1f, 1x, 1ad, 88 and 89b to the north).

Three monitoring sites were chosen as 'background' for the Monte Carlo simulation, these include the Vickery South Coal Exploration Project HVAS, the Rocglen Roseberry HVAS and the Maules Creek TEOM. As discussed in **Section 4.2.1**, these sites were considered to be less heavily influenced by local mining and representative of background levels.

There were 43 daily values of PM_{10} concentration available from the Vickery South Coal Exploration Project HVAS, 221 daily values of PM_{10} concentration available from the Rocglen Roseberry HVAS and 147 daily values of PM_{10} concentration available from the Maules Creek TEOM. There were two data points removed from the Rocglen Roseberry HVAS data set which corresponded to days where there was a regional dust storm and non-valid data were removed from the Maules Creek TEOM data set. A total of 403 data points from the three monitoring locations were used to generate a random daily background 24-hour PM_{10} concentration. A different background 24-hour PM_{10} value is randomly selected from the background dataset each time the simulation is run.

The process assumes that a randomly selected background value from the real dataset would have a chance equal to that of any other background value from the dataset of occurring on the given 'model day'. Over sufficient time this would yield a good statistical estimate of the combined and independent effects of varying background and Project contributions to total PM_{10}.

To generate greater confidence in the statistical robustness of the results, the Monte Carlo Simulation was repeated 250,000 times for each of the receivers. In other words, the same 1-year set of predicted (modelled) 24-hour PM_{10} concentrations due to the Project were added to 250,000 variations of the randomly selected background concentrations at each receiver (i.e. a different random background concentration is selected each time). The Monte Carlo Simulation is run using the Oracle Crystal Ball software (version 11.1.1.2).

The results of this analysis are presented graphically in **Figure 8.5** and **Figure 8.6**.

The plots show the statistical probability of 24-hour PM_{10} concentrations being above the EPA 24-hour PM_{10} criterion of 50 µg/m^3, and also compare the cumulative probability with the measured background.

Figure 8.5 shows that, using the method described above, it is predicted that there would be exceedances of the 24-hour average PM_{10} criterion at receivers 1v, 127b and 127c on 8 days, 6 days and 4 days, respectively. The plot also shows that due to background alone, the 24-hour average PM_{10} criterion would be exceeded on approximately 2 days in the year.

Figure 8.6 shows that the Project would potentially result in an increase in the number of days where the 24-hour average PM_{10} criterion is predicted to be exceeded at receivers 1f, 1x, 1ad, 88 and 89b. The number of days predicted to exceed the 24-hour average PM_{10} criterion is approximately three to four days at receivers 1f, 1x and 88, approximately 6 days at receiver 89b, and approximately 8 days at receiver 1ad. The Project contribution to the cumulative 24-hour average PM_{10} levels is marginal compared to background values.

Table 8.2 presents a summary of the number of days over for each of the selected receivers and for mine-only and cumulative scenarios.

It is noted that the actual number of exceedances per year cannot be predicted precisely and would depend on actual Project activities, weather conditions, implementation of real-time controls and predictive meteorological forecasting, and background levels in the future.

The Monte Carlo simulation showed that there is a slight possibility of an increase in the number of days per year that the 24-hour average PM_{10} criterion is exceeded when impacts are considered cumulatively. Any risks associated with the cumulative prediction of PM_{10} levels above the EPA criterion can be managed day to day with the best practice real-time monitoring and management systems discussed in **Section 6.2**.

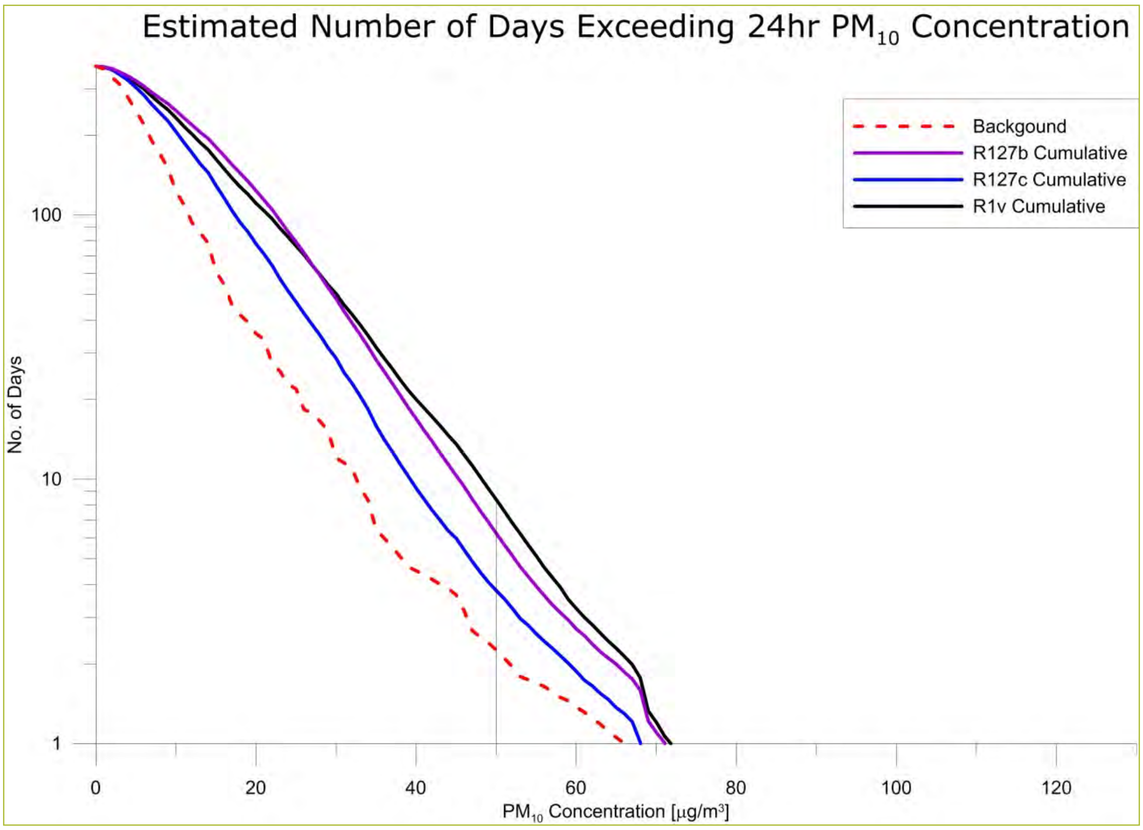


Figure 8.5: Southwest Receivers – Frequency Distribution of Year 2 24-hour PM_{10} Concentration following Monte Carlo Simulation

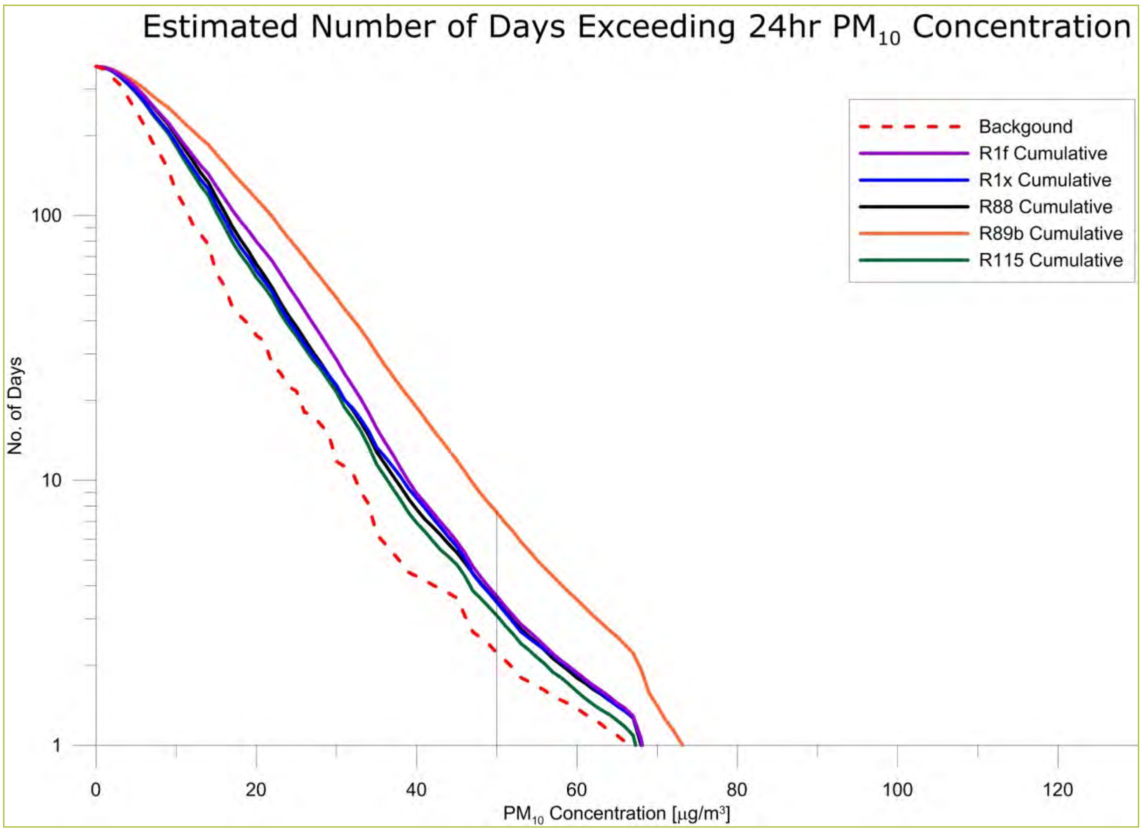


Figure 8.6: Northern Receivers – Frequency Distribution of Year 26 24-hour PM_{10} Concentration following Monte Carlo Simulation

Table 8.2: Summary of Days over 50 µg/m^3 for Mine Alone and Cumulative Scenarios

Receiver ID	Modelling Year	Maximum predicted 24-hour PM_{10} Concentration (mine alone)	Predicted Days Over 50 µg/m^3 (mine alone)	Predicted Days Over 50 µg/m^3 (background alone)	Predicted Days Over 50 µg/m^3 (cumulative)	Predicted Days Over 150 µg/m^3 (cumulative)
1f	26	36	0	2	4	0
1v	2	50	0	2	8	0
1x	26	38	0	2	3	0
1ad	26	37	0	2	3	0
88	26	49	0	2	3	0
89b	26	69	1	2	8	0
127b	2	47	0	2	6	0
127c	2	33	0	2	4	0

8.3.2 Cumulative Impacts at Receivers 44a and 44b

There is low potential for significant dust contributions from the Project, Tarrawonga Coal Project and Boggabri Coal Project at the same time on a given day at receivers between the three mines. This is because of the distance between the mines and the orientation of the receivers relative to prevailing winds. However, the potential for an increase in days of elevated dust concentrations over an annual period (i.e. temporal impacts) has been investigated.

The cumulative 24-hour average PM_{10} impacts from the Project, Tarrawonga and Boggabri were assessed using Monte Carlo simulation at two receivers (44a ["Kyalla"] and 44b ["Northam"]) located approximately equidistant between the three sites. The location of the receivers is shown in **Figure 8.7**.

Modelled PM_{10} concentrations due to Project at the selected receivers were analysed for Year 17. The modelling results at these receivers from the Tarrawonga Coal Project (**PAEHolmes, 2012**) and Boggabri Coal Project (**PAEHolmes, 2010**) were also used in the Monte Carlo simulation. The closest modelled year from the Tarrawonga Coal Project (Year 16) and the Boggabri Coal Project (Year 21) was chosen for the analysis. 'Background' is the same data set as described in **Section 8.3.1**.

The Monte Carlo Simulation was repeated 1,000,000 times for each of the receivers to take into account the number of data points from predictions at the three mines.

Figure 8.8 shows that the Project, the Tarrawonga Coal Project and the Boggabri Coal Project combined would potentially result in an increase in the number of days where the 24-hour average PM_{10} criterion is predicted to be exceeded at receivers 44a and 44b.

Table 8.3 presents a summary of the number of days that the 24-hour average PM_{10} criterion is predicted to be exceeded for receivers 44a and 44b, for Project-only and cumulative scenarios.

It is predicted that the Project in isolation would not result in any additional days of exceedance of the 24-hour average PM_{10} criterion at receivers 44a and 44b.

When the Project and background concentrations are considered, the Project is predicted to result in no additional exceedances of the 24-hour average PM_{10} criteria at receiver 44a, and one additional exceedance at receiver 44b, in comparison to the exceedances predicted due to background concentrations only (i.e. 2 days per year) (**Table 8.3**).

When impacts from the Project, Tarrawonga Coal Project, Boggabri Coal Project and background sources are considered cumulatively, is predicted that the 24-hour average PM_{10} criterion would be exceeded on 12 days at receiver 44a and 4 days at receiver 44b.

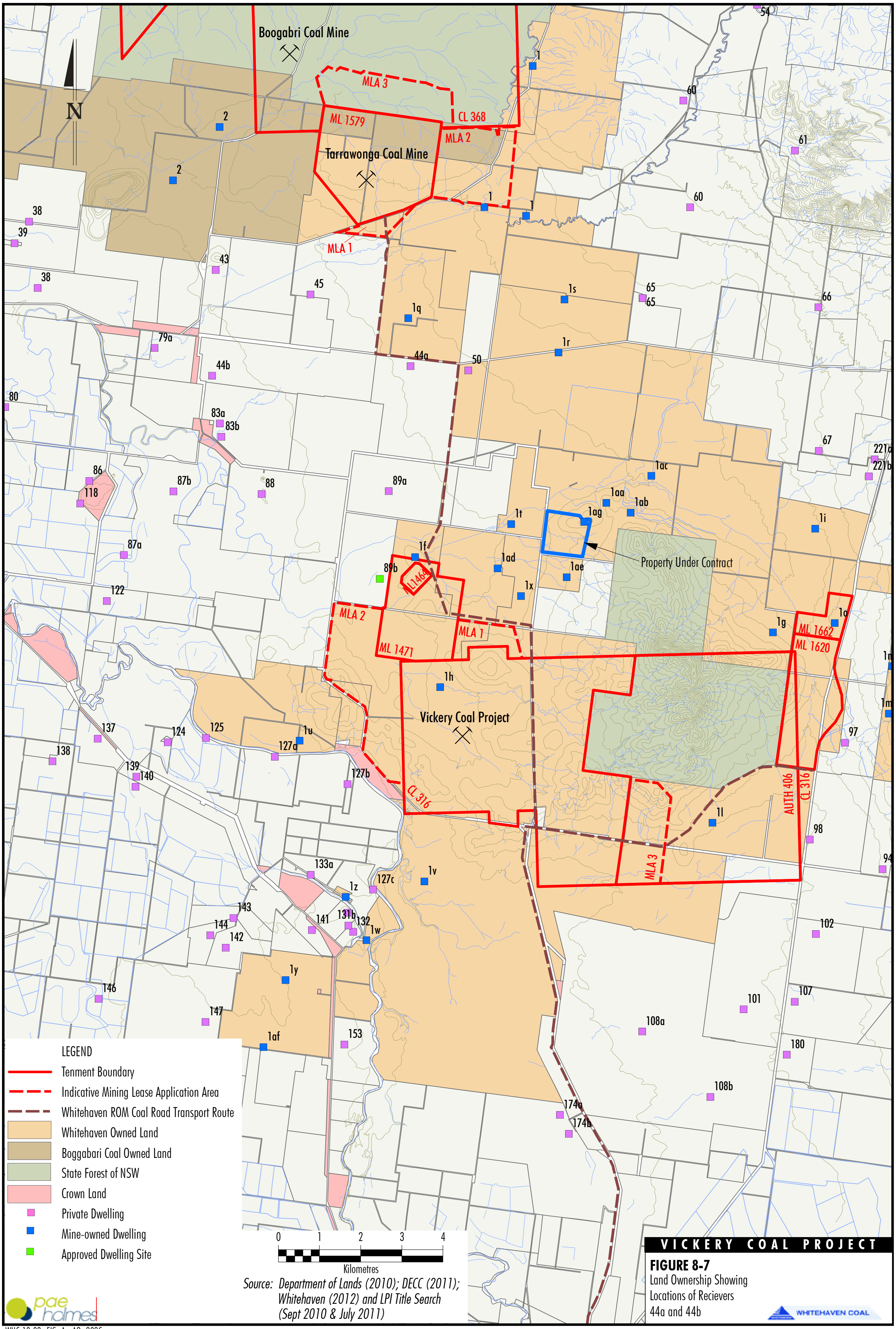


FIGURE 8-7
Land Ownership Showing Locations of Recievers 44a and 44b

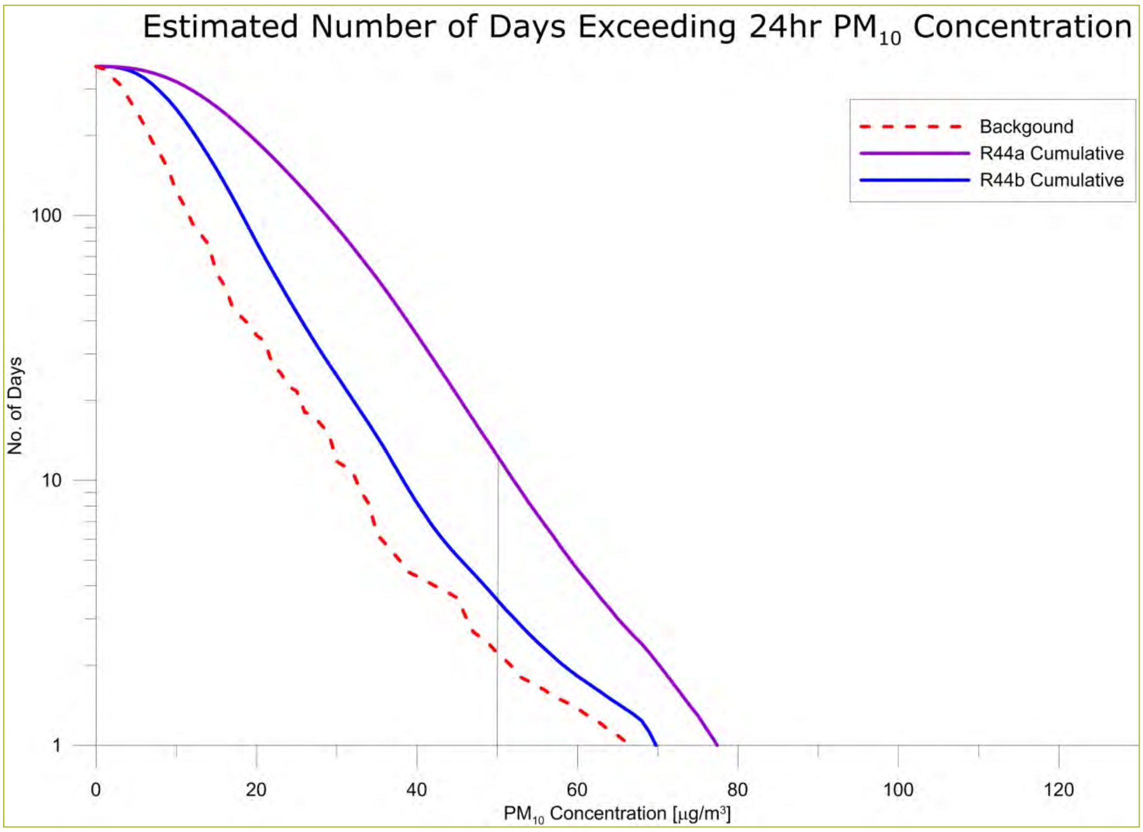


Figure 8.8: Receivers 44a and 44b – Frequency Distribution of Year 17 24-hour PM_{10} Concentration following Monte Carlo Simulation

Table 8.3: Summary of Days over 50 µg/m³ for Receivers 44a and 44b

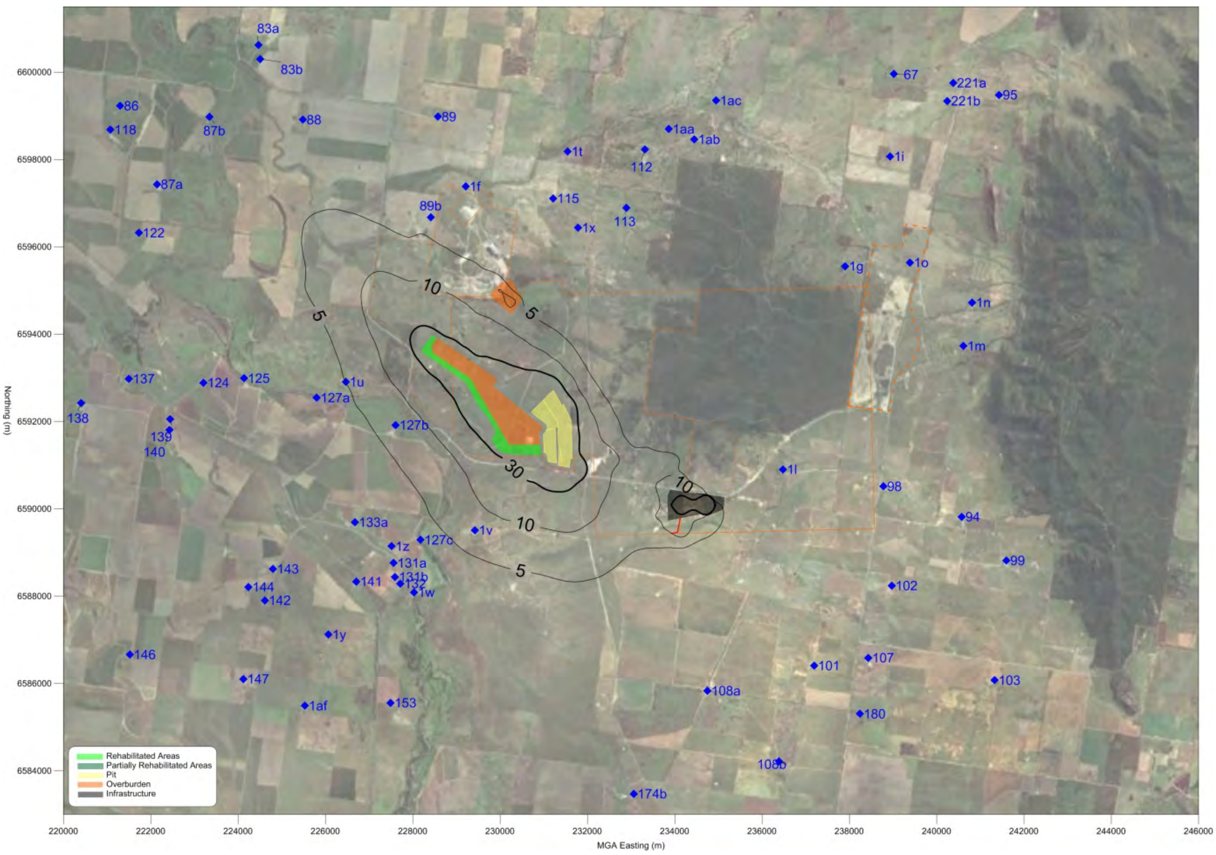
Receiver ID	Maximum predicted 24-hour PM_{10} Concentration (Project alone)	Predicted Days Over 50 µg/m³ (Project alone)	Predicted Days Over 50 µg/m³ (background alone)	Predicted Days Over 50 µg/m³ (Project and background alone)	Predicted Days Over 50 µg/m³ (cumulative)	Predicted Days Over 150 µg/m³ (cumulative)
44a	7	0	2	2	12	0
44b	21	0	2	3	4	0

Therefore, elevated 24-hour average PM_{10} concentrations at receiver 44a are predominantly due to other mines and existing background concentrations.

Potential 24-hour average PM_{10} concentration impacts would be managed day to day with real-time monitoring and management systems for the Project (**Section 6.2**), Tarrawonga Coal Project and Boggabri Coal Project.

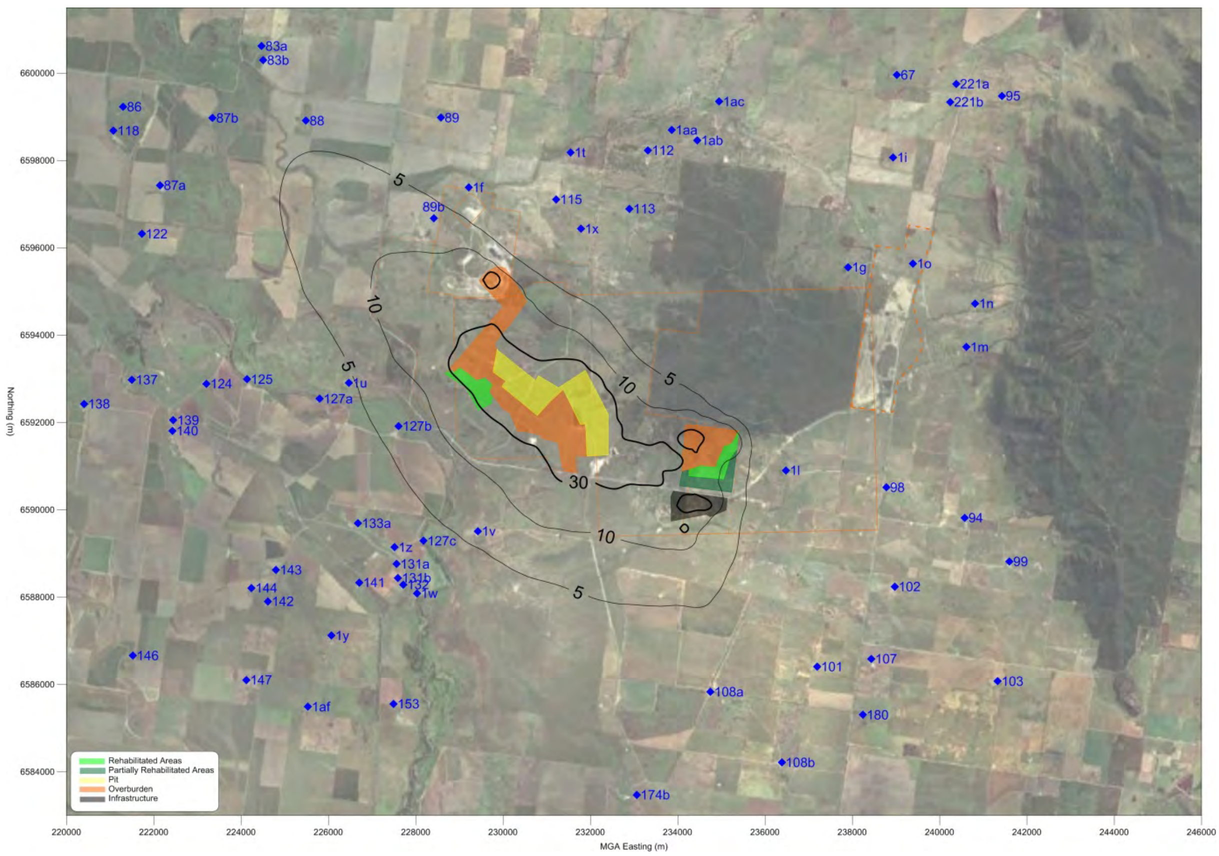
8.4 Project Only Annual Average PM_{10}

The Project-only contributions to annual average PM_{10} concentrations are presented in **Figure 8.9** to **Figure 8.12** for each modelled year.



