REPORT

TARRAWONGA COAL MINE -PARTICULATE MATTER CONTROL BEST PRACTICE POLLUTION REDUCTION PROGRAM

Whitehaven Coal Limited

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A PEL Company

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1 INTRODUCTION

The Tarrawonga Coal Mine is an open-cut mine operated by Tarrawonga Coal Pty Ltd (TCPL) located in the Gunnedah Basin, 16km north-east of Boggabri in northern NSW. The Tarrawonga Coal Mine (TCM) commenced operations in 2006 and currently produces up to 2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

TCPL is a joint venture between Whitehaven Coal Mining Pty Ltd (Whitehaven) (70% interest) and Boggabri Coal Pty Limited (BCPL) (a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd) (30%interest).TCPL is seeking approval for a proposed extension of the Tarrawonga Coal Mine for continued development of mining operations to facilitate a ROM coal production rate of up to 3 Mtpa.

1.1 Background

In 2011, the NSW Environmental Protection Authority (EPA)[a] published the document '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*' (hereafter called 'the Best Practice Report')(**Donnelly et al., 2011**).

As an outcome of the Best Practice Report, EPA developed a Pollution Reduction Program (PRP) that requires each mine company to prepare a report on the practicability of implementing best practice measures to reduce particle emissions.

The Coal Mine Particulate Matter Control Best Practice PRP is included in the Environmental Protection Licences for each coal mine in NSW.

1.2 PRP Requirements

The PRP requires the Licensee (the mine company) to conduct a site-specific Best Management Practice (BMP) and to prepare a report on the practicability of implementing measures to reduce emissions of particulate matter (PM). The report must include the following:

- The identification, quantification and justification of the measures that are currently being used to reduce PM emissions.
- The identification, quantification and justification of 'best practice' measures that could be used to minimise PM emissions.
- An evaluation of the practicability of implementing the best practice measures.
- A proposed timeframe for implementing all practicable best practice measures.

In preparing the report the Licensee must refer to the document entitled *Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline* (referred to as the Guideline) **(OEH, 2011)**, which details the process to be followed in the PRP. It also provides the required content and format of the PRP. **Table 1.1** presents a summary of the Guideline requirements and a reference to the relevant section in this report.

[a]The NSW EPA exists as a separate statutory authority within the Office of Environment and Heritage (OEH) which came into existence in April 2011. OEH was previously part of the Department of Environment, Climate Change and Water (DECCW). The DECCW was also recently known as the Department of Environment and Climate Change (DECC), and prior to that the Department of Environment and Conservation (DEC). The terms NSW EPA, OEH, DECCW, DECC and DEC are used interchangeably, where appropriate, in this report.

Table 1.1: PRP Guideline requirements and report reference

Guideline Requirement		Report Reference
1) Identification, quantification and justification of existing measures that are being used to minimise particle emissions	a. Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity using US EPA AP-42 emission estimation techniques for both uncontrolled emissions (with no particulate matter controls in place) and controlled emissions (with current particulate matter controls in place).	**Section 2.1** and **2.2**
	b. Rank the controlled emission estimates for TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity from highest to lowest.	**Section 2.3**
	c. Identify the top four mining activities that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.	**Section 2.3**
2) Identification, quantification and justification of best practice measures that could be used to minimise particle emissions	a. For each of the top four activities identified in Step 1(c) identify the measures that could be implemented to reduce emissions.	**Section 3**
	b. For each of the top four activities identified in Step 1(c) estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity following the application of the measures identified in Step 2 (a).	**Section 3.1**
3) Evaluation of the practicability of implementing these best practice measures	a. For each of the best practice measures identified in Step 2(a), assess the practicability associated with their implementation, by taking into consideration: i. Implementation costs ii. Regulatory requirements iii. Environmental impacts iv. Safety implications and v. Compatibility with current processes and proposed future developments.	**Section 3** and **Section 3.2**
	b. Identify those best practices that will be implemented at the premises to reduce particle emissions.	**Section 4**
4) A proposed timeframe for implementing all practicable best practice measures	a. For each of the best practice measures identified as being practicable in step 3(b), provide a timeframe for their implementation.	**Section 4**

1.3 Overview of Mining at Tarrawonga Coal Mine

Mining operations are conducted 20.5 hours per day (7am – 3:30am), Monday to Friday and 11 hours on Saturdays (7am-6pm). No mining occurs on Sundays or public holidays. Mining generally follows the extraction sequence outlined below.

Progressive vegetation clearing and soil stripping is undertaken ahead of the advancing open cut mining operation, and would typically be conducted using a fleet of dozers, scrapers and a water cart/truck. Drill and blast techniques are used for the removal of competent overburden (and interburden).

Following blasting, overburden and interburden is to be removed by excavator and dump truck, with supporting dozers. The overburden/interburden is placed in out-of-pit mine waste rock emplacements, or as infill in the mine void, behind the advancing open cut mining operations. Waste rock emplacements are shaped by dozers for rehabilitation.

Coal mining involves excavators loading ROM coal into haul trucks for haulage to the ROM pad for coal crushing, screening and loadout facilities into haulage contractor trucks. Sized ROM coal is transported to the Whitehaven Coal Handling and Preparation Plant (CHPP).

1.4 Mining Activity and Emission Factors

The Best Practice Guideline defines mining activities in the Site-specific Determination Guideline. Not all of these activities necessarily occur at the TCM for the reporting period and for the purposes of emission estimation, some activities are grouped.

The activities included in the emission estimation for the PRP are shown in **Table 1.2**.

The minor changes to the EPA defined activities are:

- For some of the activities in the Site-specific Determination Guideline (such as unloading coal and loading coal), the emission calculation method and potential controls are essentially the same, and in such instances the mining activities have been grouped.
- The EPA didn't include certain activities (vegetation clearance, topsoil removal, rehabilitation, ventilation shafts (for underground mines) and where relevant, these activities have been added.

The relevant emission factors for each of these activities are presented in **Appendix A**.

Table 1.2: PM-generating activities at coal mines (adapted from OEH, 2011)

General Activity	Specific Activity	Relevant to TCM
Surface preparation	Vegetation clearance/removal	No [(a)]
	Topsoil and subsoil removal with scrapers	Yes
	Topsoil removal with bulldozers/excavators	No
	Topsoil loading to trucks & unloading	No
	Hauling topsoil	No
Overburden and interburden removal	Drilling	Yes
	Blasting	Yes
	Draglines	No
	Bulldozers ripping/pushing/clean-up	Yes
	Loading to trucks & unloading at emplacement	Yes
	Hauling to emplacement	Yes
Coal removal	Drilling	No
	Blasting	No
	Bulldozers ripping/pushing/clean-up	Yes
	Loading truck with ROM coal, unloading truck to ROM pad	Yes
	Loading truck from ROM stockpile, unloading truck to ROM hopper	Yes
	Hauling ROM coal	Yes
	Coal transfer operations[(b)]	Yes
	Screening	Yes
	Crushing	Yes
	Bulldozing on ROM stockpiles	Yes
	Bulldozing on product stockpiles	No
Wind erosion	Exposed areas, including overburden dumps	Yes
	Active coal stockpiles	Yes
Road Maintenance	Graders on haul roads	Yes
Rehabilitation	Bulldozing on rehab	No [(a)]
Mine Ventilation	Ventilation Shaft Emissions	No

Note: [(a)] *e Activities did not occur during the PRP reporting period.* [(b)] *e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor, unloading to trains from conveyor, *etc*.

2 EXISTING MEASURES USED TO MINIMISE PARTICLE EMISSIONS

Emissions were calculated using the relevant USEPA AP-42 emission estimation techniques for both uncontrolled emissions and controlled emissions (**Appendix A**) and activity data provided by the mine (**Appendix B**).

2.1 Estimated Emissions –No Controls

TSP, PM_{10} and $PM_{2.5}$ emission estimates have been calculated for mining activities that occurred for the period June 2010 – July 2011 at the TCM. Emission estimates have been made with no particulate matter controls in place (uncontrolled - **Table 2.1**.) as well as with current particulate matter controls in place (controlled- **Section 2.2**).

A summary of the emissions without dust controls is provided in **Table 2.1**.

Table 2.1 Summary of PM emissions with no controls in place (tonnes/year)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Blasting	21	11	0.6
Bulldozers on Coal	53	16	1.0
Bulldozers on OB	59	14	6.2
Coal crushing	4	2	0.0
Coal Screening	1	0.4	0.0
Drilling	11	6	0.3
Graders	62	22	1.9
Hauling on Unsealed Roads	3,139	671	67.1
Material Transfer Coal	2	1	0.0
Topsoil Removal (Non-EPA Activity Category)	11	0	0.0
Trucks Loading & Unloading OB	65	31	4.6
Trucks Loading and Unloading coal	159	23	3.0
Wind Erosion - Stockpiles	5	3	0.4
Wind Erosion Exposed Areas / Dumps	209	105	15.7
TOTAL	**3,801**	**905**	**101**

Notes:OB = overburden. PM = particulate matter

2.2 Estimated Emissions- Existing Controls

Emissions were then recalculated taking into account various control factors for the dust controls that TCM has in place. These controls, as well as the control factor applied, are listed in **Table 2.2**. The control factors listed are sourced from the Best Practice Report (**Donnelly et al., 2011**).

Table 2.2 Summary of Existing Air Quality Controls

PRP Activity Category	Description of Control	EPA level of control (%)	Control applied (%)
Hauling on Unsealed Roads	Water carts on all trafficked areas • Up to hourly on unpaved roads • 4-hourly with dust suppressant	75	75
	Dust Suppressant	45-82	
	Paving of haul road to coal load-out bin	90	
	Car park area is low-silt aggregate	30	
	Larger haul vehicles are being introduced over the next 2 years	-	
Wind Erosion on OB area	Minimise pre-strip (reduction applies to area avoided).	100	30
	Rehabilitation goals	99	
	Progressive Rehabilitation (vegetative ground-cover)	70	
	Fencing, bunding, shelterbelts or in-pit dump	30-80	
Loading and unloading overburden	Minimise excavator drop height, external trainer engaged.	-	30
	Truck or loader drop height limited to 20 m instead of 40 m.	30	
	Real time air quality monitoring allows for modification of activities in adverse conditions	-	
Dozers on OB	Bulldozers on OB locked in 2nd gear to minimise travel speed	-	0
Drilling	Water injection on all drill rigs	3-96	50
	Dust curtains in use	-	
Blasting	Delay shot to avoid unfavourable weather conditions	-	0
Crushing	Crushers and bins enclosed	50	50
	Top of bin and crusher output enclosed	-	
Screening	3-sided enclosure of ROM bin	-	50
	Enclosure	50	
Material Transfer of Coal	Water sprays on conveyors and bins and at transfer points	50	40
	Conveyors partially enclosed	40	
	Scrapers used on conveyors	-	
	Conveyed material kept moist	-	
Wind Erosion – stockpiles	Coal stockpiles kept at relatively low height due to constant load-out	25	25
Trucks Loading and Unloading Coal	Truck or loader dumping coal - always dropped to ground (rather than at height)	30	30
	Limit load size to ensure coal is below sidewall.	-	
	Maintain a consistent profile	-	
	Load covered with tarp	-	
Grading roads	Graders average 7.5 km/h	75	
Topsoil removal and emplacement	Scrapers are used to strip and emplace topsoil, hence no haulage of topsoil	-	0
	Soil naturally or artificially moist	-	

A summary of the predicted annual emissions incorporating existing dust controls is provided in **Table 2.3**.