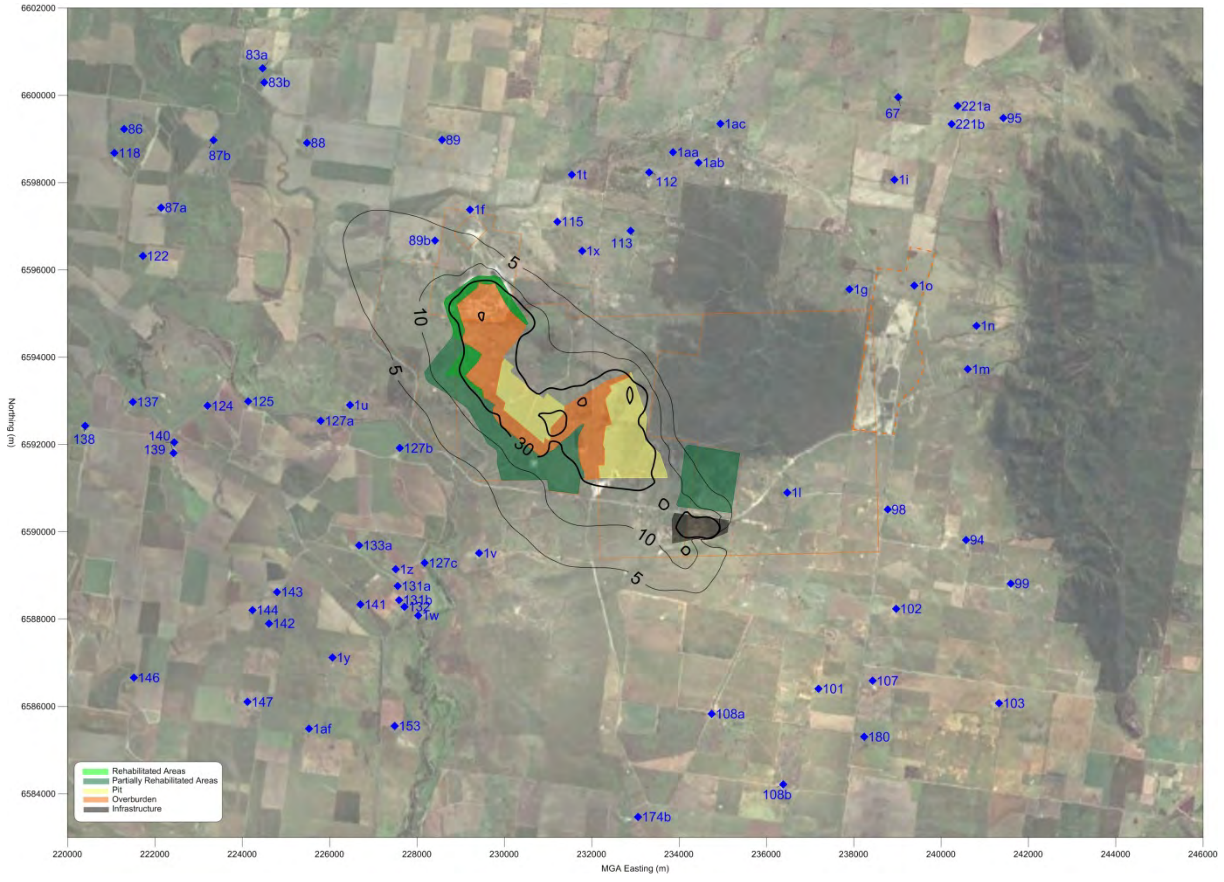
Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
PM_{10}	Vickery	Year 2	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	30 µg/m³	CALMET	R. Kan

Figure 8.9: Predicted Annual Average PM_{10} Concentration Project-Only – Year 2



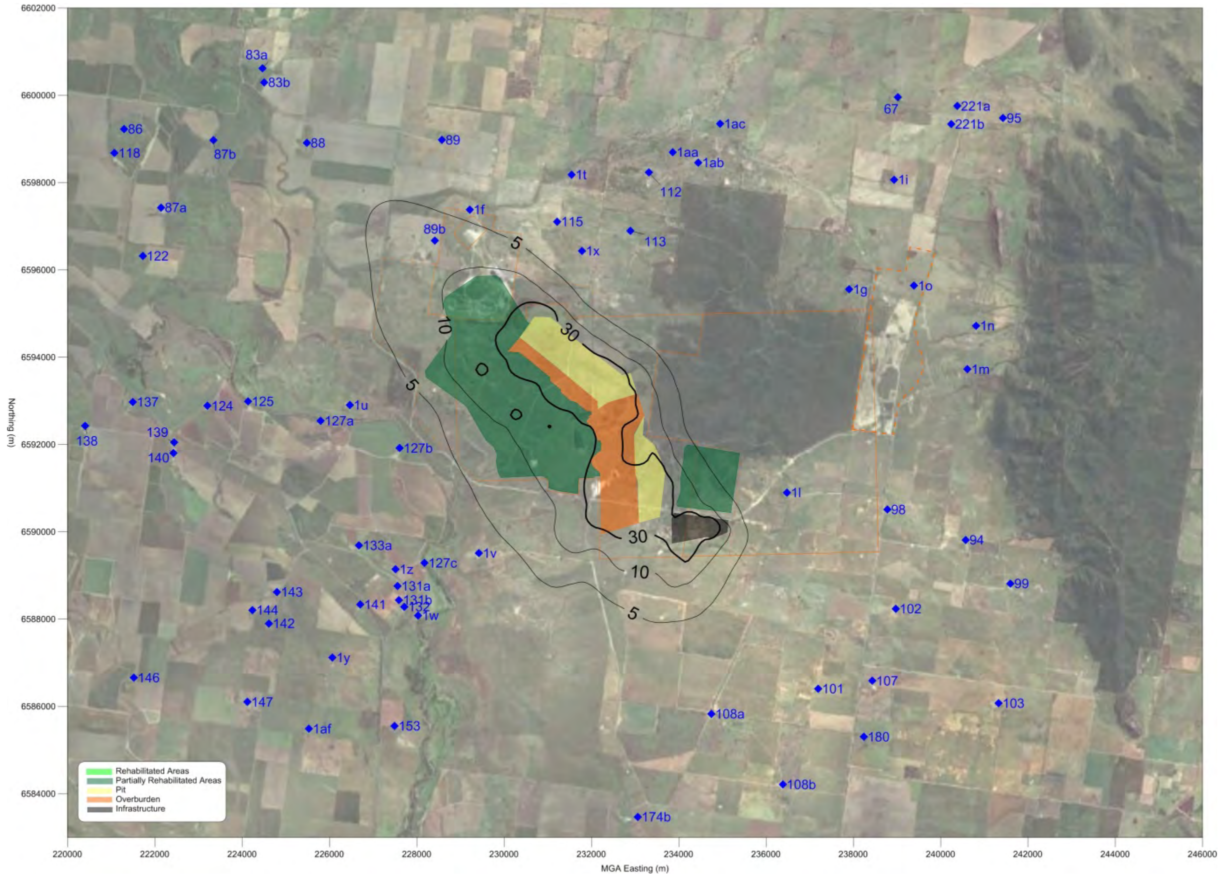
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 7	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	30 µg/m^3	CALMET	R. Kan

Figure 8.10: Predicted Annual Average PM_{10} Concentration Project-Only – Year 7



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 17	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	30 µg/m³	CALMET	R. Kan

Figure 8.11: Predicted Annual Average PM_{10} Concentration Project-Only – Year 17



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 26	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	30 µg/m^3	CALMET	R. Kan

Figure 8.12: Predicted Annual Average PM_{10} Concentration Project-Only – Year 26

8.5 Summary of Project-only Annual Average PM_{10} Results at Individual Receivers

A summary of the predicted PM_{10} concentrations at each of the individual receivers is provided in **Table 8.4**. There are no privately owned receivers that are predicted to experience annual average PM_{10} concentrations above the assessment criteria, due to emissions from the Project-only.

In addition, there are no exceedances from the Project-only when adding the background concentration of 12 µg/m³.

Table 8.4: Annual Average PM_{10} Concentrations (µg/m³)

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average PM_{10} (µg/m³) Assessment criteria = 30 µg/m³			
67	0	0	0	0
83a	2	3	2	2
83b	2	3	2	2
86	1	2	1	1
87a	2	2	2	2
87b	2	3	2	2
88	3	4	3	3
89a	1	2	2	2
89b	3	6	6	7
94	0	0	0	0
95	0	0	0	0
98	0	1	1	1
99	0	0	0	0
101	1	2	1	2
102	0	1	1	1
103	0	0	0	0
107	1	1	1	1
108a	2	3	2	2
108b	1	2	1	1
112	0	1	1	1
118	1	2	1	1
122	1	2	1	1
124	1	2	1	1
125	2	2	1	2
127a	4	4	2	2
127b	7	7	4	4
127c	4	4	2	3
131a	3	3	2	2
131b	3	3	1	2
132	3	3	1	2
133a	3	3	2	2
137	1	1	1	1
138	1	1	0	1
139	1	1	1	1
140	1	1	1	1
141	2	2	1	1
142	1	1	1	1
143	1	1	1	1
144	1	1	1	1
146	0	1	0	0
147	1	1	1	1
153	1	2	1	1
174b	1	1	1	1
180	1	1	1	1
221a	0	0	0	0
221b	0	0	0	0
1f	2	3	3	4
1g	0	0	0	1
1i	0	0	0	0
1l	1	2	2	2
1m	0	0	0	0
1n	0	0	0	0
1o	0	0	0	0
1t	1	1	1	2
1u	5	5	3	3

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average PM_{10} ($\mu g/m^3$) Assessment criteria = 30 $\mu g/m^3$			
1v	7	6	3	4
1w	3	3	1	2
1x	1	2	3	3
1y	1	2	1	1
1z	3	3	2	2
1aa	0	1	1	1
1ab	0	1	1	1
1ac	0	0	0	0
1ad	1	2	2	3
1ae	1	2	1	2
1af	1	1	1	1

Note: Receivers with prefix "1" denote mine-owned receivers

8.6 Cumulative Annual Average PM_{10}

A summary of the cumulative assessment of annual average PM_{10} concentrations is presented in **Table 8.5**. The contribution of other dust sources to cumulative impacts is included as follows:

- Project – modelled predictions for worst case year at each receiver;
- Boggabri Coal Project – modelled predictions for worst case year (from Years 1, 5, 10 and 21 modelling results presented in **PAEHolmes** [**2010**]) at each potentially affected receiver;
- Tarrawonga Coal Project - modelled predictions for worst case year (from Years 2, 4, 6 and 16 modelling results presented in **PAEHolmes** [**2012**]) at each receiver;
- Rocglen Extension Project - modelled predictions for worst case year (from 5 and 10 modelling results presented in **PAEHolmes** [**2011a**]) at each receiver; and
- all other sources – measured background PM_{10} from monitoring data.

When the contribution of other mining activities (including the Tarrawonga Coal Project, Boggabri Coal Project and Rocglen Extension Project) are added along with a background for all other sources, no privately owned receivers are predicted to exceed the annual average PM_{10} criterion of 30 $\mu g/m^3$.

Table 8.5: Maximum Predicted Cumulative Annual Average PM_{10} Concentrations ($\mu g/m^3$)

Receiver ID	Project	Rocglen	Tarrawonga	Boggabri	Background	Total
	Annual Average PM_{10} ($\mu g/m^3$) Assessment criteria = 30 $\mu g/m^3$					
67	0	N/A	N/A	N/A	12	12
83a	3	N/A	2	4	12	21
83b	3	N/A	2	4	12	21
86	2	N/A	1	4	12	19
87a	2	N/A	1	4	12	19
87b	3	N/A	1	4	12	21
88	4	N/A	2	4	12	22
89a	2	N/A	3	4	12	21
89b	7	N/A	2[1]	4[1]	12	25
94	0	4	N/A	N/A	12	16
95	0	2	N/A	N/A	12	14
98	1	3	N/A	N/A	12	16
99	0	3	N/A	N/A	12	15
101	2	1	N/A	N/A	12	14
102	1	1	N/A	N/A	12	14
103	0	N/A	N/A	N/A	12	12
107	1	1	N/A	N/A	12	14
108a	3	N/A	N/A	N/A	12	15
108b	2	N/A	N/A	N/A	12	14
112	1	N/A	1	4	12	18
118	2	N/A	1	4	12	19
122	2	N/A	N/A	N/A	12	14
124	2	N/A	N/A	N/A	12	14
125	2	N/A	N/A	N/A	12	14
127a	4	N/A	N/A	N/A	12	16

Receiver ID	Project	Rocglen	Tarrawonga	Boggabri	Background	Total
	Annual Average PM_{10} ($\mu g/m^3$) *Assessment criteria = 30 $\mu g/m^3$*					
127b	7	N/A	N/A	N/A	12	19
127c	4	N/A	N/A	N/A	12	16
131a	3	N/A	N/A	N/A	12	15
131b	3	N/A	N/A	N/A	12	15
132	3	N/A	N/A	N/A	12	15
133a	3	N/A	N/A	N/A	12	15
137	1	N/A	N/A	N/A	12	13
138	1	N/A	N/A	N/A	12	13
139	1	N/A	N/A	N/A	12	13
140	1	N/A	N/A	N/A	12	13
141	2	N/A	N/A	N/A	12	14
142	1	N/A	N/A	N/A	12	13
143	1	N/A	N/A	N/A	12	13
144	1	N/A	N/A	N/A	12	13
146	1	N/A	N/A	N/A	12	13
147	1	N/A	N/A	N/A	12	13
153	2	N/A	N/A	N/A	12	14
174b	1	N/A	N/A	N/A	12	13
180	1	N/A	N/A	N/A	12	13
221a	0	N/A	N/A	N/A	12	12
221b	0	N/A	N/A	N/A	12	12
1f	4	N/A	2	4	12	22
1g	1	7	N/A	N/A	12	20
1i	0	3	N/A	N/A	12	15
1l	2	2	N/A	N/A	12	16
1m	0	7	N/A	N/A	12	19
1n	0	4	N/A	N/A	12	17
1o	0	N/A	N/A	N/A	12	12
1t	2	N/A	2	4	12	19
1u	5	N/A	N/A	N/A	12	17
1v	7	N/A	N/A	N/A	12	19
1w	3	N/A	N/A	N/A	12	15
1x	3	N/A	N/A	N/A	12	15
1y	2	N/A	N/A	N/A	12	14
1z	3	N/A	N/A	N/A	12	15
1aa	1	N/A	1	4	12	18
1ab	1	N/A	1	4	12	18
1ac	0	N/A	1	4	12	17
1ad	3	N/A	1	4	12	20
1ae	2	N/A	N/A	N/A	12	14
1af	1	N/A	N/A	N/A	12	13

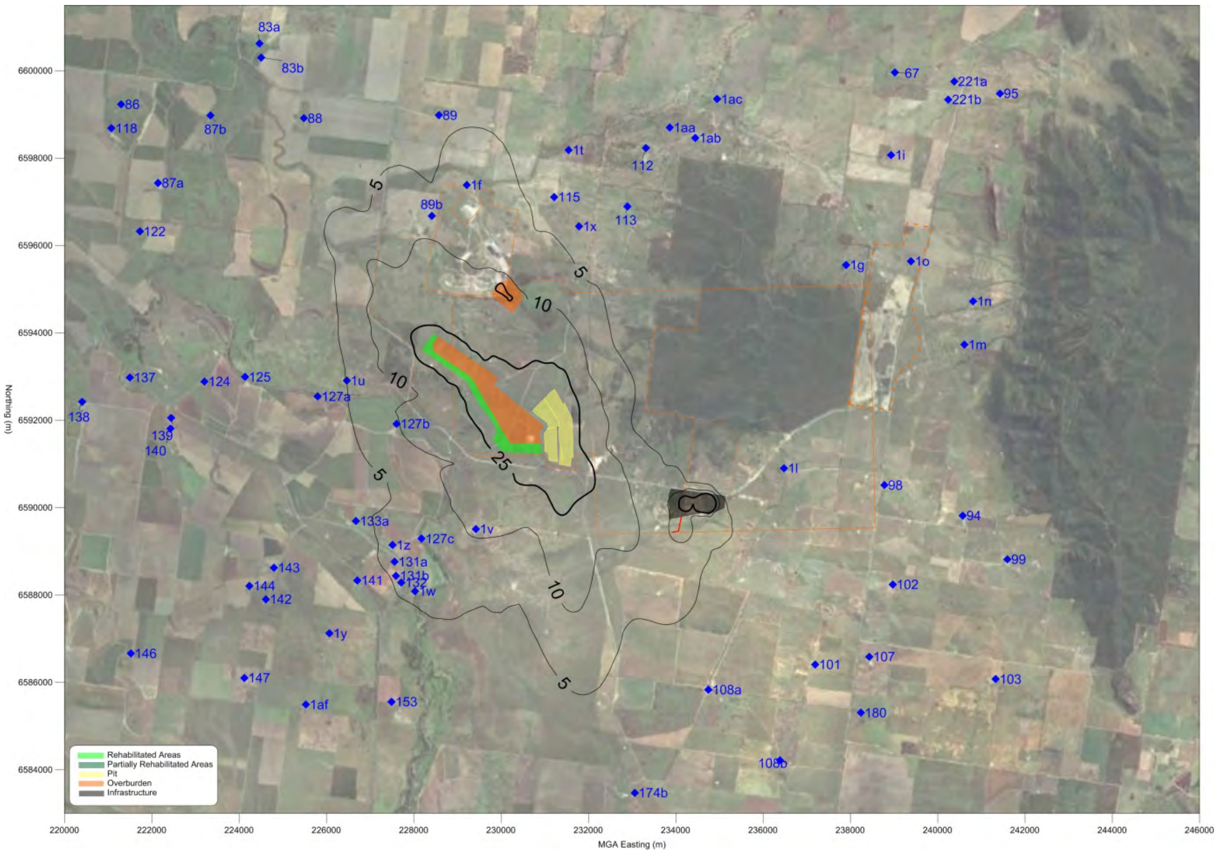
N/A – No predictions provided in relevant Environmental Assessment or contribution is negligible.

Note: Receivers with prefix “1” denote mine-owned receivers.

[1] Assumed same concentration as nearby receiver 1f.

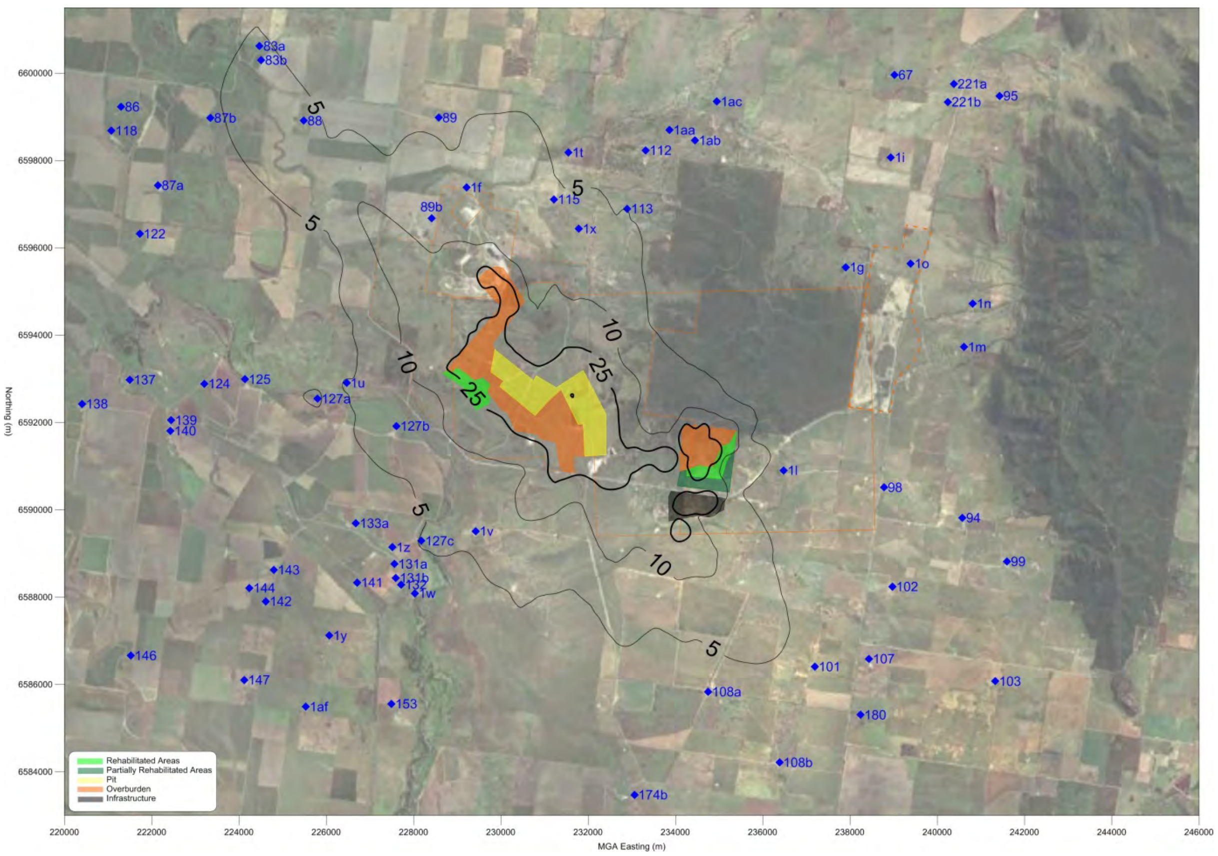
8.7 Project-only 24-hour Average $PM_{2.5}$

Figure 8.13 to **Figure 8.16** present contour plots for the predicted maximum 24-hour $PM_{2.5}$ concentrations for the Project-only for each modelled scenario. The isopleth for the 24-hour average criterion of 25 µg/m^3 is shown in bold. The 24-hour $PM_{2.5}$ contours presented **Figure 8.13** to **Figure 8.16** do not represent a single worst case day, but rather represent the potential worst case 24-hour $PM_{2.5}$ concentration that could be reached at any particular location across the entire modelling year.



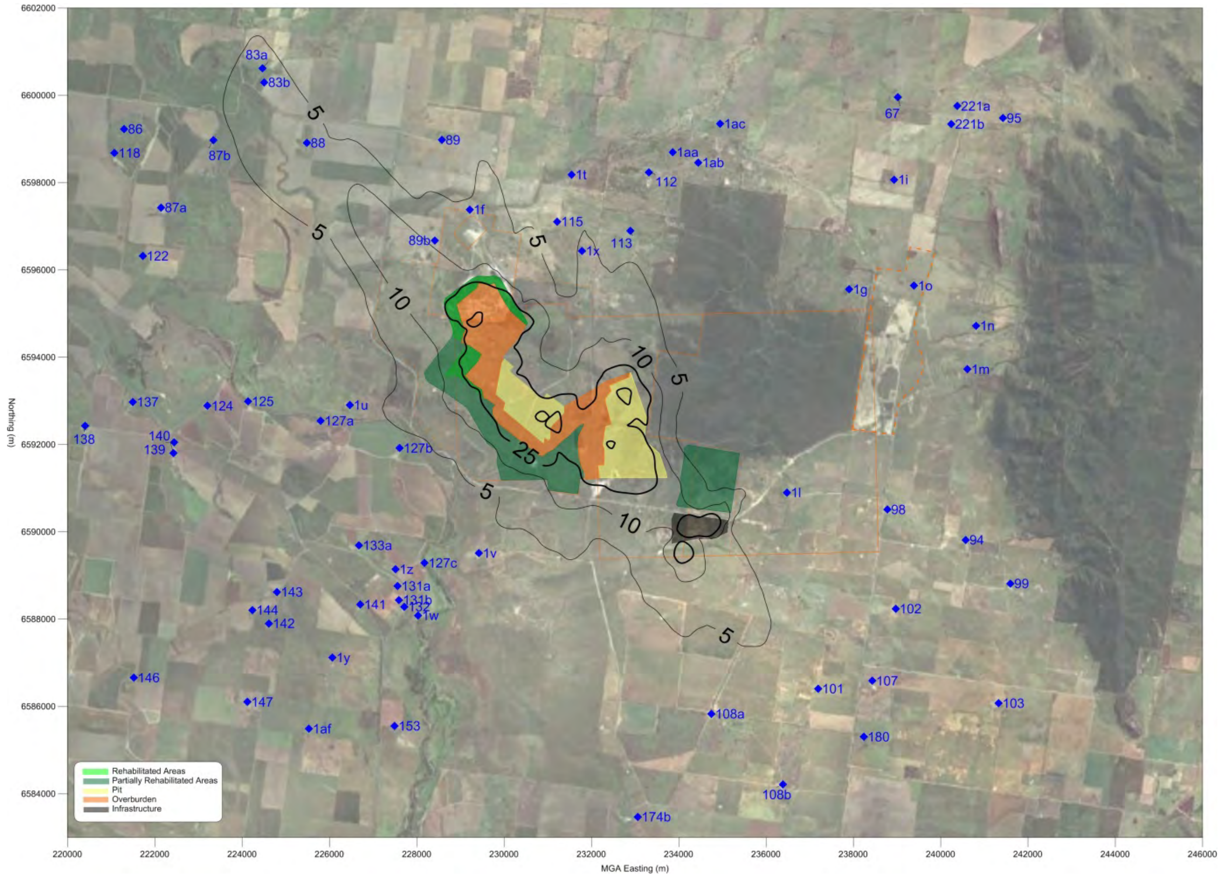
Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Vickery	Year 2	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	25 µg/m^3	CALMET	R. Kan

Figure 8.13: Predicted Maximum 24-hour $PM_{2.5}$ Concentration Project-Only – Year 2



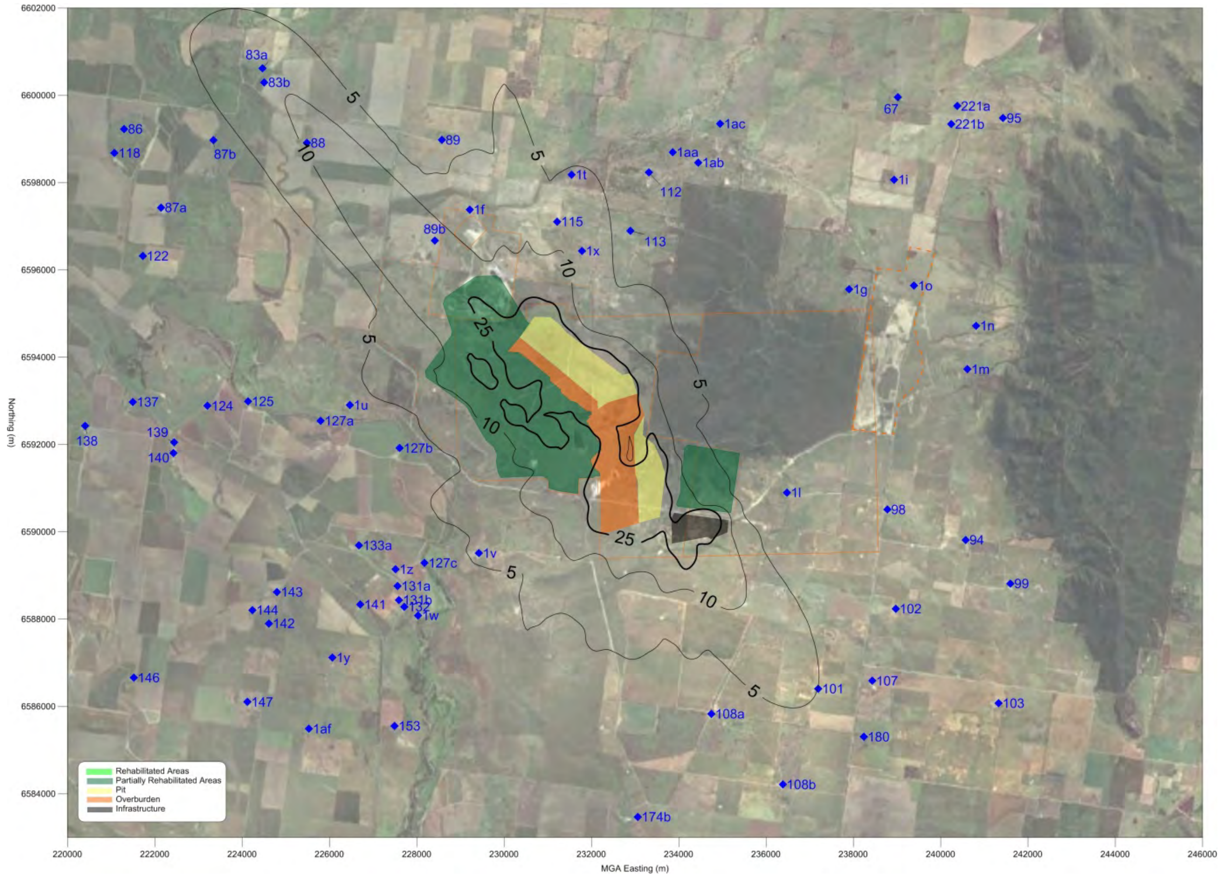
Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Vickery	Year 7	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	25 µg/m^3	CALMET	R. Kan

Figure 8.14: Predicted Maximum 24-hour $PM_{2.5}$ Concentration Project-Only – Year 7



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
$PM_{2.5}$	Vickery	Year 17	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	25 µg/m^3	CALMET	R. Kan

Figure 8.15: Predicted Maximum 24-hour $PM_{2.5}$ Concentration Project-Only – Year 17



Species: PM2.5	Location: Vickery	Scenario: Year 26	Percentile: Maximum	Averaging Time: 24-hour
Model Used: CALPUFF v6.42	**Units:** µg/m³	**Guideline:** 25 µg/m³	**Met Data:** CALMET	**Plot:** R. Kan

Figure 8.16: Predicted Maximum 24-hour $PM_{2.5}$ Concentration Project-Only – Year 26

8.8 Summary of 24-hour Average $PM_{2.5}$ Results at Individual Receivers

A summary of the predicted particulate concentrations at each of the individual receivers is provided in **Table 8.6**. There are no privately-owned receivers that are predicted to experience 24-hour average $PM_{2.5}$ concentrations above the assessment criteria, due to emissions from the Project-only.