Table 2.3: Summary of PM emissions with current controls in place (tonnes/y)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Blasting	21	11	0.6
Bulldozers on Coal	53	16	0.6
Bulldozers on OB	59	14	6.2
Coal crushing	2	1	0.0
Coal Screening	0.3	0.2	0.0
Drilling	6	3	0.2
Graders	15	6	1.9
Hauling on Unsealed Roads	785	168	16.8
Material Transfer Coal	1	0.1	0.0
Trucks Loading & Unloading OB	45	21	3.3
Trucks Loading and Unloading coal	135	19	2.6
Wind Erosion - Stockpiles	4	2	0.3
Wind Erosion Exposed Areas / Dumps	147	73	11
Topsoil Removal (Non-EPA Activity Category)	11	0	0
Grand Total	**1,285**	**335**	**43.5**

2.3 Activity Ranking – Existing Controls

Activities are ranked in terms of total annual emission (existing controls) and presented in **Table 2.4**. In accordance with the Best Practice Guideline, the top four ranked activities according to estimated mass particulate emissions for TSP, PM_{10} and $PM_{2.5}$ are shown in bold.

An evaluation of Best Practice measures for following activities is therefore presented in **Section 3**:

- Hauling on unsealed roads;
- Wind erosion of exposed areas / dumps;
- Trucks loading and unloading coal;
- Trucks loading and unloading overburden; and
- Bulldozers on overburden.

Table 2.4: Ranked activities by mass emissions (controlled)

Rank	Mining Activity	Emissions (t/y)
	TSP	
1	**Hauling on Unsealed Roads**	**785**
2	**Wind Erosion Exposed Areas / Dumps**	**147**
3	**Trucks Loading and Unloading coal**	**135**
4	**Bulldozers on OB**	**59**
5	Bulldozers on Coal	53
6	Trucks Loading & Unloading OB	45
7	Blasting	21
8	Graders	15
9	Topsoil Removal (Non-EPA Activity Category)	11
10	Drilling	6
11	Wind Erosion - Stockpiles	4
12	Coal crushing	2
13	Material Transfer Coal	1
14	Coal Screening	0.3
	PM_{10}	
1	**Hauling on Unsealed Roads**	**168**
2	**Wind Erosion Exposed Areas / Dumps**	**73**
3	**Trucks Loading & Unloading OB**	**21**
4	**Trucks Loading and Unloading coal**	**19**
5	Bulldozers on Coal	16
6	Bulldozers on OB	14
7	Blasting	11
8	Graders	6
9	Drilling	3
10	Wind Erosion - Stockpiles	2
11	Coal crushing	1
12	Coal Screening	0.2
13	Material Transfer Coal	0.1
14	Topsoil Removal (Non-EPA Activity Category)	0

Rank	Mining Activity	Emissions (t/y)
	$PM_{2.5}$	
1	**Hauling on Unsealed Roads**	**16.8**
2	**Wind Erosion Exposed Areas / Dumps**	**11.0**
3	**Bulldozers on OB**	**6.2**
4	**Trucks Loading & Unloading OB**	**3.3**
5	Trucks Loading and Unloading coal	2.6
6	Graders	1.9
7	Bulldozers on Coal	0.6
8	Blasting	0.6
9	Wind Erosion - Stockpiles	0.3
10	Drilling	0.2
11	Material Transfer Coal	0.0
12	Coal Screening	0.0
13	Coal crushing	0.0
14	Topsoil - Non-EPA Activity Category	0.0

3 PRACTICABILITY OF IMPLEMENTING ADDITIONAL BEST PRACTICE MEASURES

Based on the information presented in **Section 2** it is clear that TCM already has a number of PM-control measures in place. With current controls, emissions of TSP, PM_{10} and $PM_{2.5}$ are approximately 60% lower than with no controls in place.

The practicability associated with the implementation of each of the additional best practice measures (as documented within the Best Practice Report) was evaluated for the top four emission-generating activities. The evaluation was undertaken by the mine operators by taking into consideration the criteria outlined in the Guideline, as follows:

- Implementation costs.
- Regulatory requirements.
- Environmental impacts.
- Safety implications.
- Compatibility with current processes and proposed future developments.

The results of the evaluation are presented in **Table 3.1** (haul roads), **Table 3.2** (wind erosion), **Table 3.3** (loading and unloading coal), **Table 3.4** (loading and unloading overburden), and **Table 3.5** (dozers on overburden).

Where a given measure was considered to be practicable according to each of the criteria examined, it was taken to be practicable overall. Those measures deemed to be practicable overall were then taken forward for costing. Measures that were considered not practicable according to one or more of the assessment criteria were not considered further.

Existing controls are already in place for many of the top-ranking activities, and the top four activities in an assessment of this type are not necessarily the ones for which the greatest (or most cost-effective) reductions can be achieved. Whilst further controls may be considered for these top-ranking activities, an assessment of the remaining site activities has also been undertaken to assess whether further controls may be appropriate. It was therefore considered important to identify *any* activity for which there is potential to significantly reduce emissions.

The remaining (lower ranking activities) have also been evaluated and are included in **Table 3.6**.

It is noted that the emission reduction values presented assume an existing level of control where relevant, as presented in **Table 2.2**.

Table 3.1: BPM to reduce particulate matter emissions from haul roads

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency of 75% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls) – Existing control efficiency of 75% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$
Vehicle speed restrictions	Reduction from 75 km/hr to 50 km/hr	40-75%	N	Y	Y	Y	N	N	Current speed limit on site is 60km/hr as per Surface Transport Management Plan approved by DRE and not easily changed	317.8 to 595.8	67.2 to 125.9	6.7 to 12.6	24% to 46%	20% to 37%	15% to 27%
	Reduction from 65 km/hr to 30 km/hr	50-85%	N	Y	N	Y	N	N	Reduction in productivity - not energy efficient if diggers waiting for trucks to return to circuit	397.2 to 675.3	84.0 to 142.7	8.4 to 14.3	30% to 52%	25% to 42%	18% to 31%
Surface improvements	Pave the surface	>90%	N	Y	Y	Y	N	N	Haul roads of temporary nature	2860.0	604.4	60.5	36%	30%	22%
	Low silt aggregate	30%	N	Y	Y	Y	N	N	Silt content determined by in-situ material - not easily changed	238.3	50.4	5.0	18%	15%	11%
	Oil and double chip surface	80%	N	N	N	N	N	N	Potential for environmental damage (spill)	2542.2	537.2	53.8	12%	10%	7%
Surface treatments	Watering (standard procedure)	10-74%	Y	-	-	-	-	-	Current practice.	-	-	-	-	-	-
	Watering Level 1 (2 $L/m^2/h$)	50%	Y	-	-	-	-	-	Assumed current practice but not confirmed	-	-	-	-	-	-
	Watering Level 2 (>2 $L/m^2/h$)	75%	Y	-	-	-	-	-	Assumed current practice but not confirmed	-	-	-	-	-	-
	Watering grader routes	50%	N	Y	Y	Y	N	N	Not practical for road construction - better to water after road surface has been disturbed	73.3	36.7	5.5	6%	11%	12%
	Watering twice a day	55%	Y	-	-	-	-	-	Roads are watered once per hour	-	-	-	-	-	-
	Dust suppressants	45%-82%	Y	-	-	-	-	-	Current practice.Suppressant in use- Permanent haul roads treated once every 4 hours.	-	-	-	-	-	-

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency of 75% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls) – Existing control efficiency of 75% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$
Other	Use of larger vehicles	90t to 220t: 40%	N	Y	Y	Y	N	N	Current truck fleet has average of 100 t/load, subject to approval, over next two years, eight CAT 793's will be added to fleet, hence an average of 150 t/load.	317.8	67.2	6.7	24%	20%	15%
		140t to 220t; 20%	N	Y	Y	?	N	N		158.9	33.6	3.4	12%	10%	7%
		140t to 360t: 45%	N	Y	Y	?	N	N		357.5	75.6	7.6	27%	22%	16%
		100 t to 149 t	N	Y	Y	Y	Y	Y	Cost evaluated as practicable BPM	166.8	35.3	3.5	13%	10%	8%
	Conveyors	>95%	N	N	?	Y	N	N	No access to power grid.	3018.9	637.9	63.8	49%	40%	29%

Notes: [a]Reductions achieved by the use of larger vehicles, conveyors and lower grader speeds have been calculated from the emission factors for these activities.

b *km/hr = kilometres per hour.*

l/m2/hr = litres per square metre per hour.

t = tonnes.

Table 3.2: BPM to reduce particulate matter emissions from wind erosion of open areas

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency of 30% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls) – Existing control efficiency of 30% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$
Avoidance	Minimise pre-strip	100% per m2 of pre-strip avoided	Y	-	-	-	-	-	Current practice on basis of restricting clearing for 12 months to coincide with flora/fauna requirements	-	-	-	-	-	-
Surface stabilisation	Watering	50%	N	Y	Y	N	N	N	Depends on water availability. Safety implications of slumping of emplacements.	73.3	36.7	5.5	6%	11%	12%
	Chemical suppressants	70-84%	N	Y	Y	Y	N	N	As above	102.6 to 123.1	51.3 to 61.6	7.7 to 9.2	8% to 9%	15% to 18%	17% to 20%
	Paving and cleaning	>95%	N	Y	N	Y	N	N	Cannot pave active pit areas. Paving rehab areas is not acceptable environmentally.	198.9	99.5	14.9	10%	20%	22%
	Application of gravel to stabilise disturbed open areas	84%	N	Y	Y	?	N	N	Applying gravel to pit areas would be counterproductive (have to dig it up again).	175.9	87.9	13.2	9%	17%	18%
	Rehabilitation goals	99%	Y	-	-	-	-	-	Current practice.	-	-	-	-	-	-
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	30-80%	Y	-	-	-	-	-	In pit dumping when practical	-	-	-	-	-	-
	Vegetative ground cover	70%	Y	-	-	-	-	-	Seeded to cover as soon as practicable once reshaped to grade.	-	-	-	-	-	-

Table 3.3: BPM to reduce particulate matter emissions from trucks loading and unloading coal