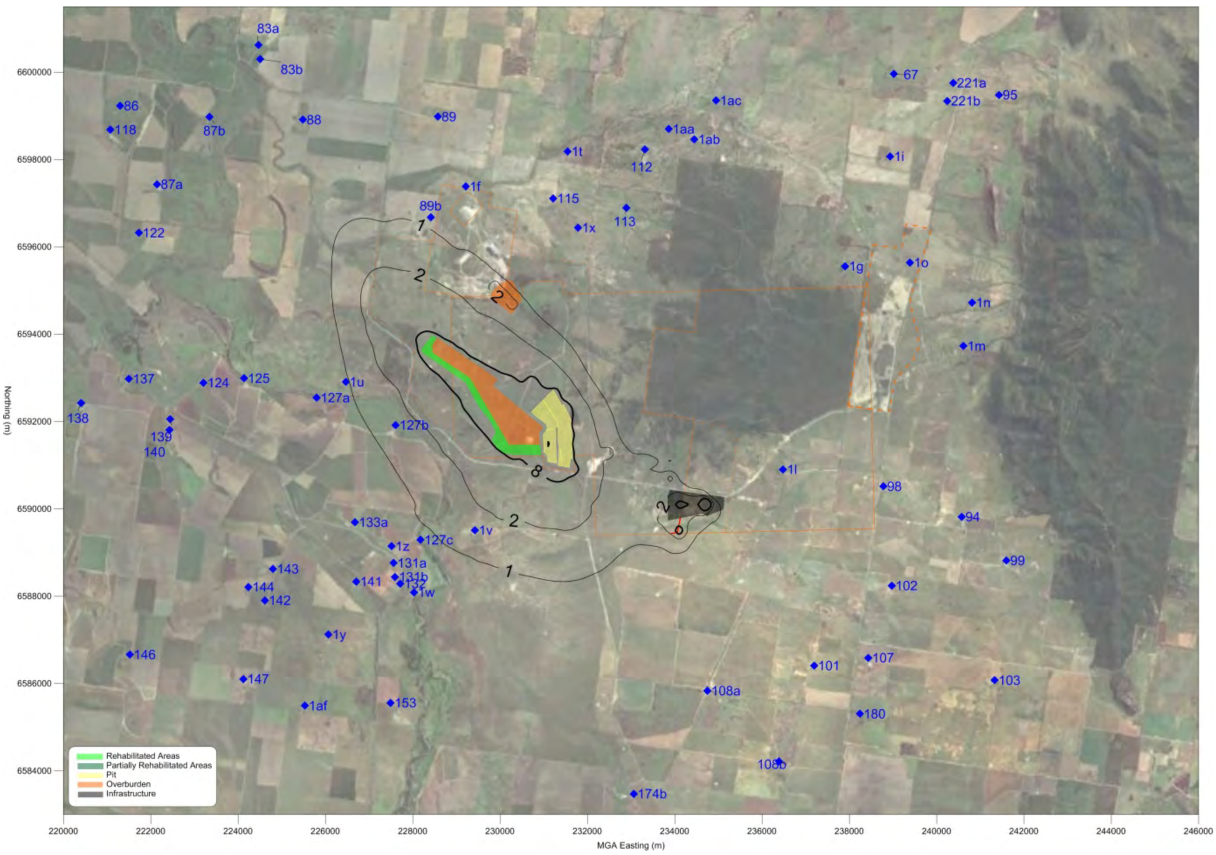
Table 8.6: Maximum Predicted Project-only 24-hour Average $PM_{2.5}$ Concentrations (µg/m³)

Receiver ID	Y2	Y7	Y17	Y26
	24-hour Average $PM_{2.5}$ (µg/m³) Assessment criteria = 25 µg/m³			
67	0	1	1	1
83a	2	6	8	9
83b	3	7	8	10
86	2	3	2	2
87a	2	3	2	2
87b	3	5	4	4
88	4	8	9	11
89a	4	5	4	4
89b	6	9	8	14
94	1	1	1	1
95	0	0	0	0
98	1	2	1	2
99	0	1	1	1
101	2	4	3	5
102	1	2	1	2
103	1	1	1	1
107	1	3	2	3
108a	3	5	3	4
108b	2	3	2	3
112	2	4	3	3
118	2	2	2	2
122	2	3	2	2
124	3	4	2	3
125	4	4	2	3
127a	6	6	4	4
127b	11	10	4	4
127c	8	6	3	4
131a	6	5	3	4
131b	6	5	2	3
132	6	5	3	3
133a	5	5	2	3
137	2	2	2	2
138	1	2	1	1
139	3	3	2	2
140	2	3	2	2
141	5	4	2	3
142	3	3	2	2
143	3	3	2	2
144	3	3	2	2
146	2	2	1	1
147	2	3	2	2
153	3	3	2	3
174b	2	3	1	2
180	2	3	2	3
221a	0	0	0	1
221b	0	1	1	1
1f	6	7	5	7
1g	1	1	1	1
1i	0	1	1	1
1l	2	4	3	3
1m	1	1	1	1
1n	0	1	1	1
1o	1	1	1	1
1t	3	5	4	5
1u	7	7	5	4
1v	11	8	4	5
1w	6	5	3	3
1x	4	8	6	8
1y	4	4	2	3
1z	6	5	2	4
1aa	1	3	2	3
1ab	1	2	2	2
1ac	1	2	1	2
1ad	4	7	4	8
1ae	3	5	4	4
1af	3	3	2	2

Note: Receivers with prefix “1” denote mine-owned receivers

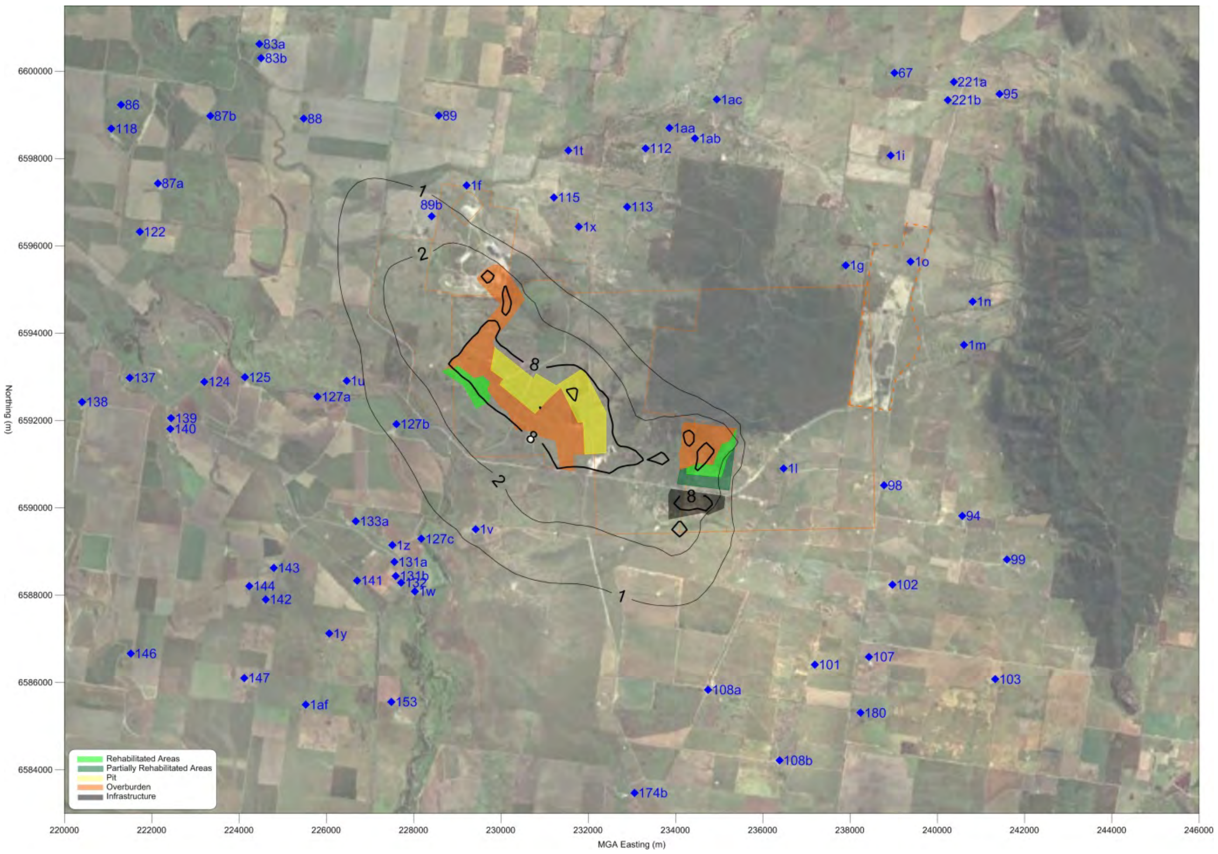
8.9 Project Only Annual Average $PM_{2.5}$

The Project-only contributions to annual average $PM_{2.5}$ concentrations are presented in **Figure 8.17** to **Figure 8.20** for each modelled year.



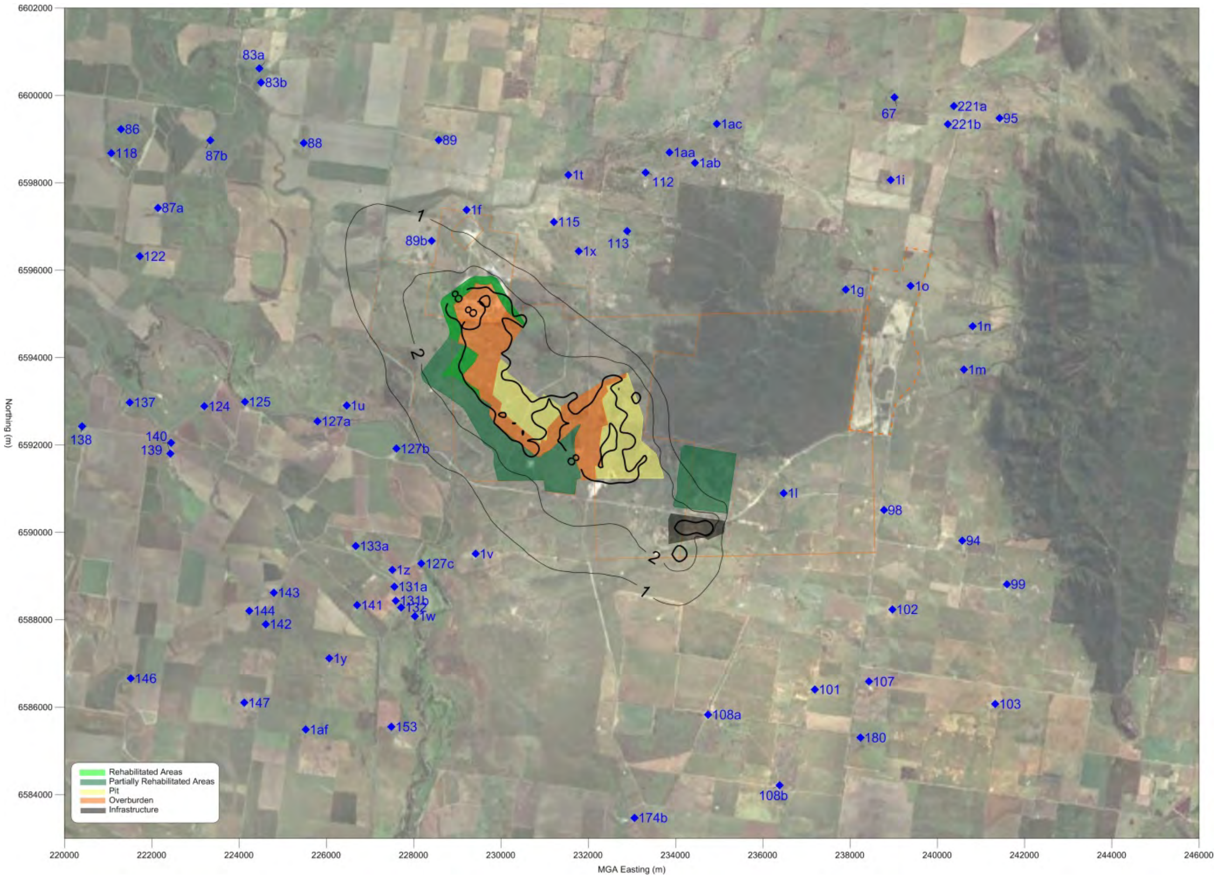
Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Vickery	Year 2	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	8 µg/m³	CALMET	R. Kan

Figure 8.17: Predicted Annual Average $PM_{2.5}$ Concentration Project-Only – Year 2



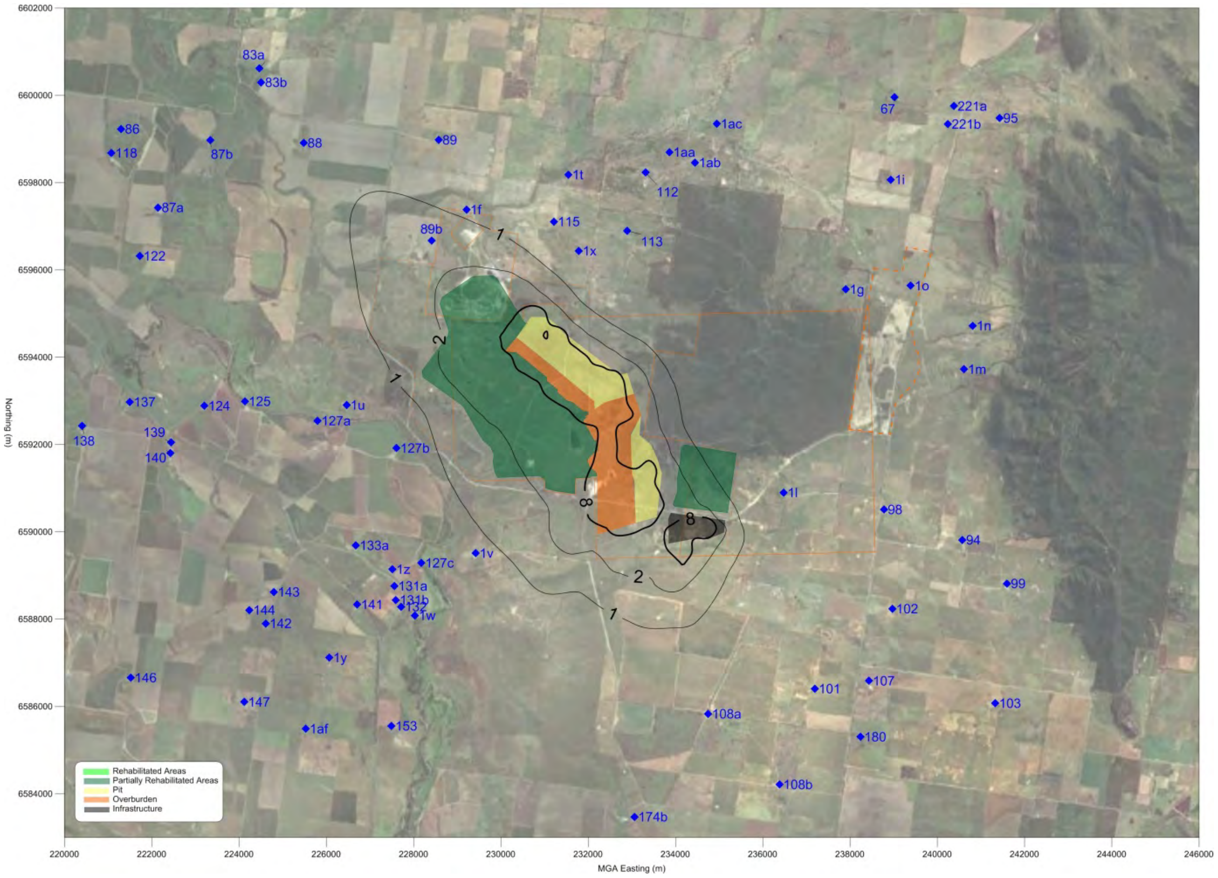
Species: PM$_{2.5}$	Location: Vickery	Scenario: Year 7	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF v6.42	**Units:** µg/m^3	**Guideline:** 8 µg/m^3	**Met Data:** CALMET	**Plot:** R. Kan

Figure 8.18: Predicted Annual Average PM$_{2.5}$ Concentration Project-Only – Year 7



Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Vickery	Year 17	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	8 µg/m^3	CALMET	R. Kan

Figure 8.19: Predicted Annual Average $PM_{2.5}$ Concentration Project-Only – Year 17



Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	Vickery	Year 26	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	$\mu g/m^3$	8 $\mu g/m^3$	CALMET	R. Kan

Figure 8.20: Predicted Annual Average $PM_{2.5}$ Concentration Project-Only – Year 26

8.10 Summary of Project-only Annual Average $PM_{2.5}$ Results at Individual Receivers

A summary of the predicted $PM_{2.5}$ concentrations at each of the individual receivers is provided in **Table 8.7**. There are no privately-owned receivers that are predicted to experience annual average $PM_{2.5}$ concentrations above the assessment criterion, due to emissions from the Project-only. It is noted that the predicted $PM_{2.5}$ concentrations are well below the assessment criterion for all years modelled.

In addition, there are no exceedances from the Project-only when adding the background concentration of 4.5 µg/m³.

Table 8.7: Annual Average $PM_{2.5}$ Concentrations (µg/m³)

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average $PM_{2.5}$ (µg/m³) Assessment criteria = 8 µg/m³			
67	0	0	0	0
83a	0	1	0	1
83b	0	1	1	1
86	0	0	0	0
87a	0	1	0	0
87b	1	1	1	1
88	1	1	1	1
89a	0	1	0	0
89b	1	2	1	1
94	0	0	0	0
95	0	0	0	0
98	0	0	0	0
99	0	0	0	0
101	0	0	0	0
102	0	0	0	0
103	0	0	0	0
107	0	0	0	0
108a	0	1	0	0
108b	0	0	0	0
112	0	0	0	0
118	0	0	0	0
122	0	0	0	0
124	0	0	0	0
125	1	1	0	0
127a	1	1	0	1
127b	2	2	1	1
127c	1	1	1	1
131a	1	1	0	0
131b	1	1	0	0
132	1	1	0	0
133a	1	1	0	0
137	0	0	0	0
138	0	0	0	0
139	0	0	0	0
140	0	0	0	0
141	1	1	0	0
142	0	0	0	0
143	0	0	0	0
144	0	0	0	0
146	0	0	0	0
147	0	0	0	0
153	0	0	0	0
174b	0	0	0	0
180	0	0	0	0
221a	0	0	0	0
221b	0	0	0	0
1f	0	1	1	1
1g	0	0	0	0
1i	0	0	0	0
1l	0	0	0	0
1m	0	0	0	0
1n	0	0	0	0
1o	0	0	0	0

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average $PM_{2.5}$ ($\mu g/m^3$) Assessment criteria = 8 $\mu g/m^3$			
1t	0	0	0	0
1u	1	1	1	1
1v	1	1	1	1
1w	1	1	0	0
1x	0	1	1	1
1y	0	0	0	0
1z	1	1	0	0
1aa	0	0	0	0
1ab	0	0	0	0
1ac	0	0	0	0
1ad	0	1	0	1
1ae	0	0	0	0
1af	0	0	0	0

Note: Receivers with prefix "1" denote mine-owned receivers

8.11 Cumulative Annual Average $PM_{2.5}$

A summary of the cumulative assessment of annual average $PM_{2.5}$ concentrations is presented in **Table 8.8**. $PM_{2.5}$ concentrations from the Project-only is well below the $PM_{2.5}$ assessment criterion and the highest predicted impact at the residences is 1 $\mu g/m^3$. A background level of 4.5 $\mu g/m^3$ was added directly to predicted worst case concentrations for the Project.

When background concentrations are considered with the Project, no privately owned receivers are predicted to exceed the annual $PM_{2.5}$ assessment criterion of 8 $\mu g/m^3$.

Table 8.8: Maximum Predicted Cumulative Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)

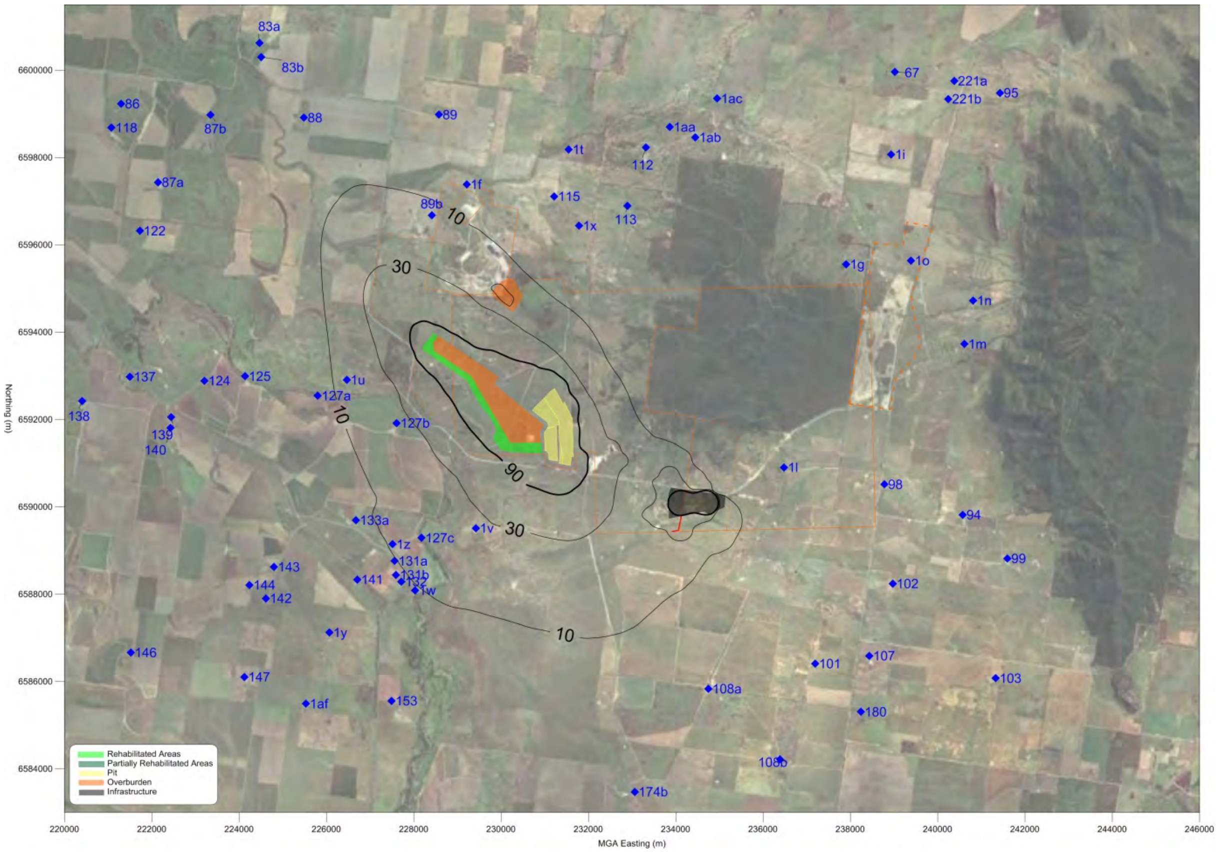
Receiver ID	Project	Background	Total
	Annual Average $PM_{2.5}$ ($\mu g/m^3$) *Assessment criteria = 8 $\mu g/m^3$*		
67	0	4.5	5
83a	1	4.5	5
83b	1	4.5	5
86	0	4.5	5
87a	1	4.5	5
87b	1	4.5	5
88	1	4.5	6
89a	1	4.5	5
89b	2	4.5	6
94	0	4.5	5
95	0	4.5	5
98	0	4.5	5
99	0	4.5	5
101	0	4.5	5
102	0	4.5	5
103	0	4.5	5
107	0	4.5	5
108a	1	4.5	5
108b	0	4.5	5
112	0	4.5	5
118	0	4.5	5
122	0	4.5	5
124	0	4.5	5
125	1	4.5	5
127a	1	4.5	5
127b	2	4.5	6
127c	1	4.5	5
131a	1	4.5	5
131b	1	4.5	5
132	1	4.5	5
133a	1	4.5	5
137	0	4.5	5
138	0	4.5	5
139	0	4.5	5
140	0	4.5	5
141	1	4.5	5

Receiver ID	Project	Background	Total
	Annual Average $PM_{2.5}$ ($\mu g/m^3$) *Assessment criteria = 8 $\mu g/m^3$*		
142	0	4.5	5
143	0	4.5	5
144	0	4.5	5
146	0	4.5	5
147	0	4.5	5
153	0	4.5	5
174b	0	4.5	5
180	0	4.5	5
221a	0	4.5	5
221b	0	4.5	5
1f	1	4.5	5
1g	0	4.5	5
1i	0	4.5	5
1l	0	4.5	5
1m	0	4.5	5
1n	0	4.5	5
1o	0	4.5	5
1t	0	4.5	5
1u	1	4.5	6
1v	1	4.5	6
1w	1	4.5	5
1x	1	4.5	5
1y	0	4.5	5
1z	1	4.5	5
1aa	0	4.5	5
1ab	0	4.5	5
1ac	0	4.5	5
1ad	1	4.5	5
1ae	0	4.5	5
1af	0	4.5	5

Note: Receivers with prefix “1” denote mine-owned receivers

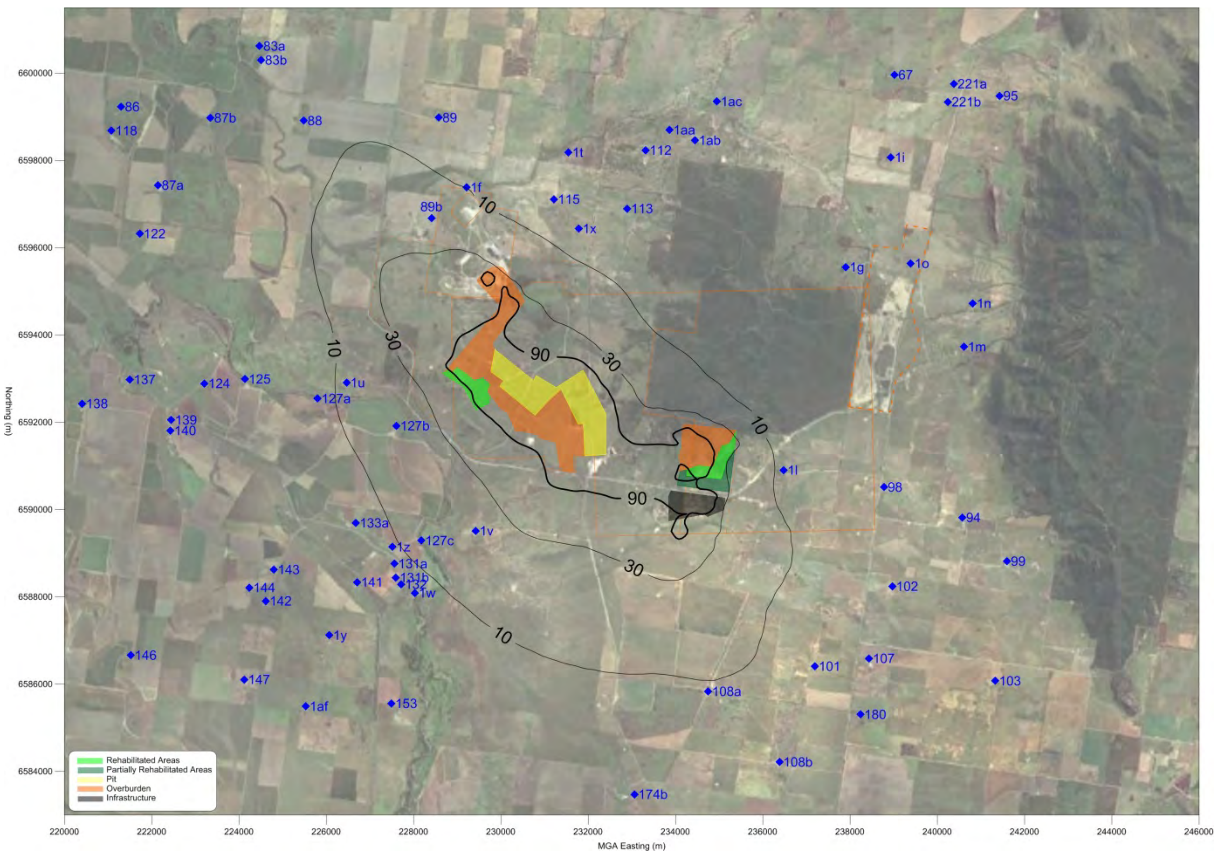
8.12 Project-Only Annual Average Total Suspended Particulate Matter

The predicted TSP concentrations for the contribution of the Project-only for annual average TSP concentrations are presented in **Figure 8.21** to **Figure 8.24** for each modelled year.