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency of 30% is assumed (see Table 2.2): TSP	PM$_{10}$	PM$_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls) – Existing control efficiency of 30% is assumed (see Table 2.2): TSP	PM$_{10}$	PM$_{2.5}$
Avoidance	Bypass ROM stockpiles	50%	N	Y	Y	Y	N	N	Not currently in place but will occur once extension is approved and ROM coal is transported direct to adjoining mine infrastructure	79.3	11.4	1.5	4%	2%	2%
		100%	N	Y	Y	Y	N	N	Not currently in place but will occur once extension is approved and ROM coal is transported direct to adjoining mine infrastructure	158.6	22.8	3.0	10%	6%	6%
Truck or loader dumping ROM coal	Minimise drop height (10m to 5m)	30%	Y	-	-	-	-	-	Always drop to the ground - drop height restricted to truck height	47.6	6.8	0.9	2%	1%	1%
	Water sprays on ROM pad	50%	N	Y	Y	Y	N	N	Water availability is an issue	67.4	9.7	1.3	5%	3%	3%
Truck or loader dumping to ROM bin	Water sprays on ROM bin or sprays on ROM pad	50%	Y	-	-	-	-	-	Sprays on conveyor on entry to bin	79.3	11.4	1.5	4%	2%	2%
	Enclosed dump hopper (3 sides and a roof)	70%	N	Y	Y	Y	Y	Y	Currently enclosed on 3 sides but not roof. Cost evaluated as practicable BPM	111.0	16.0	2.1	7%	4%	4%
	Enclosed dump hopper (3 sides and a roof) plus water sprays	85%	N	Y	Y	N	N	N		134.8	19.4	2.6	8%	5%	5%
	Enclosure with control device	90-98%	N	Y	Y	N	N	N		142.7	20.5	2.7	9%	5%	5%

Table 3.4: BPM to reduce particulate matter emissions from trucks unloading overburden

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) — Existing control efficiency of 30% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
Minimising drop height	Reduce from 3m to 1.5m	30%	Y	-	-	-	-	-	Dump drop height limited to 20m instead of 40m	0.0	0.0	0.0	0.0	0%	0%
Water application		50%	N	Y	Y	N	N	N	Not practical	22.5	10.5	1.7	2%	3%	4%
Modify activities in windy conditions		Not quantified	Y	-	-	-	-	-	Real time air quality monitoring addresses this with procedures in place to stand down dusty activities.	0.0	0.0	0.0	0.0	0%	0%

Table 3.5: BPM to reduce particulate matter emissions from bulldozers on overburden

Best Practice Control	% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency of 0% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls) – Existing control efficiency of 0% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$
Minimise travel speed and distance	Not quantified	Y	-	-	-	-	-	Locked in 2nd gear	0.0	0.0	0.0	0%	0%	0%
Keep travel routes and materials moist	50%	N	Y	Y	N	N	N	Can keep travel routes moist but not coal/overburden during pushing	29.6	7.0	3.1	2%	2%	7%

Table 3.6: BPM to reduce particulate matter emissions from remaining activities

Best Practice Control	% control	Current Use	Practicality Evaluation				Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
			Regulatory	Environmental	Safety	Compatibility			Existing control efficiency is assumed (see Table 2.2)					
									TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Blasting(assumed control efficiency of 0%, see **Table 2.2**)														
Design: delay shot to avoid unfavourable weather conditions	Not quantified	Y	-	-	-	-	-	Current practice	-	-	-	-	-	-
Design: minimise area blasted	Not quantified	N	Y	Y	N	N	N	Not always practical for safety and operational reasons	-	-	-	-	-	-
Graders(assumed control efficiency of 75%, see **Table 2.2**)														
Grader speed reduction from 16km/hr to 8 km/hr	75%	Y	-	-	-	-	-	Current Practice	-	-	-	-	-	-
Scrapers on topsoil (assumed control efficiency of 0%, see **Table 2.2**)														
Soil naturally or artificially moist	-	Y	-	-	-	-	-	-	-	-	-	-	-	-
Drilling(assumed control efficiency of 50%, see **Table 2.2**)														
Wet – Water injection sprays while drilling	3-96% NIOSH document	Y	-	-	-	-	-	Current Practice	-	-	-	-	-	-
Dry collection – Fabric filters	99	N	Y	Y	Y	Y	Y	Minor source. Any additional BPM not considered as minimal benefit	11.2	5.8	0.3	0%	1%	0%
Dry collection – Cyclone	80-90	N	Y	Y	Y	Y	Y	Minor source. Any additional BPM not considered as minimal benefit	9.0 - 10.2	4.7 - 5.3	0.2 - 0.3	0%	1%	0%

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
										Existing control efficiency assumed (see Table 2.2)					
										TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind erosion - coal stockpiles (assumed control efficiency of 25%, see **Table 2.2**)															
Avoidance	Bypassing stockpiles	100%	N	Y	Y	Y	N	N	Upon Extension approval, ROM coal will be trucked direct to adjoining mine infrastructure	11.3	5.9	0.3	1%	2%	0%
Surface stabilisation	Water sprays	50%	N	Y	Y	Y	Y	Y	Cost Evaluation as practicable BPM	5.7	3.0	0.2	0%	1%	0%
	Chemical wetting agents	80-99%	N	Y	Y	Y	Y	N	Not considered necessary	9.0-11.2	4.7 - 5.8	0.2 - 0.3	1%	1% - 2%	0%
	Surface crusting agent	95%	N	Y	Y	Y	N	N	Stockpile residence time is very short - so impractical to apply	10.7	5.6	0.3	1%	1%	0%
	Carry over wetting from load in	80%	N	Y	Y	Y	N	N	Sprays on conveyors and bins. Additional wetting not practical	9.0	4.7	0.2	1%	1%	0%
Enclosure	Silo with bag house	95-100%	N	Y	Y	Y	N	N	Not practical	10.7 – 11.2	5.6 – 5.8	0.3	1%	1% - 2%	0%
	Cover storage pile with a tarp during high winds	99%	N	Y	Y	N	N	N	Not practical	11.2	5.8	0.3	1%	2%	0%