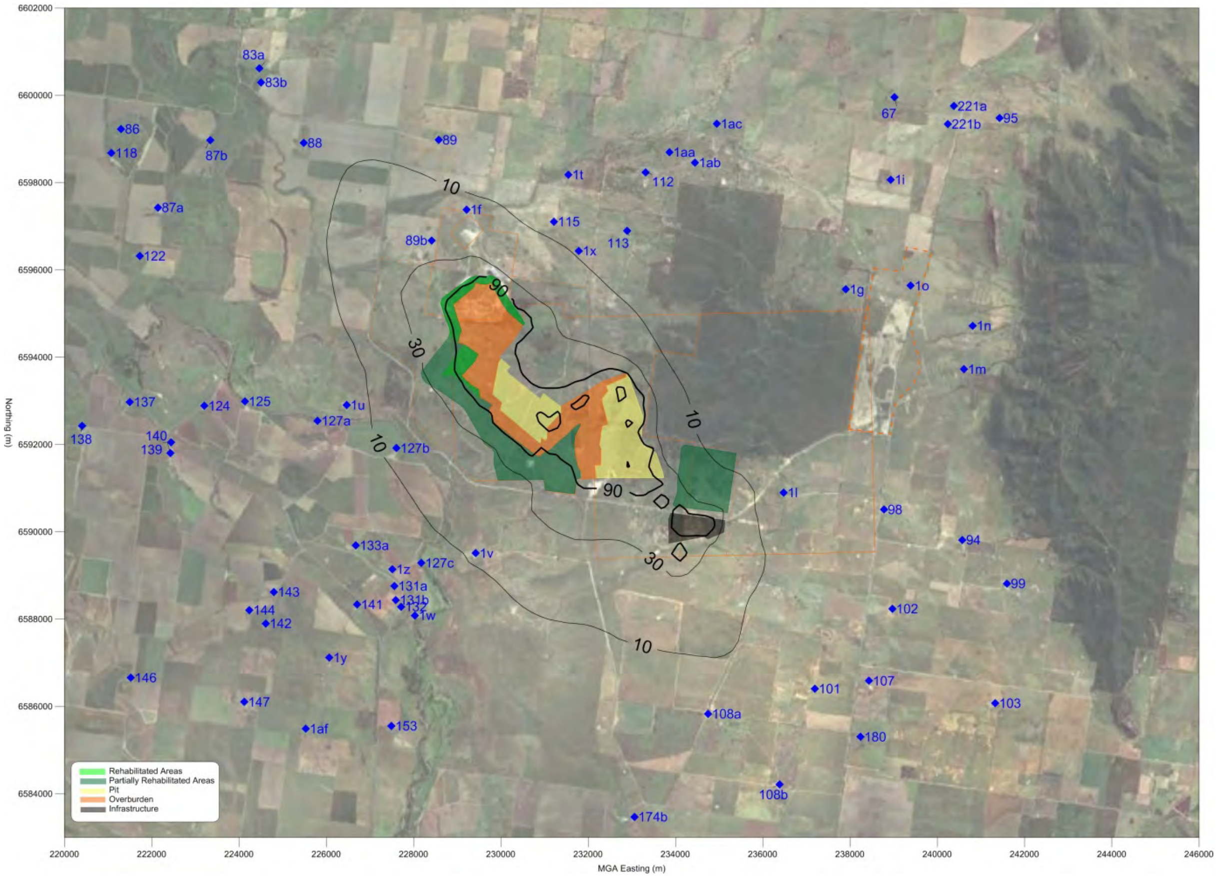
Species: TSP	Location: Vickery	Scenario: Year 2	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF v6.42	**Units:** µg/m³	**Guideline:** 90 µg/m³	**Met Data:** CALMET	**Plot:** R Kan

Figure 8.21: Predicted Annual Total Suspended Particulate Matter Concentration Project-Only – Year 2



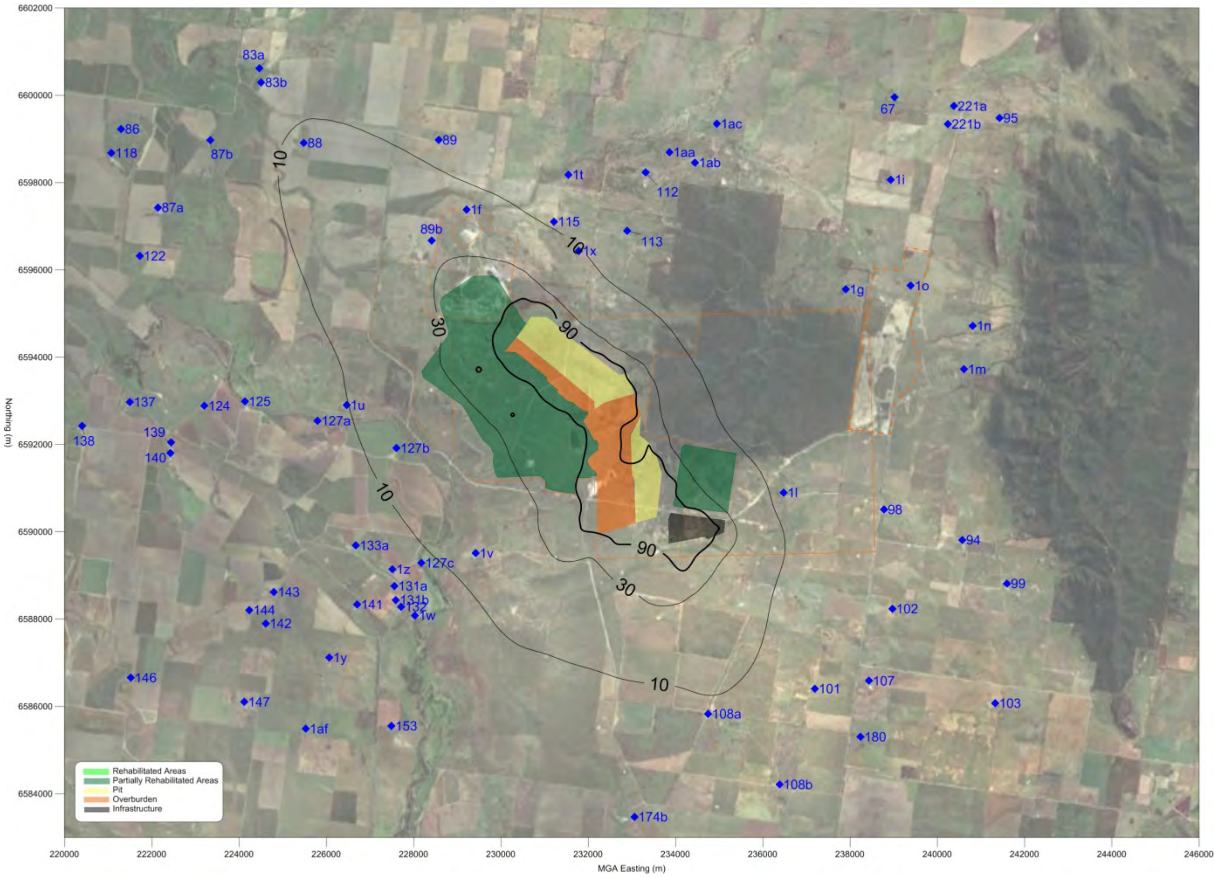
Species:	Location:	Scenario:	Percentile:	Averaging Time:
TSP	Vickery	Year 7	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	90 µg/m³	CALMET	R Kan

Figure 8.22: Predicted Annual Total Suspended Particulate Matter Concentration Project-Only – Year 7



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
TSP	Vickery	Year 17	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	90 µg/m^3	CALMET	R Kan

Figure 8.23: Predicted Annual Total Suspended Particulate Matter Concentration Project-Only – Year 17



Species:	Location:	Scenario:	Percentile:	Averaging Time:
TSP	Vickery	Year 26	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	90 µg/m³	CALMET	R Kan

Figure 8.24: Predicted Annual Total Suspended Particulate Matter Concentration Project-Only – Year 26

8.13 Summary of Project-only Annual Average Total Suspended Particulate Matter Results at Individual Receivers

A summary of the predicted particulate concentrations at each of the individual receivers is provided in **Table 8.9**. There are no privately owned receivers that are predicted to experience annual average TSP concentrations above the assessment criteria, due to emissions from the Project-only.

In addition, there are no exceedances from the Project-only when adding the background concentration of 30 µg/m³.

Table 8.9: Annual Average Total Suspended Particulate Matter Concentrations (µg/m³)

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average TSP (µg/m³) Assessment criteria = 90 µg/m³			
67	0	1	1	1
83a	5	9	7	7
83b	6	10	7	8
86	5	6	4	4
87a	6	8	5	5
87b	8	11	8	7
88	8	14	11	11
89a	4	8	7	7
89b	11	22	22	24
94	1	2	1	2
95	0	0	0	0
98	1	4	3	3
99	1	1	1	1
101	3	7	4	6
102	2	4	3	3
103	1	2	1	1
107	2	5	3	4
108a	6	11	7	9
108b	3	7	4	5
112	2	3	3	3
118	4	6	4	4
122	5	7	4	4
124	5	7	4	5
125	7	9	5	6
127a	12	14	7	8
127b	26	25	13	12
127c	14	15	8	9
131a	10	11	6	7
131b	10	10	6	7
132	10	10	6	7
133a	9	11	6	7
137	3	4	3	3
138	2	3	2	2
139	4	5	3	4
140	3	5	3	4
141	7	8	5	5
142	4	5	3	3
143	4	5	3	4
144	4	5	3	3
146	2	2	1	2
147	3	3	2	2
153	5	6	3	4
174b	3	5	3	3
180	2	5	3	4
221a	0	0	0	0
221b	0	1	0	1
1f	6	11	12	15
1g	1	2	2	2
1i	0	1	1	1
1l	3	10	7	8
1m	0	1	1	1
1n	0	1	1	1
1o	0	1	1	1
1t	2	5	5	6

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average TSP (μg/m³) Assessment criteria = 90 μg/m³			
1u	18	18	9	10
1v	24	22	12	13
1w	10	11	6	7
1x	4	9	10	10
1y	5	6	3	4
1z	11	12	7	7
1aa	1	3	2	3
1ab	1	2	2	2
1ac	1	2	2	2
1ad	3	8	9	9
1ae	2	6	6	6
1af	3	4	2	3

Note: Receivers with prefix “1” denote mine-owned receivers

8.14 Cumulative Annual Average Total Suspended Particulate Matter

A summary of the cumulative assessment of annual average TSP concentrations is presented in **Table 8.10**. The approach to cumulative assessment is similar as that for annual average PM_{10}. When the contribution of other mining activity (including the Tarrawonga Coal Project, Boggabri Coal Project and Rocglen Extension Project) are added along with a background for all other sources, no privately owned receivers are predicted to exceed the EPA assessment criterion of 90 µg/m³.

It is also relevant to note that the Project emissions alone, plus non-mining sources, would similarly not result in any predicted exceedances of the EPA assessment criterion.

Table 8.10: Maximum Predicted Cumulative Annual Average Total Suspended Particulate Matter Concentrations (µg/m³)

Receiver ID	Project	Rocglen	Tarrawonga	Boggabri	Background	Total
	Annual Average TSP (µg/m³) *Assessment criteria = 90 µg/m³*					
67	1	N/A	N/A	N/A	30	31
83a	9	N/A	3	5	30	47
83b	10	N/A	3	5	30	48
86	6	N/A	1	N/A	30	38
87a	8	N/A	1	N/A	30	39
87b	11	N/A	2	5	30	48
88	14	N/A	3	N/A	30	47
89a	8	N/A	4	5	30	47
89b	24	N/A	2[1]	5[1]	30	61
94	2	4	N/A	N/A	30	36
95	0	9	N/A	N/A	30	39
98	4	4	N/A	N/A	30	37
99	1	3	N/A	N/A	30	34
101	7	1	N/A	N/A	30	38
102	4	1	N/A	N/A	30	36
103	2	N/A	N/A	N/A	30	32
107	5	1	N/A	N/A	30	36
108a	11	N/A	N/A	N/A	30	41
108b	7	N/A	N/A	N/A	30	37
112	3	N/A	2	5	30	40
118	6	N/A	1	5	30	42
122	7	N/A	2	5	30	43
124	7	N/A	N/A	N/A	30	37
125	9	N/A	N/A	N/A	30	39
127a	14	N/A	N/A	N/A	30	44
127b	26	N/A	N/A	N/A	30	56
127c	15	N/A	N/A	N/A	30	45
131a	11	N/A	N/A	N/A	30	41
131b	10	N/A	N/A	N/A	30	40
132	10	N/A	N/A	N/A	30	40
133a	11	N/A	N/A	N/A	30	41
137	4	N/A	N/A	N/A	30	34
138	3	N/A	N/A	N/A	30	33

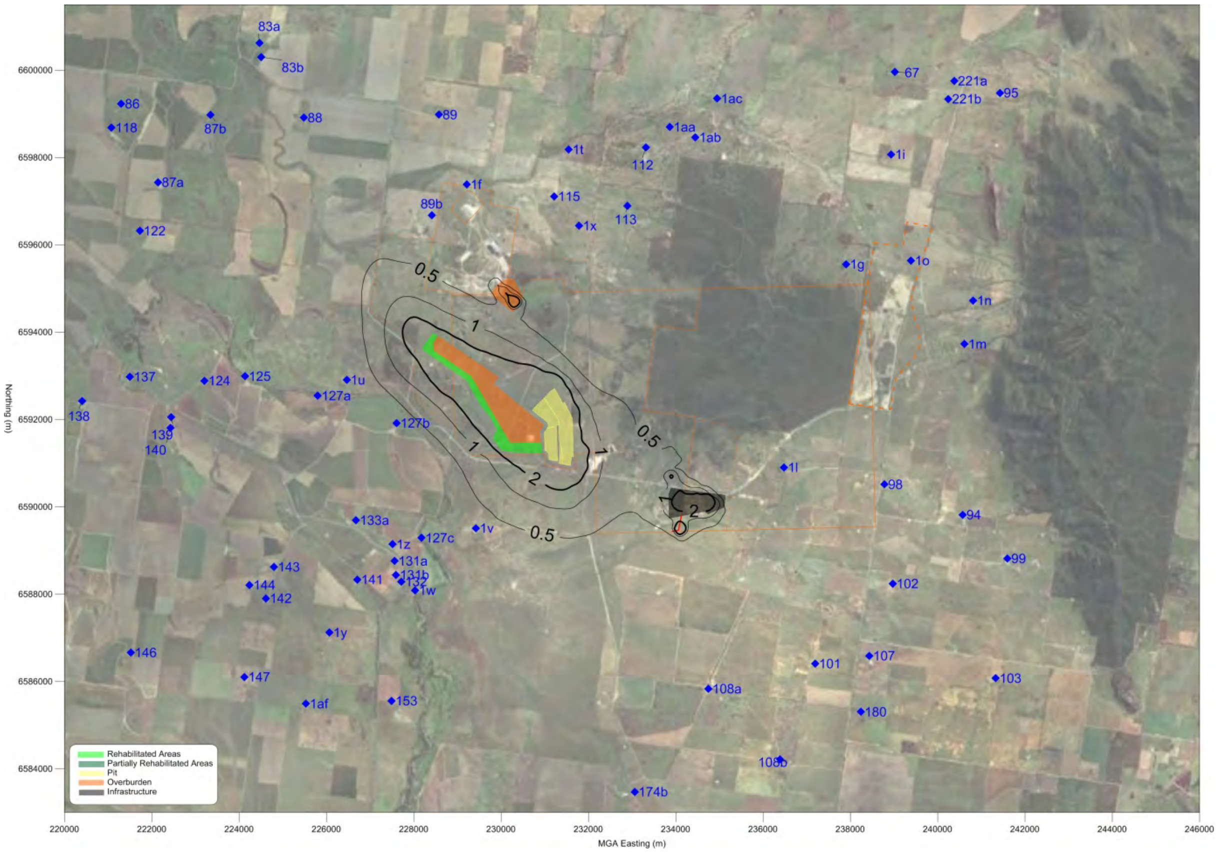
Receiver ID	Project	Rocglen	Tarrawonga	Boggabri	Background	Total
	Annual Average TSP (µg/m³) Assessment criteria = 90 µg/m³					
139	5	N/A	N/A	N/A	30	35
140	5	N/A	N/A	N/A	30	35
141	8	N/A	N/A	N/A	30	38
142	5	N/A	N/A	N/A	30	35
143	5	N/A	N/A	N/A	30	35
144	5	N/A	N/A	N/A	30	35
146	2	N/A	N/A	N/A	30	32
147	3	N/A	N/A	N/A	30	33
153	6	N/A	N/A	N/A	30	36
174b	5	N/A	N/A	N/A	30	35
180	5	N/A	N/A	N/A	30	35
221a	0	N/A	N/A	N/A	30	30
221b	1	N/A	N/A	N/A	30	31
1f	15	N/A	2	5	30	52
1g	2	9	N/A	N/A	30	40
1i	1	3	N/A	N/A	30	34
1l	10	2	N/A	N/A	30	42
1m	1	7	N/A	N/A	30	38
1n	1	5	N/A	N/A	30	35
1o	1	N/A	N/A	N/A	30	31
1t	6	N/A	2	5	30	43
1u	18	N/A	N/A	N/A	30	48
1v	24	N/A	N/A	N/A	30	54
1w	11	N/A	N/A	N/A	30	41
1x	10	N/A	N/A	N/A	30	40
1y	6	N/A	N/A	N/A	30	36
1z	12	N/A	N/A	N/A	30	42
1aa	3	N/A	2	5	30	39
1ab	2	N/A	1	5	30	39
1ac	2	N/A	1	5	30	38
1ad	9	N/A	2	5	30	46
1ae	6	N/A	N/A	N/A	30	36
1af	4	N/A	N/A	N/A	30	34

Note: Receivers with prefix "1" denote mine-owned receivers

[1] Assumed same concentration as nearby receiver 1f.

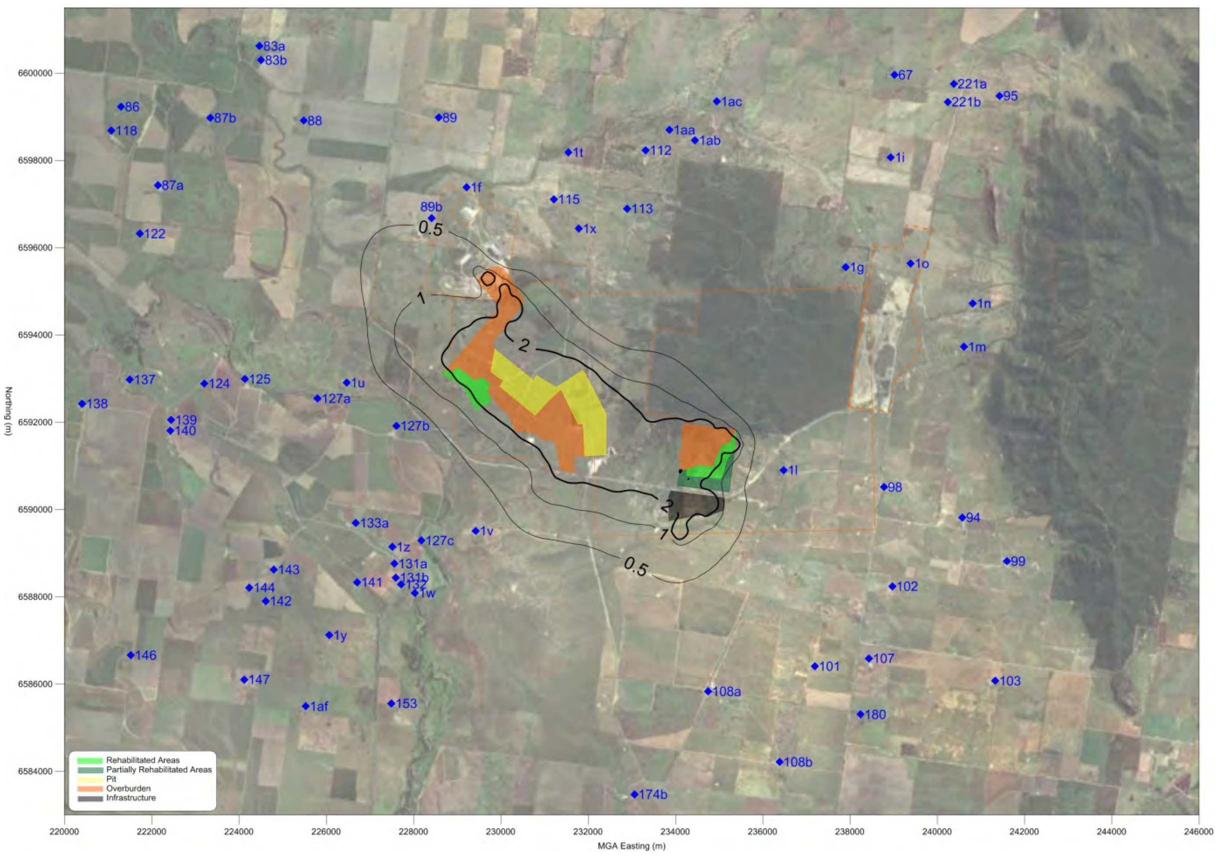
8.15 Project-Only Annual Average Dust Deposition

The predicted contribution of the Project-only to annual average dust deposition levels are presented in **Figure 8.25** to **Figure 8.28** for each modelled year. The Project-only assessment criterion for dust deposition is 2 g/m^2/month.



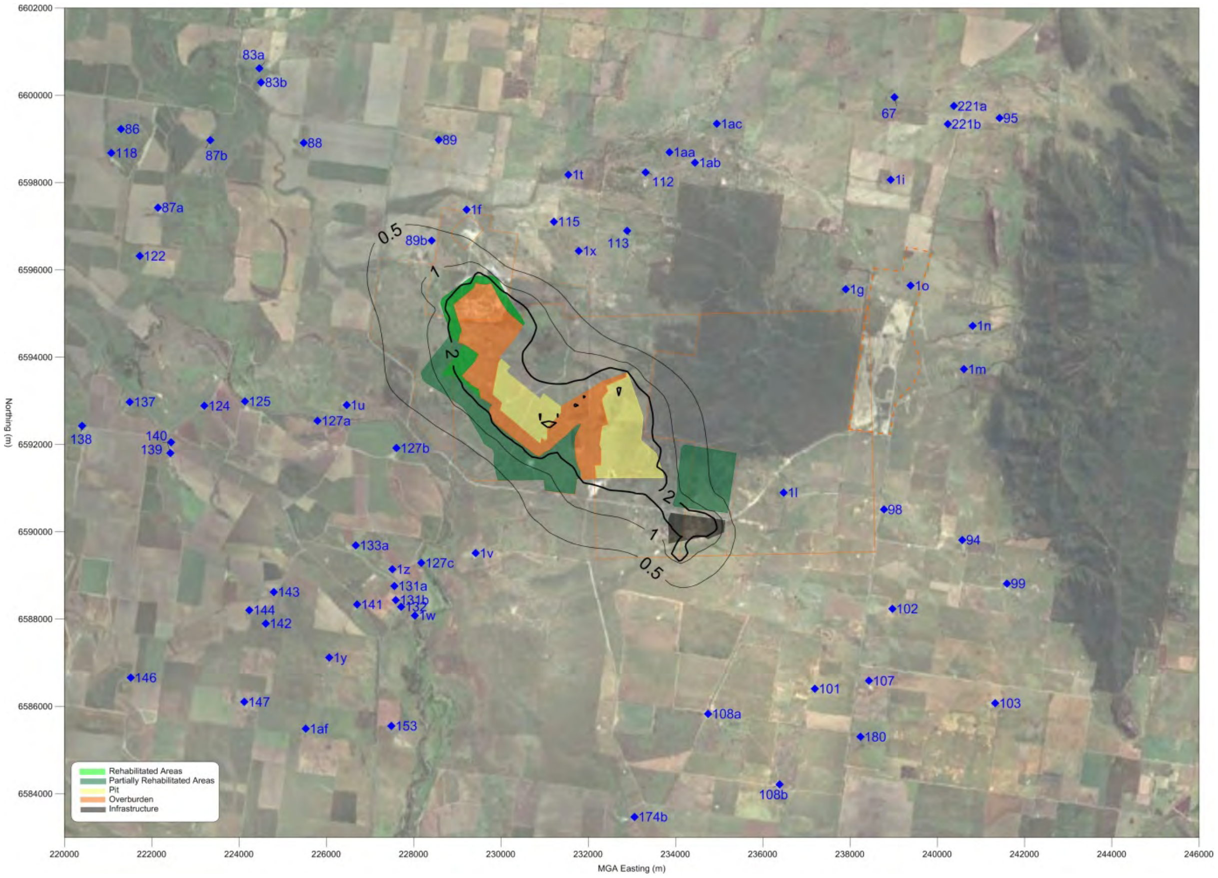
Species:	Location:	Scenario:	Percentile:	Averaging Time:
Dust Deposition	Vickery	Year 2	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	g/m^2/month	2 g/m^2/month	CALMET	R Kan

Figure 8.25: Predicted Annual Dust Deposition Project-Only – Year 2



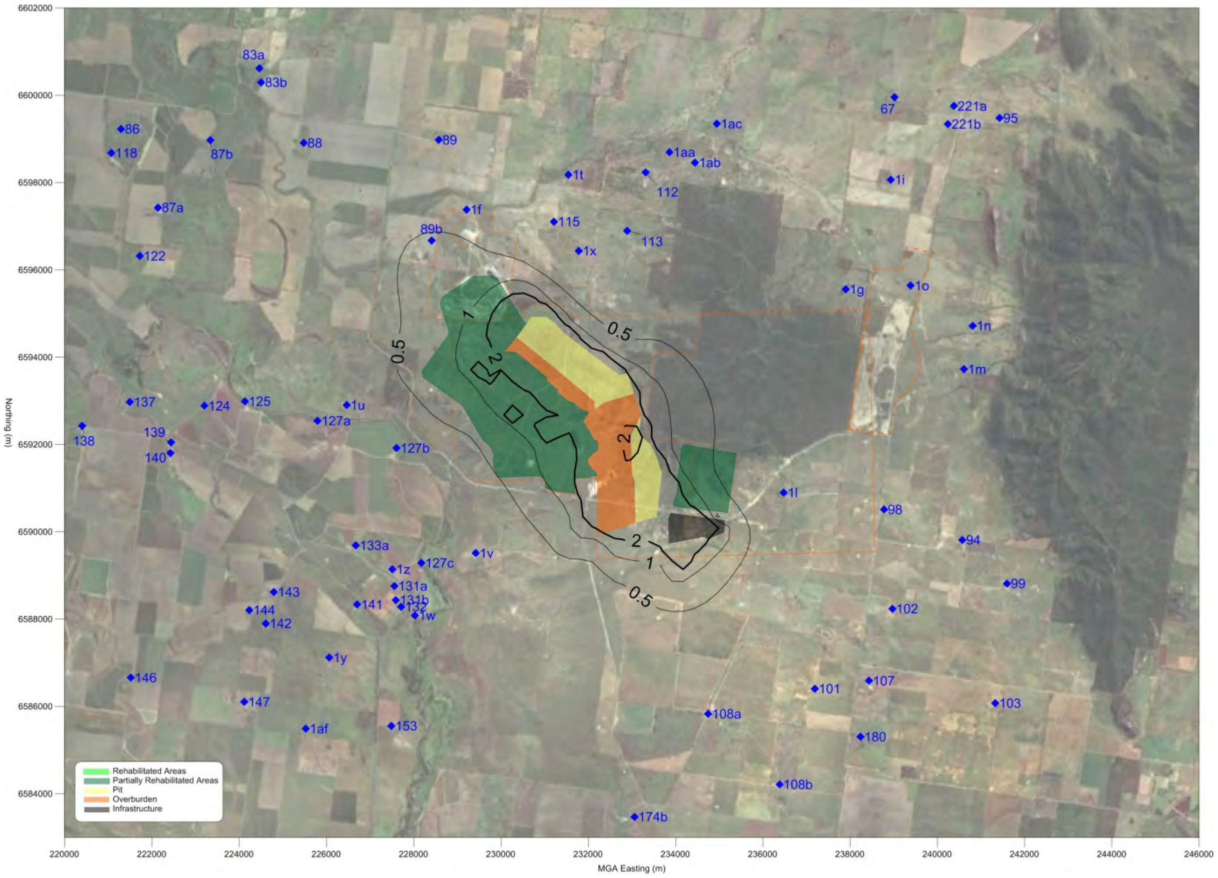
Species:	Location:	Scenario:	Percentile:	Averaging Time:
Dust Deposition	Vickery	Year 7	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	g/m^2/month	2 g/m^2/month	CALMET	R Kan

Figure 8.26: Predicted Annual Dust Deposition Project-Only – Year 7



Species: Dust Deposition	**Location:** Vickery	**Scenario:** Year 17	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: CALPUFF v6.42	**Units:** $g/m^2/month$	**Guideline:** 2 $g/m^2/month$	**Met Data:** CALMET	**Plot:** R Kan

Figure 8.27: Predicted Annual Dust Deposition Project-Only – Year 17



Species:	Location:	Scenario:	Percentile:	Averaging Time:
Dust Deposition	Vickery	Year 26	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	g/m^2/month	2 g/m^2/month	CALMET	R Kan

Figure 8.28: Predicted Annual Dust Deposition Project-Only – Year 26

8.16 Summary of Project-only Annual Average Dust Deposition Results at Individual Receivers

A summary of the predicted particulate concentrations at each of the individual receivers is provided in **Table 8.11**.

There are no privately owned receivers that are predicted to experience annual average dust deposition levels above the assessment criteria, due to emissions from the Project-only.

In addition, there are no exceedances from the Project-only when adding the background dust deposition level of 2 g/m^2/month.

Table 8.11: Annual Average Dust Deposition Levels (µg/m^3)

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average Dust Deposition (*g/m^2/month*) *Assessment criteria = 2 g/m^2/month*			
67	0.0	0.0	0.0	0.0
83a	0.1	0.1	0.1	0.1
83b	0.1	0.2	0.1	0.1
86	0.1	0.1	0.1	0.1
87a	0.1	0.1	0.1	0.1
87b	0.1	0.2	0.2	0.1
88	0.1	0.2	0.2	0.2
89a	0.1	0.1	0.1	0.1
89b	0.2	0.5	0.6	0.5
94	0.0	0.1	0.0	0.1
95	0.0	0.0	0.0	0.0
98	0.0	0.1	0.1	0.1
99	0.0	0.1	0.0	0.0
101	0.1	0.2	0.1	0.1
102	0.0	0.1	0.1	0.1
103	0.0	0.0	0.0	0.0
107	0.0	0.1	0.1	0.1
108a	0.0	0.1	0.1	0.1
108b	0.0	0.1	0.1	0.1
112	0.1	0.1	0.2	0.2
118	0.0	0.1	0.1	0.1
122	0.1	0.1	0.1	0.1
124	0.1	0.1	0.1	0.1
125	0.1	0.1	0.1	0.1
127a	0.2	0.2	0.1	0.1
127b	0.4	0.4	0.2	0.2
127c	0.2	0.2	0.1	0.1
131a	0.1	0.1	0.1	0.1
131b	0.1	0.1	0.1	0.1
132	0.1	0.1	0.1	0.1
133a	0.1	0.1	0.1	0.1
137	0.0	0.1	0.0	0.1
138	0.0	0.0	0.0	0.0
139	0.0	0.1	0.1	0.1
140	0.0	0.1	0.0	0.1
141	0.1	0.1	0.1	0.1
142	0.0	0.1	0.0	0.0
143	0.0	0.1	0.0	0.0
144	0.0	0.1	0.0	0.0
146	0.0	0.0	0.0	0.0
147	0.0	0.0	0.0	0.0
153	0.1	0.1	0.0	0.1
174b	0.0	0.1	0.0	0.1
180	0.0	0.1	0.1	0.1
221a	0.0	0.0	0.0	0.0
221b	0.0	0.0	0.0	0.0
1f	0.1	0.2	0.3	0.3
1g	0.0	0.0	0.0	0.1
1i	0.0	0.0	0.0	0.0
1l	0.1	0.4	0.2	0.2
1m	0.0	0.0	0.0	0.0
1n	0.0	0.0	0.0	0.0
1o	0.0	0.0	0.0	0.0

Receiver ID	Y2	Y7	Y17	Y26
	Annual Average Dust Deposition (g/m²/month) *Assessment criteria = 2 g/m²/month*			
1t	0.0	0.1	0.1	0.1
1u	0.3	0.3	0.2	0.2
1v	0.3	0.3	0.2	0.2
1w	0.1	0.1	0.1	0.1
1x	0.1	0.2	0.2	0.2
1y	0.1	0.1	0.0	0.0
1z	0.1	0.2	0.1	0.1
1aa	0.0	0.0	0.0	0.0
1ab	0.0	0.0	0.0	0.1
1ac	0.0	0.0	0.0	0.0
1ad	0.1	0.2	0.1	0.2
1ae	0.1	0.1	0.1	0.1
1af	0.0	0.0	0.0	0.0

Note: Receivers with prefix “1” denote mine-owned receivers

8.17 Cumulative Annual Average Dust Deposition

A summary of the cumulative assessment of annual average dust deposition is presented in **Table 8.12.** When the contribution of other mining activity (including the Tarrawonga Coal Project, Boggabri Coal Project and Rocglen Extension Project) are added along with a background for all other sources, no privately-owned receivers are predicted to exceed the EPA assessment criterion 4 g/m²/month.

Table 8.12: Maximum Predicted Cumulative Annual Average Dust Deposition Concentrations (µg/m³)

Receiver ID	Project	Rocglen	Background	Total
	Annual Average Dust Deposition (g/m²/month) *Assessment criteria = 4 g/m²/month*			
67	0.0	0.0	2.0	2.0
83a	0.1	0.0	2.0	2.1
83b	0.2	0.0	2.0	2.2
86	0.1	0.0	2.0	2.1
87a	0.1	0.0	2.0	2.1
87b	0.2	0.0	2.0	2.2
88	0.2	0.0	2.0	2.2
89a	0.1	0.0	2.0	2.1
89b	0.6	0.0	2.0	2.6
94	0.1	0.1	2.0	2.2
95	0.0	0.0	2.0	2.0
98	0.1	0.1	2.0	2.2
99	0.1	0.1	2.0	2.1
101	0.2	0.0	2.0	2.2
102	0.1	0.0	2.0	2.1
103	0.0	0.0	2.0	2.0
107	0.1	0.0	2.0	2.1
108a	0.1	0.0	2.0	2.1
108b	0.1	0.0	2.0	2.1
112	0.2	0.0	2.0	2.2
118	0.1	0.0	2.0	2.1
122	0.1	0.0	2.0	2.1
124	0.1	0.0	2.0	2.1
125	0.1	0.0	2.0	2.1
127a	0.2	0.0	2.0	2.2
127b	0.4	0.0	2.0	2.4
127c	0.2	0.0	2.0	2.2
131a	0.1	0.0	2.0	2.1
131b	0.1	0.0	2.0	2.1
132	0.1	0.0	2.0	2.1
133a	0.1	0.0	2.0	2.1
137	0.1	0.0	2.0	2.1
138	0.0	0.0	2.0	2.0
139	0.1	0.0	2.0	2.1
140	0.1	0.0	2.0	2.1
141	0.1	0.0	2.0	2.1
142	0.1	0.0	2.0	2.1
143	0.1	0.0	2.0	2.1
144	0.1	0.0	2.0	2.1

Receiver ID	Project	Rocglen	Background	Total
	Annual Average Dust Deposition (g/m²/month) *Assessment criteria = 4 g/m²/month*			
146	0.0	0.0	2.0	2.0
147	0.0	0.0	2.0	2.0
153	0.1	0.0	2.0	2.1
174b	0.1	0.0	2.0	2.1
180	0.1	0.0	2.0	2.1
221a	0.0	0.0	2.0	2.0
221b	0.0	0.0	2.0	2.0
1f	0.3	0.0	2.0	2.3
1g	0.1	0.9	2.0	2.9
1i	0.0	0.1	2.0	2.1
1l	0.4	0.1	2.0	2.4
1m	0.0	0.2	2.0	2.2
1n	0.0	0.1	2.0	2.1
1o	0.0	0.0	2.0	2.0
1t	0.1	0.0	2.0	2.1
1u	0.3	0.0	2.0	2.3
1v	0.3	0.0	2.0	2.3
1w	0.1	0.0	2.0	2.1
1x	0.2	0.0	2.0	2.2
1y	0.1	0.0	2.0	2.1
1z	0.2	0.0	2.0	2.2
1aa	0.0	0.0	2.0	2.0
1ab	0.1	0.0	2.0	2.1
1ac	0.0	0.0	2.0	2.0
1ad	0.2	0.0	2.0	2.2
1ae	0.1	0.0	2.0	2.1
1af	0.0	0.0	2.0	2.0

Note: Receivers with prefix “1” denote mine-owned receivers

8.18 Pro-active Noise Management

An assessment of predicted noise impacts associated with the Project (Wilkinson Murray, 2012; Appendix C of the EIS) identified the need for a pro-active noise management strategy during adverse weather conditions to mitigate noise impacts at some receivers. Adverse conditions would be identified through a combination of noise and meteorological monitoring and meteorological forecasting.

When these conditions are identified, mine operators would relocate the waste rock mining fleet operating on the Western Emplacement to the north-eastern-most portion of the Western Emplacement. This strategy is anticipated to be implemented approximately 14% to 35% of the time in evening period (depending on the season) and approximately 20% to 43% of the time at night (depending on the season) (Appendix C of the EIS). These meteorological conditions are expected to occur less frequently in summer and more frequently in winter when temperature inversions are more likely to take place (Appendix C of the EIS).

In order to investigate the effect of pro-active noise management on air quality, 24-hour PM_{10} impacts associated with relocating the mining fleet operating on the Western Emplacement to the northeastern-most portion of the Western Emplacement have been assessed for Years 2 and 7 (i.e. consistent with the years for which noise modelling was conducted [Appendix C of the EIS]).

The results are presented in **Appendix C** and show that no exceedances of the 24-hour PM_{10} criterion are predicted in Year 2. There is one receiver (89b) predicted to exceed the 24-hour PM_{10} criterion in Year 7. It is noted that relocation of the mining fleet would only occur during adverse weather conditions on the south-western receivers (Wilkinson Murray, 2012). Relocation of the mining fleet operations in the evening was assumed to occur every day of the year for the purposes of the air dispersion modelling.

However, from the review of Wilkinson Murray (2012), the wind conditions under which the relocated mining fleet would be in operation (e.g. easterly and northerly flows creating highest concentrations at receivers to the southwest) would not correspond when high impacts occur at receiver 89b. Therefore, the modelled impact at receiver 89b may never actually occur as winds conditions during the Pro-active Noise Management Scenario tend to blow away from this receiver.

An exceedance of the 24-hour PM_{10} criterion is predicted at receiver 89b in Year 26 for the base-case scenario, and Whitehaven is intending to enter into a private agreement or purchase agreement with the landowner of receiver 89b (**Section 8.2**).

The results of the pro-active noise management strategy are generally lower than the 24-hour and annual average PM_{10} results for the Year 2 base-case, and similar to the Year 7 base-case results (with the exception of receiver 89b). On this basis, potential air quality impacts associated with the pro-active noise management strategy are expected to be consistent with those predicted for the base case mining scenarios (i.e. no exceedances of relevant air quality criteria are predicted at privately-owned receivers due to the Project-only with the exception of receiver 89b).

8.19 Consideration of Vacant Land

Recent conditions of consent in relation to air quality have included a reference to vacant land in air quality criteria. Specifically, vacant land is considered to be affected if greater than 25% of a property is predicted to exceed the impact assessment criteria.

PAEHolmes has reviewed the relevant air quality contours and land tenure information for the Project. From this review, no potential vacant land impacts have been identified for the Project.

8.20 Construction Phase

Construction/development activities which would potentially contribute to dust and particulate matter emissions include:

- construction of stockpile areas and water management infrastructure;
- realignment of sections of Blue Value Road, Shannon Harbour Road and Hoad Lane to the east and south of the open cut;
- construction of mine infrastructure areas and service facilities; and
- construction and use of a private haul road and Kamilaroi Highway overpass between Blue Vale Road and the Whitehaven CHPP (**Figure 1.1**).

From an air quality perspective it is important to consider the potential emissions that would occur during construction. While dust emissions from construction activities can have impacts on local air quality, impacts are typically of a short duration (especially when compared to the life of mining operations) and relatively easy to manage through commonly applied dust control measures. Dust emissions from construction sites vary substantially from day-to-day, depending on the intensity and location of particular activities and it is very difficult to confidently estimate emissions on a day-to-day basis.

Procedures for controlling dust impacts during construction would include, but not necessarily be limited to the following:

Clearing/Excavation

Emissions from vegetation stripping, topsoil clearing and excavation may occur, particularly during dry and windy conditions. Emissions would be effectively controlled by increasing the moisture content of the soil/surface (i.e. through the use of water carts/trucks). Other controls that would be undertaken include:

- modifying working practices by limiting excavation during periods of high winds; and
- limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.

Access Road/Service Corridor

The use of earth moving equipment can be a significant source of dust, and emissions would be controlled through the use of water sprays. Where conditions are excessively dusty and windy, work practices would be modified by limiting scraper/grader activity.

Haulage, Heavy Plant and Equipment

Vehicles travelling over paved or unpaved surfaces tend to produce wheel generated dust. The following measures would be implemented during construction to minimise dust emissions from these activities:

- all vehicles on-site would be confined to designated routes with speed limits enforced;
- trips and trip distances would be controlled and reduced where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips; and
- when conditions are excessively dusty and windy, a water cart/truck (for water spraying of travel routes) would be used.

Wind Erosion

Wind erosion from exposed surfaces during construction would be controlled as part of the best practice environmental management of the site. Wind erosion from exposed ground would be limited by avoiding unnecessary vegetation clearing and by progressively rehabilitating exposed areas as quickly as possible (e.g. through the use of a cover crop). Wind erosion from temporary stockpiles would be limited by minimising the number of stockpiles on-site and minimising the number of work faces on stockpiles.

8.21 Blast Fume Emissions

Blasting activities have the potential to result in fugitive fume and particulate matter emissions. Particulate matter emissions from blasting are included in dispersion modelling results and are controlled by adequate stemming of the blast.

Imperfect blasts (e.g. when the explosive product is incorrectly formulated) may result in nitrogen oxide (NO_x) fumes (**Australian Explosives Industry and Safety Group Inc., 2011**). Measures to minimise or avoid imperfect blasts would be implemented in accordance with *Code of Good Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (**Australian Explosives Industry and Safety Group Inc., 2011**), and these measures would be incorporated into the Project Blast Management Plan.

Fumes from blasting would be managed in accordance with *Code of Good Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (**Australian Explosives Industry and Safety Group Inc., 2011**). Measures that would be implemented include:

- Conduct of a risk assessment prior to blasting, which would review factors such as:
  - geological conditions;
  - ground conditions (e.g. presence of clay or loose/broken ground or heavy rain affected ground);
  - location of the blast relative to previous blasts which may have triggered fume events;
  - blasting product selection; and
  - presence of groundwater.
- Based on the outcomes of the risk assessment, the blasting method would be altered including consideration of the following:
  - minimising the time between drilling and loading, and loading and shooting of the blast; and
  - formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fumes.

8.22 Spontaneous Combustion

Spontaneous combustion events have the potential to give rise to odour emissions. Based on experience from previous mining in the Project area (i.e. the Canyon Coal Mine), Whitehaven does not expect spontaneous combustion events to occur for the Project.

Notwithstanding the above, the potential for spontaneous combustion events can be reduced by the following management measures:

- identification of potential self-heating coal seams as part of coal quality assessment;
- separation of self-heating seams from other coal seams; and
- placement of inert material over areas where known self-heating seams would otherwise be permanently exposed.

8.23 Potential Effects of Dust on Agricultural Production

The potential effects of coal dust on agricultural production have been the subject of previous study (**Andrews and Skriskandarajah, 1992** in **Connell Hatch, 2008**).

This study found that:

- Cattle did not find feed unpalatable if coal mine dust was present at a dust deposition level of 4,000 milligrams per square metre per day (mg/m^2/day) (equivalent to a dust deposition level of approximately 120 g/m^2/month).
- The presence of coal mine dust in feed did not affect the amount of feed that the cattle ate or the amount of milk that the cattle produced at a level equivalent to a dust deposition level of 4,000 mg/m^2/day.
- Cattle did not preferentially eat feed that did not contain coal mine dust. The cattle were able to choose between feed that was free of coal mine dust, feed that contained 4,000 mg/m2/day of coal mine dust and feed that contained 8,000 mg/m^2/day of coal mine dust.

Given that predicted Project dust deposition levels are far lower at nearby properties that those detailed in (**Andrews and Skriskandarajah, 1992** in **Connell Hatch, 2008**), effects of Project-related dust on agricultural production are expected to be minimal.

8.24 Emissions from Coal Transport

Dust emissions from transportation of crushed ROM coal to the Whitehaven CHPP was included up to the site boundary. The on-highway trucks used for transportation of ROM coal to the Whitehaven CHPP would be covered to minimise potential dust emissions, and would travel along sealed roads. Consequently, dust emissions would be negligible with these controls in place.

At the Whitehaven CHPP, the sized ROM coal would continue to be either directly loaded onto trains (i.e. bypass) or crushed, screened and washed before being loaded onto trains for rail transport to the Port of Newcastle and export markets.

Sized ROM coal from the Tarrawonga Coal Mine is currently processed and loaded onto trains at the Whitehaven CHPP. As described in the Tarrawonga Coal Project Environmental Assessment, ROM coal from the Tarrawonga Coal Mine would be transported to the Boggabri Coal Mine Infrastructure Facilities, where it would be processed and loaded onto trains for transport to the Port of Newcastle. There would be no increase in approved rail movements from the Whitehaven CHPP due to the Project.

Fugitive dust from coal train wagons has recently been studied extensively in Queensland. Queensland Rail (QR) commissioned an environmental evaluation of coal dust emissions from rolling stock in the Central Queensland Coal Industry (**Connell Hatch, 2008**). The purpose of this study was to determine the extent of the issue and identify any potential environmental harm caused by fugitive dust from coal wagons, in the context of nuisance and health impacts and to identify the potential reasonable and feasible measures that could reduce any environmental harm.

In terms of impacts on human health, the QR study concluded that there appears to be minimal risk of adverse impacts due to fugitive coal emissions from trains throughout the network, based on results of monitoring and modelling predictions (**Connell Hatch, 2008**). In terms of impacts on amenity, the results of monitoring and modelling indicate that fugitive coal dust at the edge of the rail corridor are below levels that are known to cause adverse impacts on amenity (**Connell Hatch, 2008**).

PAEHolmes has reviewed the QR study to determine if the conclusions presented are applicable to NSW based on, for example, differences in coal volumes, loading practices, train speeds, wagon shapes and coal properties. It was concluded that many of the observations from the QR study can be applied to the NSW network.

On this basis, consistent with **Connell Hatch (2008)**, the potential for exceedances of OEH air quality criteria caused by the increased coal train movements from the Project is likely to be low, in terms of health and amenity impacts, beyond distances of approximately 15 m from the rail lines.

The Australian Rail Track Corporation Limited (ARTC) is the relevant entity responsible for off-site rail emissions. The ARTC's Environment Protection License (3142) contains a Pollution Reduction Program (PRP) entitled "PRP 4 Particulate Emissions from Coal Trains". This PRP includes a requirement for a pilot monitoring program to determine PM_{10} and $PM_{2.5}$ concentrations in the vicinity of the Main Northern Railway (in the lower Hunter Valley). The objective of the PRP is to determine whether loaded coal trains are a source of Particulate Matter emissions in close proximity to the rail line.

It is anticipated that this PRP would become the relevant avenue to address emissions from rail operations, including Project-related rail operations.

8.25 Dust from Local Unsealed Roads

Project-related and other mine-related traffic (e.g. employees) on unsealed local roads have the potential to elevate background particulate matter concentrations at receiver locations.

Whitehaven has entered agreed to a Community Enhancement Contribution with the Narrabri Shire Council, which specifically includes a funding contribution for the construction of sealed roads to the North of the Project for the benefit of local residents, with an emphasis on sealing Manila (Rangari) Road. This would result in reduced dust emissions from local travel on unsealed roads.

Whitehaven would instruct employees and delivery drivers to use sealed roads (i.e. in preference to unsealed roads) whenever possible. There would be no sized ROM coal haulage on unsealed roads.

In addition, the real-time monitoring and management systems for the Project (**Section 6.2**) would identify periods when background particulate matter levels are elevated, which would include contributions from unsealed local roads. Appropriate mitigation and response measures at the mine sites would be implemented to manage total particulate matter concentrations at receiver locations during periods of elevated background levels.

8.26 Contingency Project Development Schedule

Table 2.1 is the indicative mine schedule for the Project. It represents the base-case schedule for the construction and operation of the Project over the 30 year mine life. Whitehaven has also developed a contingency development schedule for the Project in order to accommodate possible changes in market conditions, and/or potential delays in the commissioning of the Boggabri and Tarrawonga coal processing and rail facilities.

The contingency Project development schedule involves reduced mining operations (i.e. 2 Mtpa ROM coal production or less) using a reduced fleet (i.e. approximately 40% of the fleet required for maximum production).

In addition, ROM coal from the Project would be temporarily transported to the existing Vickery infrastructure area (**Figure 2.2**), and not the Project Mine Infrastructure Area. The existing infrastructure area would be upgraded to include ROM coal crushing and screening facilities (operating during the daytime only), a truck loadout facility and associated mining and water management infrastructure.

Particulate matter emissions associated with the contingency Project development schedule would be lower than those predicted for the base-case Project, as on a year-by-year basis the contingency Project development schedule represents:

- a lower rate of ROM coal extraction and an associated reduction in haulage and ROM coal crushing/screening;
- a lower rate of waste rock removal and associated reduction in haulage;
- reduced haulage distances from the open cut to waste emplacement and infrastructure area; and
- reduced fleet (e.g. dozers).

As such, the potential impacts associated with the contingency Project development schedule would be less than those predicted for the base-case Project.

No exceedances of relevant air quality criteria are predicted at privately-owned receivers due to the base-case Project (**Sections 8.2** to **8.19**). Therefore, no exceedances of relevant air quality criteria are expected at privately-owned receivers for the contingency Project development schedule.

Notwithstanding the above, the dust controls and management measures proposed for the base-case Project (**Section 6**) would be implemented for the contingency Project development schedule.

9 GREENHOUSE GAS ASSESSMENT

The DGR's identified GHG as an issue requiring assessment. The DGRs for GHG assessment require:

- quantitative assessment of the potential scope 1, 2 and 3 GHG emissions;
- qualitative assessment of the potential impacts of these emissions on the environment; and
- an assessment of the reasonable and feasible measures to minimise the GHG emissions and ensure energy efficiency.

This GHG assessment has been prepared in accordance with these requirements.

9.1 Introduction

GHGs have been estimated based upon the methods outlined in the following documents:

- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) *Greenhouse Gas Protocol The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (**WRI/WBCSD, 2004**);
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*; and
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts (NGA) Factors 2011* (**DCCEE, 2011**).

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. The GHG Protocol has been adopted by the International Standard Organisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project) and is compatible with existing GHG trading schemes.

Three 'scopes' of emissions (scope 1, scope 2 and scope 3) are defined for GHG accounting and reporting purposes, as described below. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment.

The 'scope' of an emission is relative to the reporting entity. Indirect scope 2 and scope 3 emissions would be reportable as direct scope 1 emissions from another facility.

1) Scope 1: Direct Greenhouse Gas Emissions

Direct GHG emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct GHG emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources, the principal source of GHG emissions associated with the operation of the Project.
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, etc.).
- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).

- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; CH4 emissions from coal mines and venting); hydroflurocarbon emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

2) Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that account for GHG emissions from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity.

Scope 2 in relation to coal mines typically covers purchased electricity, defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity.

3) Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

In the case of the Project, scope 3 emissions would include emissions associated with the extraction, processing and transport of diesel, and the transportation and combustion of product coal. The GHG Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with scope 1 and scope 2. However, the GHG Protocol notes that reporting scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary.

Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG Protocol also recognises that compliance regimes are more likely to focus on the “point of release” of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.

9.2 Greenhouse Gas Emission Estimates

Emissions of CO_2 and CH_4 would be the most significant GHGs for the Project. These gases are formed and released during the combustion of fuels used on-site and from fugitive emissions occurring during the mining process, due to the liberation of CH_4 from coal seams.

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. The estimated emissions are referred to in terms of CO_2-equivalent (CO_2-e) emissions by applying the relevant global warming potential. The GHG assessment has been conducted using the NGA Factors, published by the **DCCEE (2011)**.

Project-related GHG sources included in the assessment are as follows:

- Fuel consumption during mining operations – scope 1.
- Release of fugitive CH4 during mining – scope 1.
- Emissions associated with use of explosives in blasting – scope 1.
- Emissions associated with vegetation clearing – scope 1.
- Emissions associated with the generation of electricity purchased for use at the Project – scope 2.
- Emissions from the transport of ROM coal to the Whitehaven CHPP – scope 3.
- Emissions from the processing of ROM coal (undertaken at Whitehaven CHPP) – scope 3.
- Emissions from the transportation of product coal vial rail to the Port of Newcastle – scope 3.
- Emissions from the use of the product coal – scope 3.

A summary of the annual GHG emissions is provided in **Table 9.1**. Detailed emission calculations are provided in **Appendix D**.

Emissions from the shipping of product coal are not included in this assessment due to the uncertainties in emission estimates, including uncertainty in future export destinations and limited data on emission factors and/or fuel consumption for ocean going vessels.

Table 9.1: Summary of Estimated CO_2-e (tonnes) – All Scopes

	Scope 1 Emissions ($t CO_{2-e}$)					Scope 2 Emissions ($t CO_{2-e}$)	Scope 3 Emissions ($t CO_{2-e}$)					
Year	**Diesel**	**Coal Seam Methane**	**Blasting**	**Vegetation Clearing[1]**	***Total***	**Electricity -Project**	**Diesel**	**Electricity - CHPP**	**Electricity - Project**	**Coal Burning**	**Transport**	***Total***
1	40,884	0	5,015	11,659	*57,558*	7,803	3,118	0	1,490	0	0	*3,118*
2	89,540	1,259	5,015	11,659	*107,473*	7,803	6,828	2,613	1,490	3,060,676	11,241	*3,079,164*
3	112,165	3,299	5,015	11,659	*132,138*	19,766	8,554	6,848	3,776	8,021,082	29,430	*8,060,163*
4	122,961	3,560	5,015	11,659	*143,195*	21,326	9,377	7,388	4,074	8,654,325	31,753	*8,696,640*
5	123,627	3,560	5,015	11,659	*143,861*	21,326	9,428	7,388	4,074	8,654,325	31,753	*8,696,691*
6	123,742	3,646	5,015	11,659	*144,062*	21,847	9,436	7,568	4,173	8,865,406	32,528	*8,908,584*
7	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
8	124,107	3,907	5,015	11,659	*144,688*	23,407	9,464	8,109	4,471	9,498,649	34,851	*9,544,265*
9	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
10	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
11	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
12	124,107	3,907	5,015	11,659	*144,688*	23,407	9,464	8,109	4,471	9,498,649	34,851	*9,544,265*
13	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
14	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
15	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
16	124,107	3,907	5,015	11,659	*144,688*	23,407	9,464	8,109	4,471	9,498,649	34,851	*9,544,265*
17	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
18	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
19	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
20	124,107	3,907	5,015	11,659	*144,688*	23,407	9,464	8,109	4,471	9,498,649	34,851	*9,544,265*
21	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
22	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
23	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
24	124,108	3,907	5,015	11,659	*144,689*	23,407	9,464	8,109	4,471	9,498,649	34,851	*9,544,265*
25	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
26	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
27	124,096	3,907	5,015	11,659	*144,677*	23,407	9,463	8,109	4,471	9,498,649	34,851	*9,544,264*
28	95,118	3,907	5,015	11,659	*115,699*	23,407	7,254	8,109	4,471	9,498,649	34,851	*9,542,054*
29	95,107	3,907	5,015	11,659	*115,688*	23,407	7,253	8,109	4,471	9,498,649	34,851	*9,542,053*
30	95,107	3,907	5,015	11,659	*115,688*	23,407	7,253	8,109	4,471	9,498,649	34,851	*9,542,053*
Total	**3,504,331**	**109,088**	**150,450**	**349,773**	***4,113,642***	**661,638**	**267,237**	**226,421**	**126,380**	**265,223,396**	**973,126**	***266,816,560***

[1] Annual average vegetation clearance taken as total emissions divided by 30 years.
Note: Totals may differ to the sum of the columns due to rounding and significant figures.
$t CO_2$-e = tonnes of CO_2-e

9.3 Greenhouse Gas Emissions Intensity

The estimated GHG emissions intensity of the Project is approximately 0.03 tonnes CO_2-e per tonne of saleable coal (t CO_2-e/t) (this includes all scope 1 emissions) (**Figure 9.1**), which places the Project emissions in line with the average emissions for Australian open cut mines as reported in **Deslandes, 1999**.

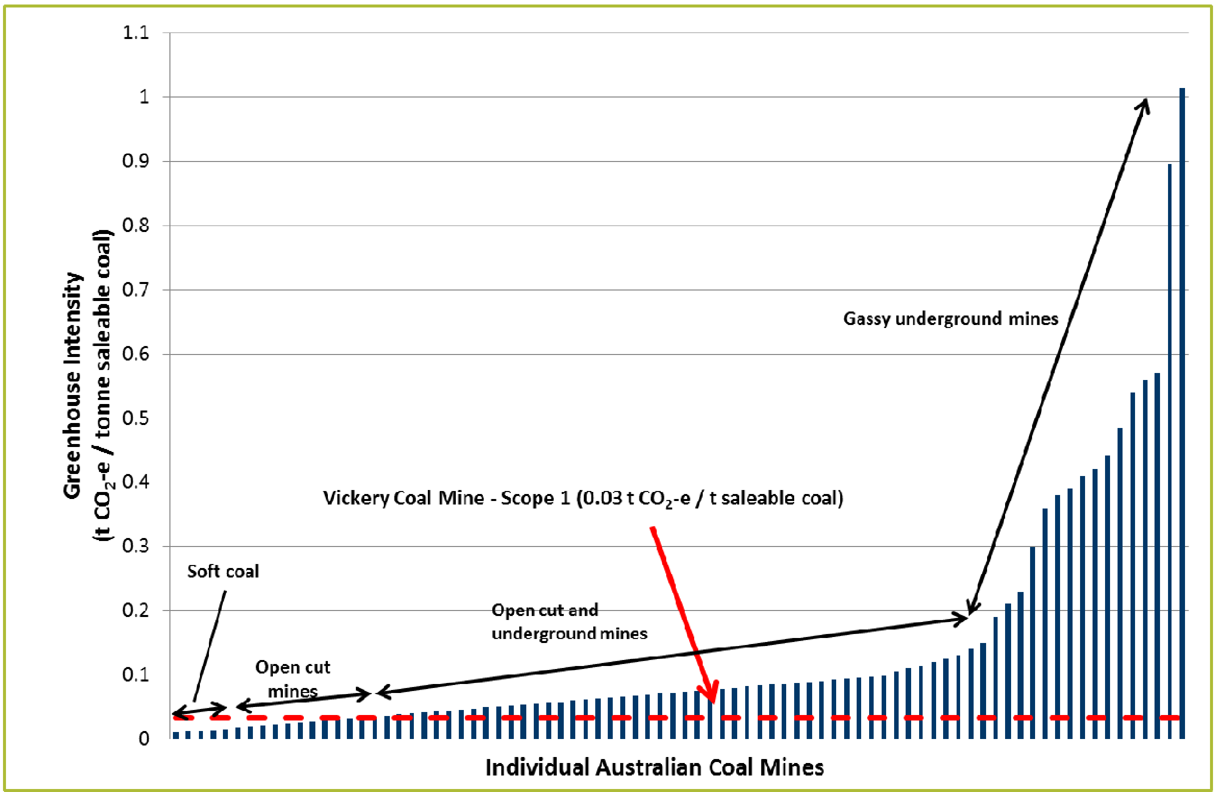


Figure 9.1: Greenhouse Gas Intensity Comparison

9.4 Impact on the Environment

According to the Intergovernmental Panel of Climate Change's (IPCC) Fourth Assessment Report, global surface temperature has increased 0.74 ± 0.18°C during the 100 years ending 2005 (**IPCC, 2007a**). The IPCC has determined "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations". "Very likely" is defined by the IPCC as greater than 90% probability of occurrence (**IPCC, 2007b**).

Climate change projections specific to Australia have been determined by the CSIRO, based on the following global emissions scenarios predicted by the IPCC (**CSIRO, 2007**):

- A1F1 (high emissions scenario) – assumes very rapid economic growth, a global population that peaks in mid-century and technological change that is fossil fuel intensive.
- A1B (mid emissions scenario) – assumes the same economic and population growth as A1F1, with a balance between fossil and non-fossil fuel intensive technological changes.
- B1 (low emissions scenario) – assumes the same economic and population growth as A1F1, with a rapid change towards clean and resource efficient technologies.