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) – Existing control efficiency is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
Wind speed reduction	Vegetative windbreaks	30%	N	Y	Y	N	N	N	Safety risk with equipment near trees etc	3.4	1.8	0.1	0%	0%	0%
	Reduced pile height	30%	Y	-	-	-	-	-	Current Practice. Stockpile height limited due to constant load out from site	-	-	-	-	-	-
	Wind screens/fences	75->80%	N	Y	Y	N	N	N	Safety risk	8.5 – 9.0	4.4 – 4.7	0.2	1%	1%	0%
	Pile shaping/orientation	<60%	N	Y	Y	Y	N	N	This reduces effectiveness of loading, reclaiming	0.0 – 6.8	0.0 – 3.5	0.0 0.2	0%	0% to 1%	0%
	Erect 3-sided enclosure around storage piles	75%	N	Y	Y	N	N	N	This reduces effectiveness of loading, reclaiming	8.5	4.4	0.2	1%	1%	0%
	Rock armour and/or topsoil applied	-	N	Y	N	N	N	N	Not practical	-	-	-	-	-	-

Best Practice Control		% control	Current Use	Practicality Evaluation: Regulatory	Practicality Evaluation: Environmental	Practicality Evaluation: Safety	Practicality Evaluation: Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) — Existing control efficiency is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
Conveyor and transfers (assumed control efficiency of 40% for transfers - see **Table 2.2**)															
Conveyors	Application of water at transfers	50%	Y	-	-	-	-	-	Current Practice	-	-	-	-	-	-
	Wind shielding - roof or side wall	40%	Y	-	-	-	-	-	Current Practice	-	-	-	-	-	-
	Wind shielding - roof AND side wall	70%	N	Y	Y	Y	Y	Y	Cost evaluated as practicable BPM	0.4	0	0.0	0%	0%	0%
	Belt cleaning and spillage minimisation	Not quantified	Y	-	-	-	-	-	In place and operating - belts have scrapers in place	-	-	-	-	-	-
Transfers	Enclosure	70%	Y	-	-	-	-	-	Current Practice - At top of bin and crusher output	-	-	-	-	-	-
	Enclosure and fabric filters	-	N	Y	Y	Y	N	N	Not practical	-	-	-	-	-	-

3.1 Estimated Emissions for Practical BPM

Table 4.1 summarises the additional BPM identified as practicable (not accounting for cost) for mining activities at TCM. The dust emissions after implementing the BPM are presented and the potential reduction of emissions as a percentage of the total emissions. Calculations indicate that the greatest potential reductions in emissions are achieved through the use of larger vehicles for hauling, followed by the installation of the roof on the ROM hopper.

Further evaluation (consideration of costs) is provided in **Section 3.2**.

3.2 Implementation Cost Evaluation

For the measures identified in **Table 4.1**, an additional cost evaluation was completed and summarised below. Full details provided in **Appendix C**.

- For hauling on unsealed roads, the net cost per tonne of PM_{10} abated as a result of increasing haul truck sizes would be of the order of \$670,000/tonne-PM_{10} in the first year, \$190,000/tonne-PM_{10} annually thereafter and a total of \$2.4 million/tonne-PM_{10} over 10 years.
- For wind erosion and maintenance of coal stockpiles the net cost per tonne of PM_{10} abated as a result of fixed water sprays was calculated to be in the order of \$550,000/tonne-PM_{10} in the first year, \$60,000/tonne-PM_{10} annually thereafter and a total of \$1 million/tonne-PM_{10} over 10 years.
- For unloading coal to ROM hopper the net cost per tonne of PM_{10} abated as a result of the installation of a roof was calculated to be in the order of \$45,000/tonne-PM_{10} in the first year, \$1000/tonne-PM_{10} annually thereafter and a total of \$50,000/tonne-PM_{10} over 10 years.
- For conveyors, emissions were estimated for transfer points, however wind erosion from the surfaces of conveyors was not considered as this is considered a very small source. The estimated total cost for the installation of side walls on the conveyors is in the order of \$666,000 over 10 years. The reduction in emissions that this would achieve is expected to be minor, on the basis that the emission factor for wind erosion for TSP is 1 tonne/ha/year and the surface area for conveyors on site would be relatively small.

4 IMPLEMENTATION TIMEFRAME

Based on a result of the practicability evaluation and subsequent cost evaluation, the following additional BPM are proposed for implementation at TCM.

- Use of larger vehicles – end of FY2014 (contingent on approval of Tarrawonga Coal Project).

The installation of a roof on the dump hopper and water sprays on stockpiles are not currently considered for implementation. Should the Tarrawonga Coal Project (extension) be approved, all ROM coal would be hauled to Boggabri Coal Mine infrastructure for unloading, stockpiling and processing. Implementation of such controls would be negotiated with Boggabri Coal Mine.