For the global emissions scenarios described above, the projected changes in annual temperature relative to 1990 levels for Australian cities for 2030 and 2070 are presented in **Table 9.2**, as determined by the **CSIRO (2007)**. The towns/cities presented in **Table 9.2** are those closest to the VCM for which results are available.

Table 9.2: Projected Changes in Annual Temperature (relative to 1990)

Location	2030 - A1B (mid-range emissions scenario)	2070 - B1 (low emissions scenario)	2070 - A1F1 (high emissions scenario)
		Temperature (°C)	
Brisbane	0.7 - 1.4	1.1 - 2.3	2.1 - 4.4
Dubbo	0.7 - 1.5	1.2 - 2.5	2.2 - 4.8
St George (Queensland)	0.7 - 1.6	1.2 - 2.7	2.4 - 5.2
Sydney	0.6 - 1.3	1.1 - 2.2	2.1 - 4.3

Notes: Range of values represents the 10^{th} and 90^{th} percentile results.
For 2030, only A1B results are shown as there is little variation in projected results for the global emission scenarios A1B, B1 and A1F1 (**CSIRO, 2007**).

Source: **CSIRO (2007)**

The CSIRO also details projected changes to other meteorological parameters (e.g. rainfall, potential evaporation, wind speed, relative humidity and solar radiation) and the predicted changes to the prevalence of extreme weather events (for example droughts, bush fires and cyclones).

The potential social and economic impacts of climate change to Australia are detailed in *The Garnaut Climate Change Review* (**Garnaut, 2008**), which draws on IPCC assessment work and the CSIRO climate projections. The Garnaut review details the negative and positive impacts associated with predicted climate change with respect to:

- agricultural productivity;
- water supply infrastructure;
- urban water supplies;
- buildings in coastal settlements;
- temperature related deaths;
- ecosystems and biodiversity; and
- geopolitical stability and the Asia-Pacific region.

The Project's contribution to projected climate change, and the associated impacts, would be in proportion with its contribution to global GHG emissions. Average annual scope 1 emissions from the Project (0.1 Mt CO_2-e) would represent approximately 0.02% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) and a very small portion of global GHG emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 **(Commonwealth of Australia, 2011)**.

A comparison of predicted annual GHG emissions from the Project with global, Australian and NSW emissions inventories are presented in **Table 9.3**.

Table 9.3: Comparison of Greenhouse Gas Emissions

Geographic coverage	Source coverage	Timescale	Emission Mt CO_2-e	Reference
Project	Scope 1 only	Average annual	0.1	This report.
Global	Consumption of fossil fuels	Total since industrialisation 1750 - 1994	865,000	**IPCC (2007a).** Figure 7.3 converted from Carbon unit basis to CO_2 basis. Error is stated greater than ±20%.
Global	CO_2-e emissions	2005	35,000	Based on Australia representing 1.5% of global emissions **(Commonwealth of Australia, 2011)**. Australian National Greenhouse Gas Inventory (2005) taken from http://www.ageis.greenhouse.gov.au/
Global	CO_2-e emission increase 2004 to 2005	2005	733	**IPCC (2007a).** From tabulated data presented in Table 7.1 on the basis of an additional 733 Mtpa. Data converted from Carbon unit basis to CO_2 basis.
Australia	1990 Base	1990	547.7	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
Australia	Kyoto target	Average annual 2008 - 2012	591.5	Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target.
Australia	Total	2009	564.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
NSW	Total	2009	160.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/

The commitment from the Australian Government to reduce GHG emissions is proposed to be achieved through the introduction of the Australian Government's proposed carbon pricing mechanisms. From 1 July 2012, this involves a fixed price on GHG emissions, with no cap on Australia's GHG emissions, or emissions from individual facilities **(Commonwealth of Australia, 2011)**. Similarly, the Federal Opposition has committed to a 5% reduction below 1990 levels by 2020 in its *Direct Action Plan* **(Liberal Party of Australia, 2010)**.

From 1 July 2015 an emissions trading scheme is proposed to be implemented. As such, Australia's GHG emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Australian Government. Under the emissions trading scheme, there would specifically be no limit on the level of GHG emissions from individual facilities, with the incentive for facilities to reduce their GHG emissions driven by the carbon pricing mechanism **(Commonwealth of Australia, 2011)**.

It is expected that the Project would participate in the carbon pricing mechanisms, and as such scope 1 GHG emissions from the Project would be subject to carbon pricing mechanisms. As such, Whitehaven would directly contribute to the revenue generated by the carbon pricing mechanisms, which is to be used to fund the following initiatives designed to reduce Australia's GHG emissions **(Commonwealth of Australia, 2011)**:

- $1.2 billion Clean Technology Programme to improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies.
- $10 billion Clean Energy Finance Corporation to invest in renewable energy, low-pollution and energy efficiency technologies.
- $946 million Biodiversity Fund (over the first six years) to protect biodiverse carbon stores and secure environmental outcomes from carbon farming.

In addition to contributing to these initiatives, Whitehaven would implement Project-specific GHG mitigation measures, as described in **Section 9.5**.

9.5 Greenhouse Gas Management

The potential for reducing GHG emissions at the Project is related predominantly to consumption of diesel use by plant and equipment. Methods would be put in place to maximise efficiency from the mining fleet through regular maintenance scheduling and, where possible, minimising the gradient and length of loaded haul runs for the operating dump trucks. This would be achieved by appropriate mine scheduling and planning.

Ongoing monitoring and management of GHG emissions and energy consumption for the Project would be achieved through Whitehaven's participation in the Commonwealth Government's National Greenhouse and Energy Report System (NGERS). Under NGERS requirements, relevant sources of GHG emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified.

Whitehaven is also a participant in the Commonwealth Government's Energy Efficiency Opportunities Program. As such, Whitehaven would assess energy usage from all aspects of its operations, including the Project, and publicly report the results of energy efficiency assessments, and the opportunities that exist for energy efficiency projects with a financial payback of up to four years.

10 CONCLUSION

Dispersion modelling has been used to predict off-site dust concentration and deposition levels due to the activities that would occur as a result the Project. Emissions inventories were developed for Years 2, 7, 17 and 26 of the Project. The dispersion conditions in the vicinity of the Project were characterised based on regional and local meteorological data, generated using a diagnostic meteorological modelling system known as CALMET. The annual winds predicted by CALMET correlate with the windroses presented for on-site data. CALPUFF was used to predict the maximum 24-hour average PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition.

EPA assessment criteria are generally based on thresholds relating to human health effects. These criteria have been developed to a large extent in urban areas, where the primary pollutants are the products of combustion, which are more harmful to human health than particulates of crustal origin, such as dust from mining operations.

Detailed modelling was conducted to assess whether the proposed mining operations of the Project would adversely impact any privately owned or mine-owned receivers located in the vicinity of the Project. The assessment included predictions of air quality impacts from the Project in isolation as well as the potential cumulative impacts of other neighbouring mines and other cumulative sources.

There are no privately-owned receivers predicted to experience annual average PM_{10} concentrations, TSP concentrations or dust deposition levels above the EPA assessment criteria due to the Project-only. Similarly, $PM_{2.5}$ concentrations were predicted to be below the relevant advisory reporting standards. There is one receiver (89b) predicted to experience 24-hour average PM_{10} concentrations above the EPA assessment criterion due to the Project-only. Whitehaven is intending to enter into a private agreement or purchase agreement with the landowner of receiver 89b.

Cumulative impacts were also considered, taking into account the approved Rocglen Extension Project, the Tarrawonga Coal Project, the Boggabri Coal Project as well as other non-mining sources. All annual averages were below the relevant criteria, including when accounting for background dust levels and concentrations.

A Monte Carlo Simulation was completed to assess cumulative PM_{10} 24-hour impacts at the most affected receiver locations. The analysis included four representative private receivers (88, 89b, 127b and 127c) and one Whitehaven owned receiver (1ad) and predicted that the nearest receivers may exceed the EPA criterion of 50 $\mu g/m^3$ between three to eight days per year. It is noted that due to background alone, the criterion is predicted to be exceeded on approximately two days per year. Background concentrations accounted for the major contribution to total predicted PM_{10} concentrations. The real time monitoring and predictive forecasting system for the Project would be designed to manage potential 24-hour impacts associated with the Project.

No privately-owned vacant property is predicted to exceed the 24-hour PM_{10} criterion over greater than 25% of its area.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the inherent conservative nature of dispersion modelling. As a result, it is expected that actual ground level concentrations would be lower during the normal operation of the Project. Notwithstanding, it is proposed that the emissions would be managed day-to-day using a best practice real-time dust management system.

The potential GHG emissions that are likely to occur as a result of the operation of the Project have been estimated based on an inventory for each year of the Project's life. On average, Scope 1 emissions from the Project represent 0.02% of Australia's Kyoto commitment.

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APPENDIX A - MODEL SET UP

Model Set Up

TAPM (v 4.0.4)	
Number of grids (spacing)	3 (30 km, 10 km, 3 km)
Number of grid points	40 x 40 x 35
Year of analysis	March 2011 to February 2012
Centre of analysis (local co-ordinates)	233896, 6593092
CALMET (v. 6.333) Outer Grid	
Meteorological grid domain	90 km x 90 km
Meteorological grid resolution	2 km
Input data	Prognostic 3D.dat extracted from TAPM at 3 km grid
Surface meteorological stations	Tarrawonga AWS - Wind speed - Wind direction - Temperature Narrabri AWS (Bureau of Meteorology, Station No. 54038) - Wind speed - Wind direction - Temperature - Relative humidity - Sea level pressure Gunnedah AWS (Bureau of Meteorology, Station No. 55202) - Wind speed - Wind direction - Temperature - Relative humidity - Sea level pressure Tamworth AWS (Bureau of Meteorology, Station No.55325) - Wind speed - Wind direction - Temperature - Cloud height - Cloud cover - Relative humidity - Sea level pressure
CALMET (v. 6.333) Inner Grid	
Meteorological grid domain	14 km x 20 km
Meteorological grid resolution	0.2 km
Input data	Outer CALMET grid
Surface meteorological stations	Vickery South AWS - Wind speed - Wind direction - Temperature Rocglen AWS - Wind speed - Wind direction - Temperature Tamworth AWS (Bureau of Meteorology, Station No.55325) - Wind speed - Wind direction - Temperature - Cloud height - Cloud cover - Relative humidity - Sea level pressure

TAPM = The Air Pollution Model
km = kilometres
3D = three-dimensional
AWS = Automatic Weather Station

CALMET Model Options used – Inner Grid

Flag	Descriptor	Default	Value Used
IEXTRP	Extrapolate surface wind observations to upper layers	Similarity theory	Similarity theory
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations versus upper air data	NZ * 0	-1 for first layer, -0.5 for second layer, for all other layers
TERRAD	Radius of influence of terrain	No default (typically 5- 15km)	4 km (reduced to account for local terrain influence)
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	2 km
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	1 km

CALPUFF Model Options used

Flag	Flag Descriptor	Value Used	Value Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Briggs plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion Coefficients	2	Based on micrometeorology
MPDF	Probability density function used for dispersion under convective conditions	0	No
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	1	ISC method

APPENDIX B - ESTIMATION OF DUST EMISSIONS

Vickery Coal Project

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by Whitehaven.

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below. Activities have generally been modelled for 24-hours per day, with the exception of equipment items on rehabilitation which was modelled from 7.00 am to 6.00 pm.

Dust from wind erosion is assumed to occur over 24-hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This would mean that most wind erosion occurs during the day when wind speeds are highest.

For each stage of the mine shown in **Figures B1** to **B4**, a corresponding emissions inventory has been developed. The modelled scenarios are considered to be representative of worst-case operations e.g. where coal and waste rock production is highest, where extraction or wind erosion areas are largest or where operations are located closest to receivers.

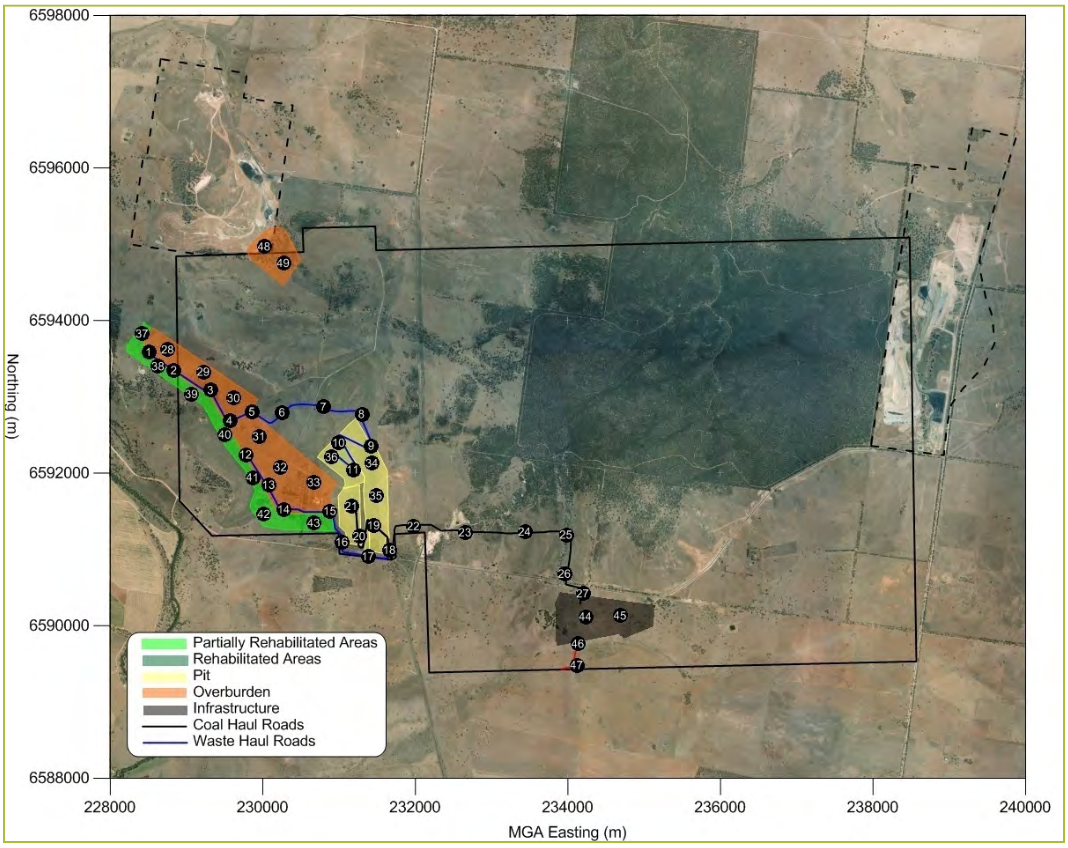


Figure B1: Location of Sources for Year 2

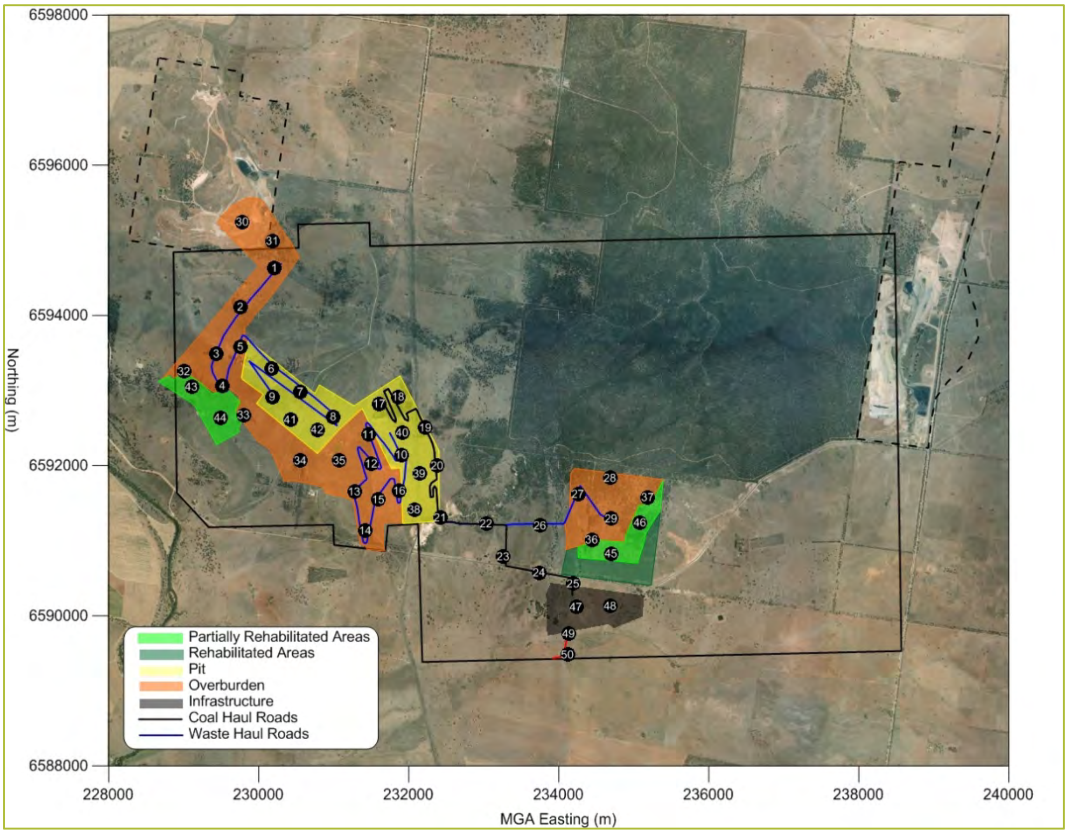


Figure B2: Location of Sources for Year 7

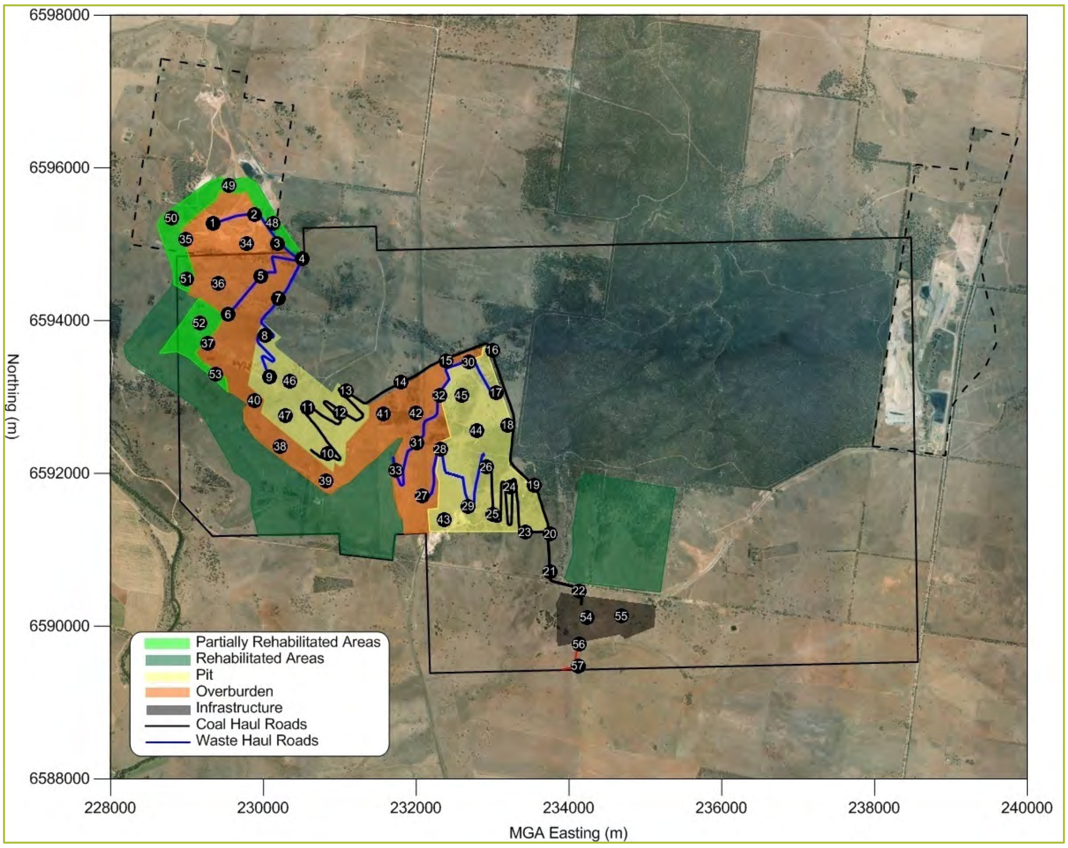


Figure B3: Location of Sources for Year 17

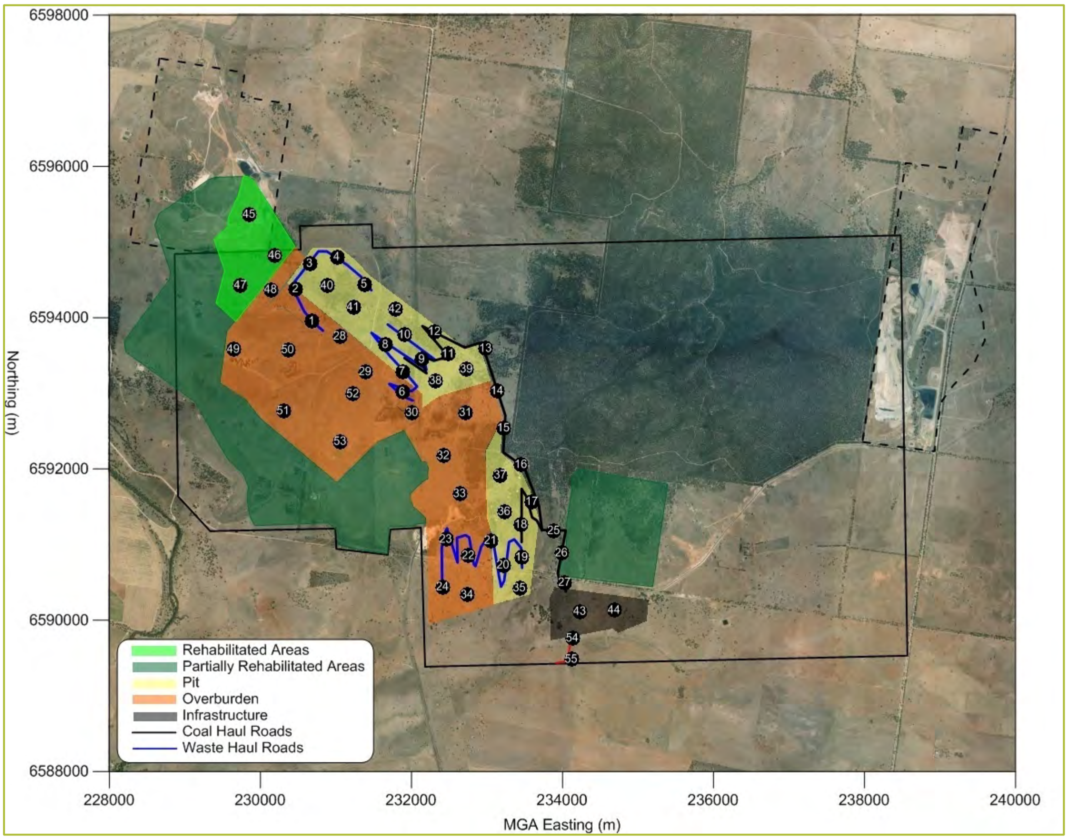


Figure B4: Location of Sources for Year 26

Blasting overburden and coal

TSP emissions from blasting were estimated using the **US EPA (1985 and updates)** emission factor equation given in **Equation 1**.

Equation 1

$$E_{TSP} = 0.00022 \times A^{1.5}\ (kg|blast)$$

where,

E_{TSP} = TSP emissions
A = area to be blasted in m^2

The scaling factor of 0.52 for PM_{10} and 0.03 for $PM_{2.5}$ was applied to the TSP emission factor (**US EPA, 1985 and updates**). The area blasted for each scenario is 6,000 m^2.

Drilling overburden and coal

The emission factor used for drilling has been taken to be 0.59 kg/hole for TSP (**US EPA, 1985 and updates**). There are no emission factors for drilling for PM_{10} and $PM_{2.5}$. Therefore, the scaling factor for blasting for PM_{10} (0.52) and $PM_{2.5}$ (0.03) was applied to the TSP emission factor.

Loading material /transfer material dumping overburden

Each tonne of material loaded would generate a quantity of TSP that would depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

$$E = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) (kg|t)$$

Where,

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

U – wind speed (m/s)

M – moisture content (%)

The mean wind speed has been taken to be approximately 2.8 m/s (from CALMET) and a moisture content of 2.5%.

Hauling material/product on unsealed surfaces

The emission estimate of wheel generated dust presented in the EIS is based the US EPA AP42 emission factor for unpaved surfaces at industrial sites shown in **Equation 3**.

Equation 3

$$E = 0.2819 \times \left[k \times \left(\frac{s}{12}\right)^a \times \left(\frac{W \times 1.1023}{3}\right)^b \right] (kg|VKT)$$

Where:

k = 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$

a = 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

b = 0.45 for TSP, PM_{10} and $PM_{2.5}$

s = silt content of road surface (%)

W = mean vehicle weight (t)

The adopted silt content (s) was 2%. This is consistent with testing done at multiple mines sites in the Hunter Valley which measured average haul road silt contents of 2-3%, for a current ACARP project. The mean vehicle weight used in the emissions estimates is an average of the loaded and unloaded gross vehicle mass, to account for one empty trip and one loaded trip.

	Capacity	Full (GVM)	Empty	For Inventory
OB trucks (t) – CAT793	240	357	117	237
OB and CL trucks (t) - CAT785	195	294	99	197

Dozers working on overburden

Emissions from dozers on waste have been calculated using the US EPA emission factor equation given in **Equation 4** (**US EPA, 1985 and updates**).

Equation 4

$$E = k \times \frac{s^a}{M^b} (kg/hr)$$

Where:

k = 2.6 for TSP, 0.3375 for PM_{10} and 0.273 for $PM_{2.5}$

a = 1.2 for TSP and $PM_{2.5}$ and 1.5 for PM_{10}

b = 1.3 for TSP and $PM_{2.5}$ and 1.4 for PM_{10}

s = silt content (assumed to be 10%)

M = moisture content (assumed to be 2%).

The silt content of the overburden was assumed to be 10%, and the moisture content 2.5%.

Crushing of Gravel

The emission factor used for tertiary crushing of gravel has been taken to be 0.0027 kg/t for TSP and 0.0012 kg/t for PM_{10} (**US EPA, 1985 and updates**). There is no $PM_{2.5}$ emission factor for crushing. $PM_{2.5}$ emissions from crushing of gravel are expected to be minimal and therefore it was to be negligible for the inventory.

Dozers working on coal

The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 5**.

Equation 5

$$E = k \times \frac{s^a}{M^b} (kg/hr)$$

Where,

k = 35.6 for TSP, 6.33 for PM_{10} and 0.7832 for $PM_{2.5}$

a = 1.2 for TSP and $PM_{2.5}$ and 1.5 for PM_{10}

b = 1.3 for TSP and $PM_{2.5}$ and 1.4 for PM_{10}

s = silt content (assumed to be 10%)

M = moisture content (assumed to be 2%).

The silt content of the coal was assumed to be 10%, and the moisture content 8%.

Loading/unloading coal

The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 6**.

Equation 6

$$E = \frac{k}{M^a}(kg|t)$$

Where,

k = 0.58 for TSP, 0.0447 for PM_{10} and 0.01102 for $PM_{2.5}$

a = 1.2 for TSP and $PM_{2.5}$ and 0.9 for PM_{10}

M = moisture content (%)

The moisture content of the coal was assumed to be 8%.

Hauling product on sealed surfaces

The emission estimate of wheel generated dust is based the US EPA AP42 emission factor for dry paved surfaces is shown in **Equation 7**.

Equation 7

$$E = k \times \left(\frac{s}{2}\right)^{0.65} \times \left(\frac{W \times 1.1023}{3}\right)^{1.5} - C\ (kg|VKT)$$

Where:

K = 24 for TSP, 4.6 for PM_{10} and 1.1 for $PM_{2.5}$

C = 0.1317 for TSP and PM_{10} and 0.1005 for $PM_{2.5}$

s = silt loading of surface (g/m^2)

W = mean vehicle weight (t)

The silt loading content of the paved road was assumed to be 0.6 g/m^2 for average daily traffic of <500 vehicles.

Wind erosion

The **US EPA (1985 and updates)** emission factor equation has been used for wind erosion. It is given below in **Equation 8**.

Equation 8

$$E_{TSP}\ (kg/ha/hr) = 1.8\ x\ U$$

Where:

U= mean wind speed (m/s) and is taken as 2.7 m/s from the Vickery South meteorological site.

For PM_{10} this is multiplied by a factor of 0.5 and for 0.075 for $PM_{2.5}$.

Grading roads

Estimates of TSP emissions from grading roads have been made using the **US EPA (1985 and updates)** emission factor equation (**Equation 9**).

Equation 9

$$E = k \times S^a$$

where,

k = 0.0034 for TSP, 0.00336 for PM_{10} and 0.000105 for $PM_{2.5}$

a = 2.5 for TSP and $PM_{2.5}$ and 2 for PM_{10}

S = speed of the grader in km/h (taken to be 8 km/h)

The following tables present the calculated emissions for Y2, Y7, Y17 and Y26 which correspond to the sources allocations as represented in **Figures B1** to **B4**.

The abbreviations used in the tables are as follows:

- OB - overburden related activities
- CL - coal related activities
- Rh – rehabilitation activities
- WE - wind erosion emissions

Particle Size Categories

Emission rates of TSP, PM_{10} and $PM_{2.5}$ has been separately calculated using emission factors described above.