As hauling on unsealed roads is by far the largest emission source at TCM, it is recommended that site specific control efficiency is determined so that the required watering rates and suppressant application frequencies are better understood, as outlined in **Section 5.**

Table 4.1: Estimated Emissions for Practical BPM

Mining Activity	BPM	Dust Emissions after BPM (t/y)			Potential Reduction as % of total site dust emission		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Hauling on unsealed roads [1]	Use of larger trucks	628	134	13.4	12%	10%	8%
Unloading Coal to hopper [2]	Enclosed hopper (roof and sides)	16.7	2.4	0.3	3.0%	1.7%	1.8%
Wind Erosion and Maintenance – Stockpiles [c]	Water sprays on stockpiles	10.6	4.1	0.2	0.8%	1.2%	0.3%
Conveyors [4]	Shielding – roof and side wall	-	-	-	-	-	-

Note: [1] Current truck fleet has average of 100 t/load, subject to approval, over next two years, eight CAT 793's will be added to fleet, hence an average of 150 t/load.Control efficiency of 20% assumed. [2]BPM control emissions estimated based on if all ROM coal directly dumped to hopper. [3]Emissions reductions are calculated for wind erosion on stockpiles plus dozers operating on stockpiles. [4]Wind erosion from surfaces of the conveyors not estimated as not considered a significant source.

5 MONITORING AND TRACKING THE EFFECTIVENESS OF BPM

On the 9 May 2012, the EPA held an information session and workshop to provide feedback to consultants and mines on the dust PRPs received to date. A key outcome of the workshop (referred to as 'Key Message 3' (**EPA, 2012**)) was that the control effectiveness of both existing and proposed BPM should be measured and reported, as follows:

"Control effectiveness must be supported by:

- *Key performance indicator*
- *Monitoring method*
- *Location, frequency and duration of monitoring*
- *Monitoring data records and analysis*
- *Management procedures"*

In accordance with EPA expectations, the following Key Performance Indicators (KPIs) are proposed for TCM.

5.1 KPI-1 - Emissions of PM_{10} per tonne of ROM coal

This headline KPI will provide an indication of the overall effectiveness of all PM controls (for all activities) at TCM, and makes direct use of the emissions inventory compiled for the PRP process.

The value of the KPI will change each year depending not only on the application of control measures, but also on any changes in the distribution of mining activities (*e.g*. as the lengths of haul roads change).

The KPI will be recalculated on an annual basis (AEMR reporting period) using the PRP emissions inventory spreadsheet. The annual recalculation will be relatively straightforward, requiring input data on intensity for each mining activity (*e.g.* material production rates, VKT, dozer hours etc). For consistency, it is recommended that future National Pollutant Inventory (NPI) reporting periods and emission calculations are aligned with this more refined calculation method.

It is also recommended that this KPI is improved by using site specific input data (silt content, moisture content, control efficiencies). An outline of the monitoring recommended for improvements to this KPI is outlined in **Section 5.5**.

Further details for this KPI are outlined in **Table 5.1**, along with objectives and targets and reporting requirements. If adopted for the mine, a site specific procedure would be developed for this KPI. Based on the emission estimates presented for this PRP, the existing kg PM_{10} / t ROM ratio is 0.2 kg/t. This is the baseline against which this KPI can be tracked.

5.2 KPI-2 Control of PM_{10} Emissions

This KPI will quantify the progress of the mine towards achieving best practicable controls on PM_{10} emissions (**Donnelly *et al,* 2011**). It provides a measure of improvement of the mine as a whole, by combining the efficiency of each individual control. It is therefore not dependent on such variables as productivity, VKT and dozer hours as is the case for KPI-1.

The current control measure for each mining activity is compared to the best practically achievable control measure for that activity. This ratio is then weighted according to the contribution of that uncontrolled activity to the total uncontrolled annual emission. A mine that is operating with best practicable controls on activities producing the majority of emissions, would score close to 100.

This KPI will be recalculated annually using the PRP emissions inventory spreadsheet and it is recommended that it be improved by using site specific data, as outlined in **Section 5.5**. Further details about the KPI, including the metric, objectives, targets and reporting requirements are outlined in **Table 5.1**. If adopted for the mine, a site specific procedure would be developed for this KPI.

5.3 KPI-3 Opacity (Visible Dust Emissions)

This KPI is designed to provide an indication of visibile dust emissions at the mine site. There are various methods for monitoring opacity, and the chosen method would determine the monitoring locations and intervals.

Further details for this KPI are outlined in **Table 5.1**, including the various methods and standards for measurement, objectives and targets and reporting requirements. If adopted for the mine, a site specific procedure would be developed for this KPI, relevant to the chosen opacity monitoring method.

5.4 KPI-4 Watering intensity for haul roads

Hauling on unpaved roads is the major contributor to total dust emissions. Controlling emissions from this activity is therefore important, and there are a number of measures listed in the Best Practice Report which can produce significant reductions.

An existing control efficiency of 75% is assumed for this PRP report, equivalent to Level 2 watering (75%) and / or the application of dust suppressants (84%), as per the Best Practice Report. The actual site specific control efficiency for the TCM haul roads, for watering and application of dust suppressants is unknown, and it is recommended that this is determined. Once the site specific control efficiency is measured, and the equivalent watering rate determined, it is used for tracking and reporting against this KPI. Where the site specific control efficiency is found to be less than 75%, the watering/suppressant application rate required for achieve 75% control can be determined and used for tracking and reporting against this KPI.

Further details for this KPI are outlined in **Table 5.1** including objectives and targets and reporting requirements. If adopted for the mine, a site specific procedure would be developed for this KPI, relevant to the chosen monitoring method. The options for the measurement of site specific control efficiencies are outlined in **Table 5.3**.