Modelling for PM_{10} and $PM_{2.5}$ was conducted according to the derived emission rate for PM_{10} and $PM_{2.5}$ and the relevant particle size fraction. Modelling for TSP was conducted according to the derived emission rate for TSP and then assumed to deposit from the plume in accordance with the deposition rate appropriate for the three particle size fractions shown below. Similarly dust deposition was modelled according to the TSP emissions and particle size fractions as shown below. The distribution of particles in each particle size range is outlined in **State Pollution Control Commission [1986]**, as follows:

- $PM_{2.5}$ (FP) is 0.0468 of the TSP.
- $PM_{2.5-10}$ (CM) is 0.3440 of TSP.
- PM_{10-30} (Rest) is 0.6090 of TSP.

Year 2 TSP Inventory

ACTIVITY	TSP emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling Pit	9,462	53,456	holes/y	0.59	kg/hole											70	% control
OB - Blasting Pit	8,627	84	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	634	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	48,468	57,500,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut to Main Emplacement	1,760,549	57,500,000	t/y	0.1225	kg/t	240	t/load	237	Vehicle gross mass (t)	10.0	km/return trip	2.94	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut to ROM pad for gravel	7,461	207,000	t/y	0.1442	kg/t	195	t/load	197	Vehicle gross mass (t)	10.4	km/return trip	2.70	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	48,468	57,500,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	177,693	14,191	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	266,540	21,287	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	249	207,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	207,000	t/y	0.0076	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.64	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	81,443	6,504	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (travel mode)	216,463	104,069	km/y	2.08	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	268,177	7,096	h/y	37.79	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks Pit	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut to ROM pad	54,065	1,500,000	t/y	0.144	kg/t	195	t/load	197	Vehicle gross mass (t)	10.40	km/return trip	2.70	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	50,224	1,500,000	t/y	0.048	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	1,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	1,500,000	t/y	0.0125	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	11,456	1,500,000	t/y	0.008	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.64	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	78,840	90	ha	0.10	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	132,977	152	ha	0.10	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (adverse weather)	27,071	31	ha	0.10	kg/ha/hr	8761	hrs										
WE - Partially Rehab Area - Western	569	65	ha	0.10	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	876	2	ha	0.10	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	42,574	2	ha	5	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	75,481	122,640	km/y	0.62	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 2 PM_{10} Inventory

ACTIVITY	PM10 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling Pit	4,920	53,456	holes/y	0.31	kg/hole											70	% control
OB - Blasting Pit	4,486	84	blasts/y	53	kg/blast	6,000	Area of blast in square metres	634	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks	22,924	57,500,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in	3	moisture content in %							30	% control
OB - Hauling OB from Open Cut to Main Emplacement	385,737	57,500,000	t/y	0	kg/t	231	t/load	228	Vehicle gross mass (t)	10.0	km/return trip	1	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut to ROM pad for gravel	1,596	207,000	t/y	0	kg/t	195	t/load	197	Vehicle gross mass (t)	10.4	km/return trip	1	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	22,924	57,500,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in	3	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	41,993	14,191	h/y	3	kg/h	10	% silt content	3	moisture content in %								% control
OB - Dozers on OB (on emplacement)	62,989	21,287	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	118	207,000	t/y	0.0006	kg/t	1.4	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	303	207,000	t/y	0.0015	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	19,247	6,504	h/y	3	kg/h	10	% silt content	3	moisture content in %								% control
Rh - Scrapers on partial rehab area (travel mode)	54,116	104,069	km/y	1	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	77,280	7,096	h/y	10.89	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks Pit	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut to ROM pad	11,566	1,500,000	t/y	0.031	kg/t	195	t/load	197	Vehicle gross mass (t)	10.4	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	7,223	1,500,000	t/y	0.007	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	1,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	1,500,000	t/y	0.0043	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	2,194	1,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	39,420	90	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	66,488	152	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (adverse weather)	13,534	31	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	285	65	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	438	2	ha	0.05	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	21,287	2	ha	2	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	26,373	122,640	km/y	0.22	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 2 $PM_{2.5}$ Inventory

ACTIVITY	PM2.5 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling Pit	284	53,456	holes/y	0.02	kg/hole											70	% control
OB - Blasting Pit	259	84	blasts/y	3	kg/blast	6,000	Area of blast in square metres	634	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	3,471	57,500,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in	3	moisture content in %							30	% control
OB - Hauling OB from Open Cut to Main Emplacement	37,663	57,500,000	t/y	0	kg/t	240	t/load	237	Vehicle gross mass (t)	10.0	km/return trip	0	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut to ROM pad for gravel	160	207,000	t/y	0	kg/t	195	t/load	197	Vehicle gross mass (t)	10.4	km/return trip	0	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	3,471	57,500,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in	3	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	18,658	14,191	h/y	1	kg/h	10	% silt content	3	moisture content in %								% control
OB - Dozers on OB (on emplacement)	27,987	21,287	h/y	1	kg/h	10	% silt content	3	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	-	207,000	t/y	-	kg/t												% control
OB - Loading crushed gravel to trucks	18	207,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	138	207,000	t/y	0.0007	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	8,551	6,504	h/y	1	kg/h	10	% silt content	3	moisture content in %								% control
Rh - Scrapers on partial rehab area (travel mode)	-	104,069	km/y	-	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	5,900	7,096	h/y	0.83	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks Pit	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut to ROM pad	1,157	1,500,000	t/y	0.003	kg/t	195	t/load	197	Vehicle gross mass (t)	10.40	km/return trip	0.06	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	954	1,500,000	t/y	0.0009	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	1,500,000	t/y	-	kg/t											100	% control
CL - Screening ROM	-	1,500,000	t/y	-	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	1,001	1,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	5,913	90	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	9,973	152	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (adverse weather)	2,030	31	ha	0.008	kg/ha/hr	8761	hrs										
WE - Partially Rehab Area - Western	43	65	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	66	2	ha	0.008	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	3,193	2	ha	0.4	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	2,340	122,640	km/y	0.02	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 7 TSP Inventory

ACTIVITY	TSP emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	6,308	35,637	holes/y	0.59	kg/hole											70	% control
OB - Blasting East Pit	10,122	99	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Drilling West Pit	3,154	17,819	holes/y	0.59	kg/hole											70	% control
OB - Blasting West Pit	5,061	50	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	56,870	67,466,667	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	28,435	33,733,333	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Main Emplacement	330,514	22,488,889	t/y	0.0588	kg/t	240	t/load	237	Vehicle gross mass (t)	4.8	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Eastern Emplacement	1,870,571	44,977,778	t/y	0.1664	kg/t	195	t/load	197	Vehicle gross mass (t)	12.0	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	8,322	207,000	t/y	0.1608	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	743,656	33,733,333	t/y	0.0882	kg/t	240	t/load	237	Vehicle gross mass (t)	7.2	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	37,913	44,977,778	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (Main)	47,391	56,222,222	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	444,233	35,478	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	355,386	28,382	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	249	207,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	207,000	t/y	0.0076	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.64	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	81,443	6,504	h/y	13	kg/h	10	% silt content	3	moisture content in %								% control
Rh - Scrapers on partial rehab area (eastern)	108,232	52,034	km/y	2	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
Rh - Scrapers on partial rehab area (western)	108,232	52,034	km/y	2	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	268,177	7,096	h/y	37.79	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	143,496	3,000,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	120,607	3,000,000	t/y	0.161	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	2.70	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	60,304	1,500,000	t/y	0.161	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	2.70	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	150,671	4,500,000	t/y	0.048	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0125	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	34,367	4,500,000	t/y	0.008	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.64	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	183,960	210	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (Main)	296,964	339	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (East)	82,081	94	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	362	41	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	323	37	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	876	2	ha	0.1	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	42,574	2	ha	4.9	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	75,481	122,640	km/y	0.62	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 7 PM_{10} Inventory

ACTIVITY	PM10 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	3,280	35,637	holes/y	0.31	kg/hole											70	% control
OB - Blasting East Pit	5,264	99	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Drilling West Pit	1,640	17,819	holes/y	0.31	kg/hole											70	% control
OB - Blasting West Pit	2,632	50	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	26,898	67,466,667	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	13,449	33,733,333	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Main Emplacement	70,706	22,488,889	t/y	0.0126	kg/t	240	t/load	237	Vehicle gross mass (t)	4.8	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Eastern Emplacement	400,165	44,977,778	t/y	0.0356	kg/t	195	t/load	197	Vehicle gross mass (t)	12	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	1,780	207,000	t/y	0.0344	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	159,088	33,733,333	t/y	0.0189	kg/t	240	t/load	237	Vehicle gross mass (t)	7.2	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	17,932	44,977,778	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (Main)	22,415	56,222,222	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	104,982	35,478	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	83,986	28,382	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	118	207,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	303	207,000	t/y	0.0015	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	19,247	6,504	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (eastern)	27,058	52,034	km/y	0.52	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
Rh - Scrapers on partial rehab area (western)	27,058	52,034	km/y	0.52	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	77,280	7,096	h/y	10.89	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	20,637	3,000,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	25,801	3,000,000	t/y	0.034	kg/t	195	t/load	197	Vehicle gross mass (t)	11.60	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	12,901	1,500,000	t/y	0.034	kg/t	195	t/load	197	Vehicle gross mass (t)	11.60	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	21,669	4,500,000	t/y	0.007	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0043	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	6,581	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	91,980	210	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (Main)	148,482	339	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (East)	41,041	94	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	181	41	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	161	37	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	438	2	ha	0.05	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	21,287	2	ha	2	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	26,373	122,640	km/y	0.22	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 7 $PM_{2.5}$ Inventory

ACTIVITY	PM2.5 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	189	35,637	holes/y	0.02	kg/hole											70	% control
OB - Blasting East Pit	304	99	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Drilling West Pit	95	17,819	holes/y	0.02	kg/hole											70	% control
OB - Blasting West Pit	152	50	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	360	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	4,073	67,466,667	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	2,037	33,733,333	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Main Emplacement	7,071	22,488,889	t/y	0.0013	kg/t	240	t/load	237	Vehicle gross mass (t)	4.8	km/return tri	0.063	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Eastern Emplacement	40,017	44,977,778	t/y	0.0036	kg/t	195	t/load	197	Vehicle gross mass (t)	12	km/return tri	0.058	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	178	207,000	t/y	0.0034	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return tri	0.058	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	15,909	33,733,333	t/y	0.0019	kg/t	240	t/load	237	Vehicle gross mass (t)	7.2	km/return tri	0.063	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	2,715	44,977,778	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (Main)	3,394	56,222,222	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	46,644	35,478	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	37,316	28,382	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	-	207,000	t/y	-	kg/t												% control
OB - Loading crushed gravel to trucks	249	207,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	138	207,000	t/y	0.0007	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return tri	0.06	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	8,551	6,504	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (eastern)	-	52,034	km/y	-	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
Rh - Scrapers on partial rehab area (western)	-	52,034	km/y	-	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	5,900	7,096	h/y	0.83	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	2,726	3,000,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	2,580	3,000,000	t/y	0.003	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	0.06	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	1,290	1,500,000	t/y	0.003	kg/t	195	t/load	197	Vehicle gross mass (t)	11.6	km/return trip	0.06	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	2,863	4,500,000	t/y	0.0009	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	3,002	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.6	g/m2 silt loading		% control
WE - Active Pit	13,797	210	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (Main)	22,272	339	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (East)	6,156	94	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	27	41	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	24	37	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	66	2	ha	0.008	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	3,193	2	ha	0.4	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	2,340	122,640	km/y	0.02	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 17 TSP Inventory

ACTIVITY	TSP emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	6,308	35,637	holes/y	0.59	kg/hole											70	% control
OB - Blasting East Pit	10,352	101	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Drilling West Pit	3,154	17,819	holes/y	0.59	kg/hole											70	% control
OB - Blasting West Pit	5,176	51	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	58,162	69,000,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	29,081	34,500,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 1)	528,165	34,500,000	t/y	0.0612	kg/t	240	t/load	237	Vehicle gross mass (t)	5	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 2)	676,051	34,500,000	t/y	0.0784	kg/t	240	t/load	237	Vehicle gross mass (t)	6.4	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	7,174	207,000	t/y	0.1386	kg/t	195	t/load	197	Vehicle gross mass (t)	10	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	884,801	34,500,000	t/y	0.1026	kg/t	195	t/load	197	Vehicle gross mass (t)	7.4	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	58,162	69,000,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (West)	29,081	34,500,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	355,386	28,382	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	355,386	28,382	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	559	207,000	t/y	0.0027	kg/t												% control
OB - Loading crushed gravel to trucks	249	207,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	207,000	t/y	0.0076	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.6	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	81,443	6,504	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	216,463	104,069	km/y	2.08	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	268,177	7,096	h/y	37.79	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	143,496	3,000,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	103,972	3,000,000	t/y	0.139	kg/t	195	t/load	197	Vehicle gross mass (t)	10.0	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	96,694	1,500,000	t/y	0.258	kg/t	195	t/load	197	Vehicle gross mass (t)	18.6	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	150,671	4,500,000	t/y	0.048	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0027	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0125	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	34,367	4,500,000	t/y	0.008	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.6	kg/VKT	0.6	g/m2 silt loading		% control
WE - Active Pit	314,747	359	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	374,840	428	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	907	104	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	876	2	ha	0.1	kg/ha/hr	8760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance)	42,574	2	ha	4.9	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	75,481	122,640	km/y	0.62	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 17 PM_{10} Inventory

ACTIVITY	PM10 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	3,280	35,637	holes/y	0.31	kg/hole											70	% control
OB - Blasting East Pit	5,383	101	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Drilling West Pit	1,640	17,819	holes/y	0.31	kg/hole											70	% control
OB - Blasting West Pit	2,692	51	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	27,509	69,000,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	13,755	34,500,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 1)	127,894	34,500,000	t/y	0.0148	kg/t	195	t/load	197	Vehicle gross mass (t)	5	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 2)	144,625	34,500,000	t/y	0.0168	kg/t	240	t/load	237	Vehicle gross mass (t)	6.4	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	1,535	207,000	t/y	0.0297	kg/t	195	t/load	197	Vehicle gross mass (t)	10	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	167,223	34,500,000	t/y	0.0194	kg/t	240	t/load	237	Vehicle gross mass (t)	7.4	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	27,509	69,000,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (West)	13,755	34,500,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	83,986	28,382	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	83,986	28,382	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	118	207,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	303	207,000	t/y	0.0015	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	19,247	6,504	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	54,116	104,069	km/y	0.52	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	77,280	7,096	h/y	10.89	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	20,637	3,000,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	22,242	3,000,000	t/y	0.030	kg/t	195	t/load	197	Vehicle gross mass (t)	10.0	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	20,685	1,500,000	t/y	0.055	kg/t	195	t/load	197	Vehicle gross mass (t)	18.6	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	21,669	4,500,000	t/y	0.007	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0043	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	6,581	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.6	g/m2 silt loading		% control
WE - Active Pit	157,373	359	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	187,420	428	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	453	104	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	438	2	ha	0.05	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	21,287	2	ha	2	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	26,373	122,640	km/y	0.22	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 17 $PM_{2.5}$ Inventory

ACTIVITY	PM2.5 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling East Pit	189	35,637	holes/y	0.0177	kg/hole											70	% control
OB - Blasting East Pit	311	101	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Drilling West Pit	95	17,819	holes/y	0.0177	kg/hole											70	% control
OB - Blasting West Pit	155	51	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	352	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks East Pit	4,166	69,000,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks West Pit	2,083	34,500,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 1)	11,299	34,500,000	t/y	0.0013	kg/t	240	t/load	237	Vehicle gross mass (t)	5	km/return trip	0.063	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to Emplacement (Haul 2)	14,463	34,500,000	t/y	0.0017	kg/t	240	t/load	237	Vehicle gross mass (t)	6.4	km/return trip	0.063	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (East) to ROM pad for gravel	153	207,000	t/y	0.0030	kg/t	195	t/load	197	Vehicle gross mass (t)	10	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (West) to Emplacement	18,928	34,500,000	t/y	0.0022	kg/t	195	t/load	197	Vehicle gross mass (t)	7.4	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area (East)	4,166	69,000,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Emplacing OB at Emplacement Area (West)	2,083	34,500,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	37,316	28,382	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	37,316	28,382	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	-	207,000	t/y	-	kg/t												% control
OB - Loading crushed gravel to trucks	18	207,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	138	207,000	t/y	0.0007	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	8,551	6,504	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	-	104,069	km/y	-	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	5,900	7,096	h/y	0.83	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks East Pit	2,726	3,000,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks West Pit	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (East) to ROM pad	2,224	3,000,000	t/y	0.003	kg/t	195	t/load	197	Vehicle gross mass (t)	10.0	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (West) to ROM pad	2,069	1,500,000	t/y	0.006	kg/t	195	t/load	197	Vehicle gross mass (t)	18.6	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	2,863	4,500,000	t/y	0.0009	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	3,002	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.6	g/m2 silt loading		% control
WE - Active Pit	23,606	359	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	28,113	428	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	68	104	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	66	2	ha	0.008	kg/ha/hr	8760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance)	3,193	2	ha	0.4	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	2,340	122,640	km/y	0.02	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 26 TSP Inventory

ACTIVITY	TSP emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling North Pit	6,308	35,637	holes/y	0.59	kg/hole											70	% control
OB - Blasting North Pit	11,503	113	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Drilling South Pit	3,154	17,819	holes/y	0.59	kg/hole											70	% control
OB - Blasting South Pit	5,751	56	blasts/y	102.2	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks North Pit	64,624	76,666,667	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks South Pit	32,312	38,333,333	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 1)	575,113	38,333,333	t/y	0.0600	kg/t	240	t/load	237	Vehicle gross mass (t)	4.9	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 2)	868,538	38,333,333	t/y	0.0906	kg/t	240	t/load	237	Vehicle gross mass (t)	7.4	km/return trip	2.9	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to Emplacement	1,288,675	38,333,333	t/y	0.1345	kg/t	195	t/load	197	Vehicle gross mass (t)	9.7	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to ROM pad for gravel	4,591	207,000	t/y	0.0887	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return trip	2.7	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	96,937	115,000,000	t/y	0.0012	kg/t	1	average of (wind speed/2.2)^1.3 in	3	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	355,386	28,382	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	355,386	28,382	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	559	207,000	t/y	0.0027	kg/t												% control
OB - Loading crushed gravel to trucks	249	207,000	t/y	0.0012	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	1,581	207,000	t/y	0.0076	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.6	kg/VKT	0.60	g/m2 silt		% control
Rh - Dozers on partial rehab area	81,443	6,504	h/y	12.52	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	216,463	104,069	km/y	2.08	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	268,177	7,096	h/y	37.79	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks North Pit	143,496	3,000,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks South Pit	71,748	1,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (North) to ROM pad	141,402	3,000,000	t/y	0.189	kg/t	195	t/load	197	Vehicle gross mass (t)	13.6	km/return	2.7	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (South) to ROM pad	33,271	1,500,000	t/y	0.089	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return	2.7	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	150,671	4,500,000	t/y	0.048	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0027	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0125	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	215,245	4,500,000	t/y	0.048	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	34,367	4,500,000	t/y	0.008	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return	0.6	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	297,840	340	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	297,840	340	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (West)	276,816	316	ha	0.1	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	955	109	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.1	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	876	2	ha	0.1	kg/ha/hr	8760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance)	42,574	2	ha	4.9	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	75,481	122,640	km/y	0.62	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

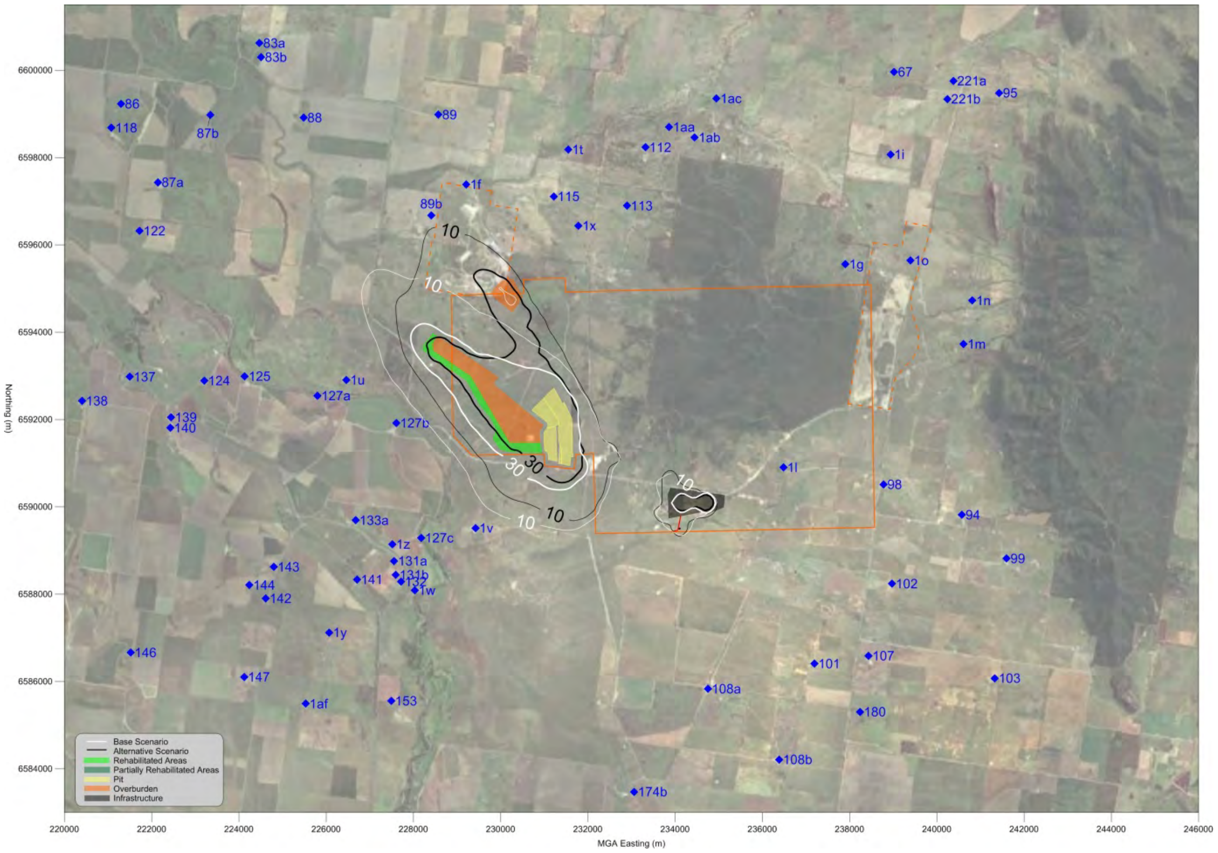
Year 26 PM_{10} Inventory

ACTIVITY	PM10 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling North Pit	3,280	35,637	holes/y	0.31	kg/hole											70	% control
OB - Blasting North Pit	5,981	113	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Drilling South Pit	1,640	17,819	holes/y	0.31	kg/hole											70	% control
OB - Blasting South Pit	2,991	56	blasts/y	53.2	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks North Pit	30,566	76,666,667	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks South Pit	15,283	38,333,333	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 1)	123,032	38,333,333	t/y	0.0128	kg/t	240	t/load	237	Vehicle gross mass (t)	4.9	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 2)	185,803	38,333,333	t/y	0.0194	kg/t	240	t/load	237	Vehicle gross mass (t)	7.4	km/return trip	0.63	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to Emplacement	275,682	38,333,333	t/y	0.0288	kg/t	195	t/load	197	Vehicle gross mass (t)	9.7	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to ROM pad for gravel	982	207,000	t/y	0.0190	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	45,848	115,000,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	83,986	28,382	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	83,986	28,382	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	248	207,000	t/y	0.0012	kg/t												% control
OB - Loading crushed gravel to trucks	118	207,000	t/y	0.0006	kg/t	1.390	average of (wind speed/2.2)^1.3 in	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	303	207,000	t/y	0.0015	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	19,247	6,504	h/y	2.96	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	54,116	104,069	km/y	0.52	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	77,280	7,096	h/y	10.89	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks North Pit	20,637	3,000,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks South Pit	10,319	1,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (North) to ROM pad	30,250	3,000,000	t/y	0.040	kg/t	195	t/load	197	Vehicle gross mass (t)	13.6	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (South) to ROM pad	7,118	1,500,000	t/y	0.019	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return trip	0.58	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	21,669	4,500,000	t/y	0.007	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	0.0012	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	0.0043	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	30,956	4,500,000	t/y	0.007	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	6,581	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.12	kg/VKT	0.6	g/m2 silt loading		% control
WE - Active Pit	148,920	340	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	148,920	340	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement (West)	138,408	316	ha	0.05	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	477	109	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.05	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	438	2	ha	0.05	kg/ha/hr	8,760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance by dozer/FEL)	21,287	2	ha	2	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	26,373	122,640	km/y	0.22	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

Year 26 $PM_{2.5}$ Inventory

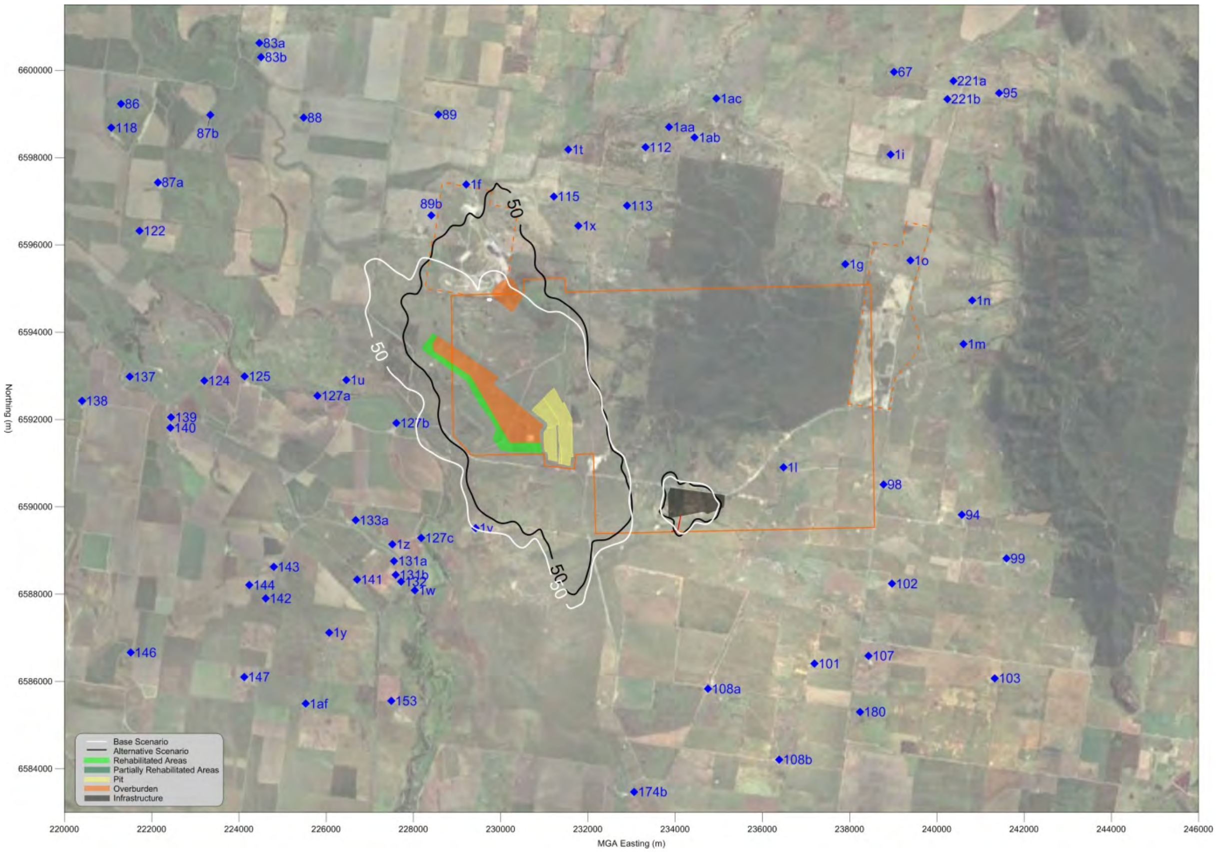
ACTIVITY	PM2.5 emission (kg/y) with control	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling North Pit	189	35,637	holes/y	0.0177	kg/hole											70	% control
OB - Blasting North Pit	345	113	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Drilling South Pit	95	17,819	holes/y	0.0177	kg/hole											70	% control
OB - Blasting South Pit	173	56	blasts/y	3.1	kg/blast	6000	Area of blast in square metres	317	holes/blast								% control
OB - Sh/Ex/FELs loading OB to haul trucks North Pit	4,629	76,666,667	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %							30	% control
OB - Sh/Ex/FELs loading OB to haul trucks South Pit	2,314	38,333,333	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %							30	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 1)	12,303	38,333,333	t/y	0.0013	kg/t	240	t/load	237	Vehicle gross mass (t)	4.9	km/return trip	0.063	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (North) to Emplacement (Haul 2)	18,580	38,333,333	t/y	0.0019	kg/t	240	t/load	237	Vehicle gross mass (t)	7.4	km/return trip	0.063	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to Emplacement	27,568	38,333,333	t/y	0.0029	kg/t	195	t/load	197	Vehicle gross mass (t)	9.7	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
OB - Hauling OB from Open Cut (South) to ROM pad for gravel	98	207,000	t/y	0.0019	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
OB - Emplacing OB at Emplacement Area	6,943	115,000,000	t/y	0.0001	kg/t	1	average of (wind speed/2.2)^1.3 in m/s	3	moisture content in %							30	% control
OB - Dozers on OB (In Pit)	37,316	28,382	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Dozers on OB (on emplacement)	37,316	28,382	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
OB - Crushing gravel (mobile crusher)	-	207,000	t/y	-	kg/t												% control
OB - Loading crushed gravel to trucks	18	207,000	t/y	0.0001	kg/t	1.390	average of (wind speed/2.2)^1.3 in m/	2.5	moisture content in %								% control
OB - Hauling gravel from mobile crusher to site exit (sealed)	138	207,000	t/y	0.0007	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.60	g/m2 silt loading		% control
Rh - Dozers on partial rehab area	8,551	6,504	h/y	1.31	kg/h	10	% silt content	2.5	moisture content in %								% control
Rh - Scrapers on partial rehab area (western)	-	104,069	km/y	-	kg/VKT	8	speed of scraper in km/h	3,252	hours								% control
CL - Dozers ripping/pushing/clean-up (In Pit)	5,900	7,096	h/y	0.83	kg/h	10	silt content in %	8	moisture content of coal in %								% control
CL - Sh/Ex/FELs Loading ROM to trucks North Pit	2,726	3,000,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Sh/Ex/FELs Loading ROM to trucks South Pit	1,363	1,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling CL from Open Cut (North) to ROM pad	3,025	3,000,000	t/y	0.004	kg/t	195	t/load	197	Vehicle gross mass (t)	13.6	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
CL - Hauling CL from Open Cut (South) to ROM pad	712	1,500,000	t/y	0.002	kg/t	195	t/load	197	Vehicle gross mass (t)	6.4	km/return trip	0.058	kg/VKT	2	% silt content	75	% control
CL - Unloading ROM at ROM pad	2,863	4,500,000	t/y	0.0009	kg/t	8	moisture content in %									30	% control
CL - Sh/Ex/FELs loading ROM to dump hopper	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Crushing ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Screening ROM	-	4,500,000	t/y	-	kg/t											100	% control
CL - Loading crushed/screened ROM to trucks	4,090	4,500,000	t/y	0.0009	kg/t	8	moisture content in %										% control
CL - Hauling crushed ROM to site exit (sealed)	3,002	4,500,000	t/y	0.001	kg/t	42	t/load	41	Vehicle gross mass (t)	0.5	km/return trip	0.06	kg/VKT	0.6	g/m2 silt		% control
WE - Active Pit	22,338	340	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	22,338	340	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Waste Emplacement	20,761	316	ha	0.008	kg/ha/hr	8760	hrs										% control
WE - Partially Rehab Area - Western	72	109	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE - Partially Rehab Area - Eastern	-	-	ha	0.008	kg/ha/hr	8760	hrs									99	% control
WE- Topsoil Stockpiles	66	2	ha	0.008	kg/ha/hr	8760	hrs									50	% control
WE - ROM Stockpiles (Wind Erosion & Maintenance)	3,193	2	ha	0.4	kg/ha/h	2.7	Average windspeed (m/s)	8760	h/y							50	% control
Grading roads	2,340	122,640	km/y	0.02	kg/km	8	speed of graders in km/h	15,330	grader hours								% control

APPENDIX C – RESULTS FOR PRO-ACTIVE NOISE MANAGEMENT



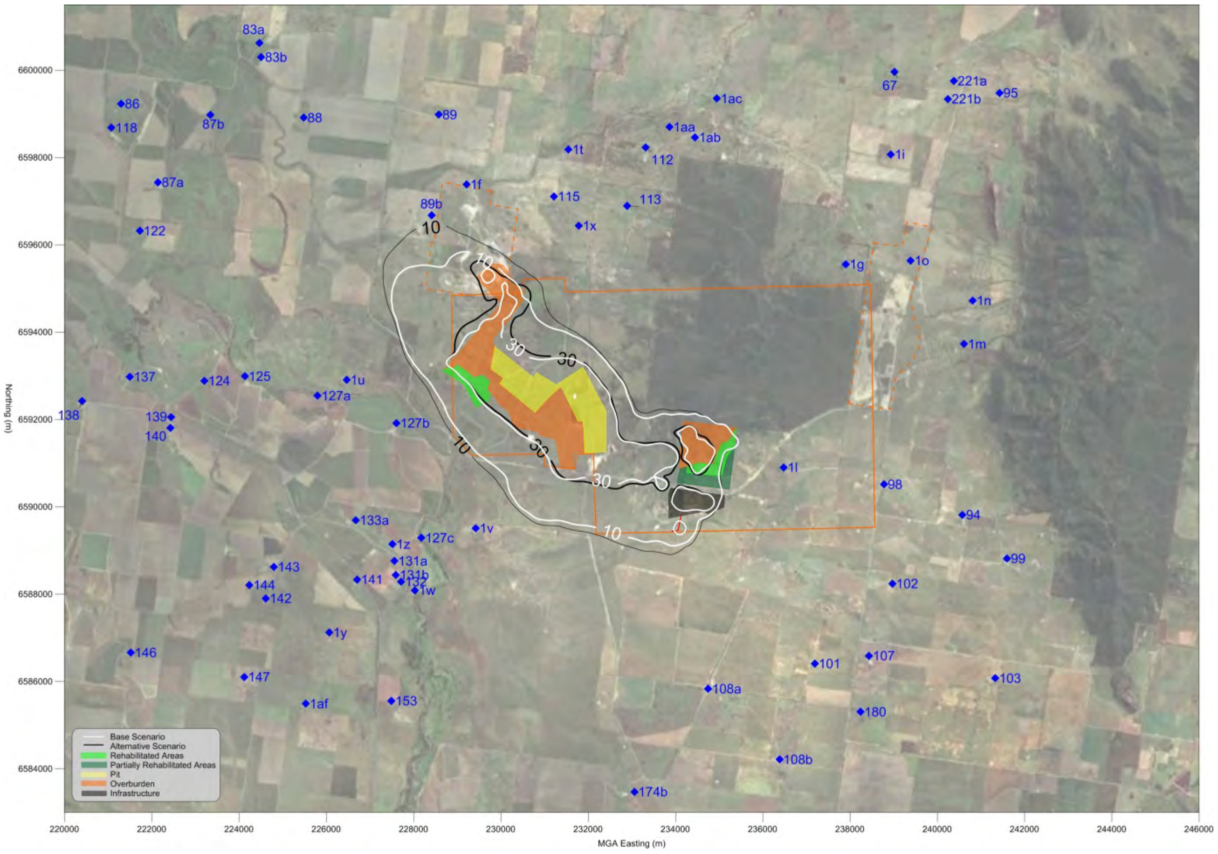
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 2 – Integrated Pro-active Noise Management	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m³	30 µg/m³	CALMET	R. Kan

Figure C1: Predicted Annual Average PM_{10} Concentration Project-Only – Year 2



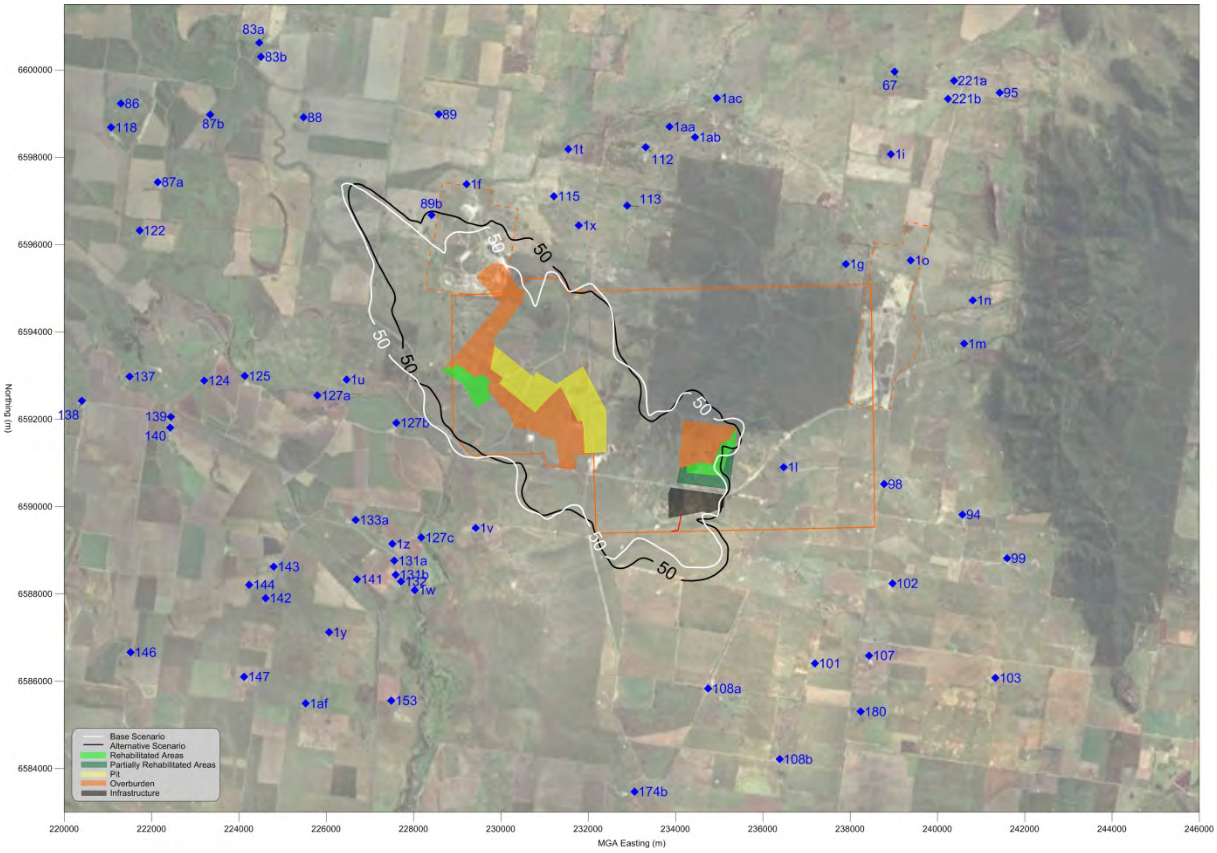
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 2 – Integrated Pro-active Noise Management	N/A	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	50 µg/m^3	CALMET	R. Kan

Figure C2: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 2



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
PM_{10}	Vickery	Year 7 – Integrated Pro-active Noise Management	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	30 µg/m^3	CALMET	R. Kan

Figure C3: Predicted Annual Average PM_{10} Concentration Project-Only – Year 7



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Vickery	Year 7 – Integrated Pro-active Noise Management	N/A	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.42	µg/m^3	50 µg/m^3	CALMET	R. Kan

Figure C4: Predicted Maximum 24-hour PM_{10} Concentration Project-Only – Year 7

Table C1: Predicted Project Only PM_{10} Concentrations for Base and Alternative Scenario (µg/m³)

Receiver ID	24-hr Average PM_{10}				Annual Average PM_{10}			
	Year 2		Year 7		Year 2		Year 7	
	Base	Alternative	Base	Alternative	Base	Alternative	Base	Alternative
67	1	1	2	2	0	0	0	0
83a	12	12	31	32	2	2	3	3
83b	13	13	34	35	2	2	3	3
86	9	7	13	14	1	1	2	2
87a	11	9	15	16	2	1	2	3
87b	14	11	20	21	2	2	3	4
88	18	16	40	41	3	3	4	5
89a	18	17	23	30	1	1	2	3
89b	30	32	40	**52**	3	6	6	9
94	2	2	4	4	0	0	0	1
95	1	1	1	1	0	0	0	0
98	4	4	9	9	0	0	1	1
99	2	1	3	3	0	0	0	0
101	10	9	18	19	1	1	2	2
102	5	4	8	9	0	0	1	1
103	2	2	4	5	0	0	0	0
107	6	6	13	15	1	1	1	1
108a	15	12	24	27	2	1	3	3
108b	8	7	15	17	1	1	2	2
112	8	8	15	16	0	0	1	1
118	8	6	12	13	1	1	2	2
122	11	9	14	15	1	1	2	2
124	13	11	14	15	1	1	2	2
125	16	13	17	18	2	2	2	3
127a	24	19	24	26	4	3	4	4
127b	47	36	40	43	7	5	7	7
127c	33	28	22	25	4	3	4	4
131a	27	23	19	21	3	2	3	3
131b	25	21	19	20	3	2	3	3
132	23	20	19	19	3	2	3	3
133a	21	17	19	21	3	2	3	3
137	8	7	10	11	1	1	1	1
138	5	4	7	7	1	0	1	1
139	10	9	11	12	1	1	1	1
140	10	8	11	12	1	1	1	1
141	22	18	17	18	2	2	2	2
142	13	10	12	13	1	1	1	1
143	12	9	12	13	1	1	1	2
144	11	8	10	12	1	1	1	1
146	6	5	6	7	0	0	1	1
147	10	8	11	11	1	1	1	1
153	15	13	13	14	1	1	2	2
174b	10	9	11	12	1	1	1	1
180	8	7	13	15	1	1	1	1
221a	1	1	2	2	0	0	0	0
221b	1	1	2	2	0	0	0	0
1f	26	32	30	43	2	3	3	4
1g	2	2	5	5	0	0	0	0
1i	1	2	3	3	0	0	0	0
1l	11	10	18	19	1	1	2	3
1m	1	1	2	2	0	0	0	0
1n	1	1	2	2	0	0	0	0
1o	1	2	3	3	0	0	0	0
1t	10	13	19	25	1	1	1	2
1u	30	22	27	29	5	4	5	5
1v	50	42	27	29	7	5	6	6
1w	22	18	19	19	3	2	3	3
1x	16	17	31	39	1	1	2	3
1y	15	13	15	15	1	1	2	2
1z	27	22	20	23	3	2	3	4
1aa	6	6	12	13	0	0	1	1
1ab	5	5	11	12	0	0	1	1
1ac	4	4	8	9	0	0	0	1
1ad	14	21	30	36	1	1	2	3
1ae	13	13	23	25	1	1	2	2
1af	8	7	10	11	1	1	1	1

Note: Receivers with prefix "1" denote mine-owned receivers
Exceedances highlighted in bold.

APPENDIX D - ESTIMATION OF GHG EMISSIONS

D.1 FUEL CONSUMPTION

Greenhouse gas (GHG) emissions from diesel consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from diesel combustion	(t CO_2-e)[1]
Q	=	Estimated combustion of diesel	(GJ)[2]
EF	=	Emission factor (scope 1 or scope 3) for diesel combustion	(kg CO_2-e/GJ)[3]

1 t CO_2-e = tonnes of carbon dioxide equivalent.

2 GJ = gigajoules.

3 kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule.

Table D1: Estimated CO_2-e (tonnes) for Diesel Consumption

Year	Diesel Consumption (kL/annum)	Emission Factor (kg CO_{2-e}/GJ)		Energy Content (GJ/kL)	Emissions (t CO_{2-e})		Total
		Scope 1	Scope 3		Scope 1	Scope 3	
1	15,240	69.5	5.3	38.6	40,884	3,118	44,001
2	33,377	69.5	5.3	38.6	89,540	6,828	96,368
3	41,810	69.5	5.3	38.6	112,165	8,554	120,718
4	45,835	69.5	5.3	38.6	122,961	9,377	132,338
5	46,083	69.5	5.3	38.6	123,627	9,428	133,055
6	46,126	69.5	5.3	38.6	123,742	9,436	133,178
7	46,258	69.5	5.3	38.6	124,096	9,463	133,560
8	46,262	69.5	5.3	38.6	124,107	9,464	133,572
9	46,258	69.5	5.3	38.6	124,096	9,463	133,560
10	46,258	69.5	5.3	38.6	124,096	9,463	133,560
11	46,258	69.5	5.3	38.6	124,096	9,463	133,560
12	46,262	69.5	5.3	38.6	124,107	9,464	133,572
13	46,258	69.5	5.3	38.6	124,096	9,463	133,560
14	46,258	69.5	5.3	38.6	124,096	9,463	133,560
15	46,258	69.5	5.3	38.6	124,096	9,463	133,560
16	46,262	69.5	5.3	38.6	124,107	9,464	133,572
17	46,258	69.5	5.3	38.6	124,096	9,463	133,560
18	46,258	69.5	5.3	38.6	124,096	9,463	133,560
19	46,258	69.5	5.3	38.6	124,096	9,463	133,560
20	46,262	69.5	5.3	38.6	124,107	9,464	133,572
21	46,258	69.5	5.3	38.6	124,096	9,463	133,560
22	46,258	69.5	5.3	38.6	124,096	9,463	133,560
23	46,258	69.5	5.3	38.6	124,096	9,463	133,560
24	46,262	69.5	5.3	38.6	124,108	9,464	133,572
25	46,258	69.5	5.3	38.6	124,096	9,463	133,560
26	46,258	69.5	5.3	38.6	124,096	9,463	133,560
27	46,258	69.5	5.3	38.6	124,096	9,463	133,560
28	35,456	69.5	5.3	38.6	95,118	7,254	102,372
29	35,452	69.5	5.3	38.6	95,107	7,253	102,360
30	35,452	69.5	5.3	38.6	95,107	7,253	102,360
Total	**1,306,270.2**				**3,504,331**	**267,237**	**3,771,568**

D.2 ELECTRICITY

Greenhouse gas emissions from electricity usage at the Whitehaven CHPP were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from electricity usage	(t CO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)[1]
EF	=	Emission factor (Scope 2 or Scope 3) for electricity usage	(kg CO_2-e/kWh)[2]

[1] kWh/annum = kilowatt hours per annum

[2] kg CO_2-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

It has been assumed that 1.7 kWh electricity is required to process 1 tonne of ROM coal, based on historical electricity consumption and ROM coal processing rates at the Whitehaven CHPP, as provided by TCPL.

Estimates for the amount of electricity purchased over the life of the project were provided by Whitehaven.

Table D2: Estimated CO_2-e (tonnes) for Electricity for the Project and Whitehaven CHPP

Year	Electricity (MWh)		Emission Factors (kg CO2-e/kWh)		Emissions (t CO2-e)				
					Project		CHPP		Total (Project)
	Project	CHPP	Scope 2	Scope 3	Scope 2	Scope 3	Scope 3[1]	Scope 3	
1	8,767	0	0.89	0.17	7,803	1,490	0	0	9,293
2	8,767	2,465	0.89	0.17	7,803	1,490	2,194	419	9,293
3	22,209	6,460	0.89	0.17	19,766	3,776	5,749	1,098	23,542
4	23,962	6,970	0.89	0.17	21,326	4,074	6,203	1,185	25,400
5	23,962	6,970	0.89	0.17	21,326	4,074	6,203	1,185	25,400
6	24,547	7,140	0.89	0.17	21,847	4,173	6,355	1,214	26,020
7	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
8	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
9	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
10	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
11	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
12	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
13	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
14	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
15	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
16	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
17	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
18	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
19	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
20	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
21	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
22	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
23	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
24	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
25	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
26	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
27	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
28	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
29	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
30	26,300	7,650	0.89	0.17	23,407	4,471	6,809	1,301	27,878
Total	**743,413**	**213,605**			**661,638**	**126,380**	**190,108**	**36,313**	**788,019**

[1] All emissions associated with the Whitehaven CHPP would be scope 3 emissions for the Project (as the Whitehaven CHPP is not part of the Project). However, these emissions have been calculated using the scope 2 emissions methodology.

D.3 FUGITIVE METHANE

Emissions from fugitive CH_4 were estimated using the following equation:

$$E_{co2-e} = Q \times EF$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from fugitive CH_4	(t CO_2-e/annum)
Q	=	ROM coal extracted during the year	(t)
EF	=	Scope 1 emission factor	(t CO_2-e/tonne)

A site specific emission factor for fugitive methane has been derived based on measurements of gas content for boreholes samples taken for each coal seam by **GeoGas** (**2009**). The measured gas content in m^3/t was converted to t CO_{2-e}/t using the measured % gas composition (reported for CH_4 and CO_2) and using the conversion factors reported in the NGERs Technical Guidelines (**DCCEE, 2009**) to convert from m_3 to CO_{2-e} tonnes, as follows:

- For methane – $6.784 \times 10^{-4} \times 21$
- For CO_2 – 1.861×10^{-3}

The derived site specific emission factor and estimated annual and Project total GHG emissions from fugitive methane are presented in **Table D3**.

Table D3: Estimated CO_2-e (tonnes) for Fugitive Methane

Year	ROM (Open Cut) (Mtpa)	Emission Factor (tCO_{2-e} / tonne ROM)	Scope 1 Emissions (t CO_{2-e})
1	0	0.00087	0
2	1.5	0.00087	1,259
3	3.8	0.00087	3,299
4	4.1	0.00087	3,560
5	4.1	0.00087	3,560
6	4.2	0.00087	3,646
7	4.5	0.00087	3,907
8	4.5	0.00087	3,907
9	4.5	0.00087	3,907
10	4.5	0.00087	3,907
11	4.5	0.00087	3,907
12	4.5	0.00087	3,907
13	4.5	0.00087	3,907
14	4.5	0.00087	3,907
15	4.5	0.00087	3,907
16	4.5	0.00087	3,907
17	4.5	0.00087	3,907
18	4.5	0.00087	3,907
19	4.5	0.00087	3,907
20	4.5	0.00087	3,907
21	4.5	0.00087	3,907
22	4.5	0.00087	3,907
23	4.5	0.00087	3,907
24	4.5	0.00087	3,907
25	4.5	0.00087	3,907
26	4.5	0.00087	3,907
27	4.5	0.00087	3,907
28	4.5	0.00087	3,907
29	4.5	0.00087	3,907
30	4.5	0.00087	3,907
Total			**109,088**

D.4 EXPLOSIVES

Emissions from explosive usage were estimated based on the using the following equation:

$$E_{co2-e} = Q \times EF$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases from explosives	(t CO_2-e/annum)
Q	=	Quantity of explosive used (assumed AnFo)	(t)
EF	=	Scope 1 emission factor	(t CO_2-e/tonne explosive)

Table D4: Estimated CO_2-e (tonnes) for explosive use

Year	Explosive Usage (tonnes per annum)	Emission Factors (t $CO_{2\text{-}e}$ / tonne product) AnFo	Scope 1 Emissions (t $CO_{2\text{-}e}$)
1	29,500	0.17	5,015
2	29,500	0.17	5,015
3	29,500	0.17	5,015
4	29,500	0.17	5,015
5	29,500	0.17	5,015
6	29,500	0.17	5,015
7	29,500	0.17	5,015
8	29,500	0.17	5,015
9	29,500	0.17	5,015
10	29,500	0.17	5,015
11	29,500	0.17	5,015
12	29,500	0.17	5,015
13	29,500	0.17	5,015
14	29,500	0.17	5,015
15	29,500	0.17	5,015
16	29,500	0.17	5,015
17	29,500	0.17	5,015
18	29,500	0.17	5,015
19	29,500	0.17	5,015
20	29,500	0.17	5,015
21	29,500	0.17	5,015
22	29,500	0.17	5,015
23	29,500	0.17	5,015
24	29,500	0.17	5,015
25	29,500	0.17	5,015
26	29,500	0.17	5,015
27	29,500	0.17	5,015
28	29,500	0.17	5,015
29	29,500	0.17	5,015
30	29,500	0.17	5,015
Total	**885,000**		**150,450**

Note: tCO_2-e/tonne – tonne of carbon dioxide equivalent per tonne

D.5 COAL TRANSPORTATION

The scope 3 emissions for the diesel consumption used in the transportation of ROM coal to the Whitehaven CHPP have been estimated using the same method described in **Section D.1**.

The scope 3 emissions associated with product coal transportation by rail have been estimated based on all product coal being transported to Newcastle for export by rail. Emissions associated with product coal transportation have been estimated based on an emission factor for loaded trains of 12.3 grams per net tonne per kilometre (**QR Network Access, 2002**). In reality, some coal would be sold at the mine gate for domestic use. However, this coal is sold in multiple small quantities, therefore, its related transportation emissions are difficult to estimate.

Emission factors were not available for unloaded trains so the factor for loaded trains is conservatively applied for the return trip. The return rail trip to the port of Newcastle is estimated to be 720 kilometres.

Emissions from the shipping of product coal are not included in this assessment due to the difficulties in emission estimates, including uncertainty in export markets and limited data on emission factors and/or fuel consumption for ocean going vessels.

Table D5: Estimated CO_2-e (tonnes) for ROM Coal and Product Coal Transportation

Year	Product Coal Mtpa	t CO_{2-e} from rail transport Scope 3	t CO_{2-e} from road transport Scope 3	Total t CO_{2-e} from transport
1	0.0	0	0	0
2	1.2	10,915	326	11,241
3	3.2	28,605	825	29,430
4	3.5	30,863	890	31,753
5	3.5	30,863	890	31,753
6	3.6	31,616	912	32,528
7	3.8	33,874	977	34,851
8	3.8	33,874	977	34,851
9	3.8	33,874	977	34,851
10	3.8	33,874	977	34,851
11	3.8	33,874	977	34,851
12	3.8	33,874	977	34,851
13	3.8	33,874	977	34,851
14	3.8	33,874	977	34,851
15	3.8	33,874	977	34,851
16	3.8	33,874	977	34,851
17	3.8	33,874	977	34,851
18	3.8	33,874	977	34,851
19	3.8	33,874	977	34,851
20	3.8	33,874	977	34,851
21	3.8	33,874	977	34,851
22	3.8	33,874	977	34,851
23	3.8	33,874	977	34,851
24	3.8	33,874	977	34,851
25	3.8	33,874	977	34,851
26	3.8	33,874	977	34,851
27	3.8	33,874	977	34,851
28	3.8	33,874	977	34,851
29	3.8	33,874	977	34,851
30	3.8	33,874	977	34,851
Total	**106**	**945,843**	**27,283**	**973,126**

D.6 VEGETATION CLEARANCE

GHG emissions due to vegetation clearance have been calculated based on estimated areas of vegetation communities to be cleared. Assumptions have been made as to the biomass density for each vegetation community based on information presented in the AGO Technical Report No.17 (**AGO, 2000**). It is assumed that 50% of the biomass in the vegetation cleared is carbon.

Emissions from vegetation clearance for the life of the Project were estimated based on the using the following equation:

$$E_{co2-e} = Q \times EF$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from vegetation clearance	(t CO_2-e)
Q	=	Quantity of carbon emitted	(t)
EF	=	Scope 1 emission factor	(t CO_2-e/tonne carbon)

Table D6: Estimated CO_2-e (tonnes) for Vegetation Clearance

Vegetation Community	Area (ha)	Biomass Density (t/ha)	Carbon (t/ha)	Total Carbon (t)	Emission Factor (t CO_{2-e}/t carbon)	Total Emission (t CO_{2-e})
Mature and Derived Woodland/Forest/Shrubland/Sedgeland	54	272	136	7,344	3.67	*26,952*
Cypress Regeneration	180	200	100	18,000	3.67	*66,060*
Semi-cleared Areas	188	100	50	9,400	3.67	*34,498*
Derived Native Pasture	1,165	100	50	58,250	3.67	*213,778*
Mature Cypress Woodland	8	272	136	1,088	3.67	*3,993*
Mature Cypress Forest	9	272	136	1,224	3.67	*4,492*
Total						***349,773***

D.7 ENERGY PRODUCTION - USE OF PRODUCT COAL

It is assumed that 70% of product coal would be sold as thermal coal, with the remaining 30% sold as coking coal. The scope 3 emissions associated with the combustion of product coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from coal combustion	(t CO_2-e)
Q	=	Quantity of product coal burnt	(GJ)
EC	=	Energy Content Factor for black/coking coal	(GJ/t)[1]
EF	=	Emission factor for black/coking coal combustion	(kg CO_2-e/GJ)

[1] GJ/t = gigajoules per tonne

The quantity of thermal coal burnt in Mtpa is converted to GJ using an energy content factor for black coal of 27 GJ/t. The quantity of coking coal burnt in Mtpa is converted to GJ using an energy content factor for coking coal of 30 GJ/t. The greenhouse gas emission factor and energy content for coal were sourced from the NGA Factors (**DCCEE, 2011**). The emissions associated with the use of the product coal are presented in the table below.

Table D7: Estimated CO_2-e (tonnes) for Energy Production

Year	Product Coal Mtpa	Product Coal Mtpa		Energy Content GJ/t		EF kg CO_{2-e}/GJ		Scope 3 Emissions (t CO_{2-e})		
		Thermal	Coking	Black	Coking	Black	Coking	Black	Coking	Total
1	0.0	0.0	0.0	27	30	88	90	0	0	0
2	1.2	0.9	0.4	27	30	88	90	2,059,911	1,000,765	3,060,676
3	3.2	2.3	1.0	27	30	88	90	5,398,386	2,622,695	8,021,082
4	3.5	2.4	1.0	27	30	88	90	5,824,575	2,829,750	8,654,325
5	3.5	2.4	1.0	27	30	88	90	5,824,575	2,829,750	8,654,325
6	3.6	2.5	1.1	27	30	88	90	5,966,637	2,898,769	8,865,406
7	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
8	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
9	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
10	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
11	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
12	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
13	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
14	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
15	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
16	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
17	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
18	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
19	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
20	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
21	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
22	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
23	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
24	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
25	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
26	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
27	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
28	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
29	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
30	3.8	2.7	1.1	27	30	88	90	6,392,826	3,105,824	9,498,649
Total								**178,501,902**	**86,721,494**	**265,223,396**