Table 5.1: KPIs for BPM

KPI-1 – Annual emissions of PM_{10} per tonne of ROM coal (kg PM_{10}/t ROM)				
Metric	**Method / Standard**	**Objective / Target**	**Frequency**	**Report**
This KPI is defined as follows: $$K1_y = \left(\frac{E_{PM10}}{M_{ROM}}\right)_y$$ Where: K1y is the value of KPI-1 (in kg of PM_{10} per tonne of ROM coal) in year y. E_{PM10} is the total emission of PM_{10} from the mine (in kg, with current controls) in year y. M_{ROM} is the mass of ROM coal (in tonnes) mined in year y	Annual dust emissions inventory using PRP emissions inventory template	Downward trend in PM_{10}/ROM ratio until best practicable control is achieved	Annual (matching 12 month reporting period for AEMR/NPI)	Include in AEMR
KPI-2 – PM_{10} Emission Control (%)				
This KPI is defined as follows: $$K2_y = \left(\frac{CF_i}{CF_{i-B}}\right) \times 100$$ Where: K2y is the value of KPI-2 (%) in year y. CF_i is the current control factor for activity i in year y. CF_{i-B} is the best practicable control factor for activity i	Annual dust emissions inventory using PRP emissions inventory template in conjunction with site specific measurements of individual parameters and control efficiencies.	Progression towards 100%. This indicates that the mine is doing everything practicable and achievable within the constraints of operations, to reduce emissions.	Annual (matching 12 month reporting period for AEMR/NPI)	Include in AEMR

KPI-3 – Visible Dust Emissions (Opacity)				
This KPI is defined as follows: $$K3_y = \bar{k}_y$$ Where: K3y is the value of KPI-3 (dimensionless) in year y $\bar{k}$y is the average opacity in year y	<u>Visual Observations</u> US EPA Method 9 – Visual Determination of the opacity of emissions from stationary sources San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 8011 General Requirements (Appendix A – Visual Determination of Apacity)	<20% Opacity at source - hauling, open pit and stockpile area	Weekly	Weekly operators log.
	<u>Digital Imagery</u> ASTM WK 30382 "*New Test Method for Determining the Opacity of Fugitive Emissions in the Outdoor Ambient Atmosphere, Using Digital Imagery*"	<20% Opacity at source	Continuous	
KPI 4 - Watering Intensity for Hauling (L/VKT)				
This KPI is defined as follows: $$K4_y = \left(\frac{W_{Haul}}{VKT_{Haul}}\right)_y$$ Where: K4y is the value of KPI-3 (in litres per vehicle-kilometre) in year y W_{Haul} is the total amount of water applied to haul roads in year y VKT_{Haul} is the total number of vehicle-kilometres on haul roads in year y	N/A	No less than the level of watering (L/VKT) to achieve the site specific control efficiency. (Derived through site specific determination of watering control effectiveness)	Annual	Include in AEMR

5.5 Recommendations for Ongoing improvement of KPIs

Another key message from the EPA information sessions (referred to as 'Key Message 2' (**EPA, 2012**)) was the use of site specific data in deriving PM emissions estimates for the PRP, such as:

- Material parameters – moisture and silt contents.
- Meteorology.
- Vehicle weight, speed, traffic volume.
- Activity data – areas disturbed, stockpiles, material transfer.

The available site specific data has been provided by the mine (refer **Appendix B**) and used for the PM emissions estimates presented in the report.

However, due to time constraints the sampling and analysis of material properties was not completed. For ongoing evaluation against the KPIs, it is recommended that improvements are made to emission estimates using site specific data and site specific control efficiencies are determined. The recommended monitoring for input into the KPIs are outlined in **Table 5.2**. Measurement methods for determination of site specific controls for water are outlined in **Table 5.3**.

Table 5.2: Site specific measurements for improvements to KPI-1

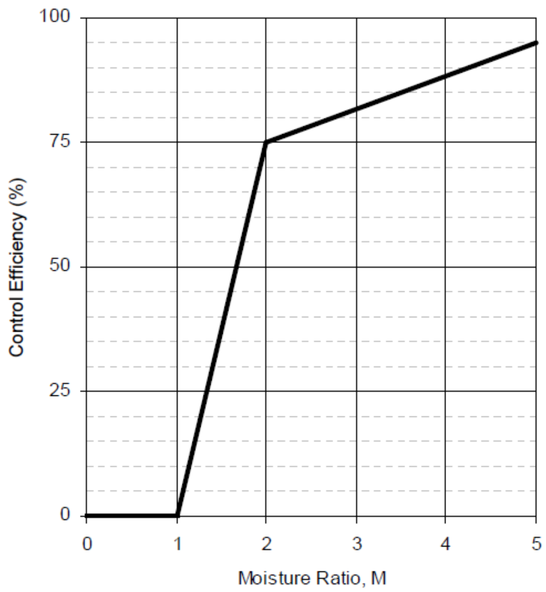
Parameter	Measurement Method / Standard	Frequency
% moisture content (overburden dumps, ROM coal and product coal)	US EPA AP42 Appendix C.1 Procedures for Sampling Surface / Bulk Dust Loading US EPA AP42 Appendix C.2 Procedures for Laboratory Analysis of Surface Dust Loading Samples	Annual
% silt content (overburden dumps, ROM coal and product coal, haul roads)	US EPA AP42 Appendix C.1 Procedures for Sampling Surface / Bulk Dust Loading US EPA AP42 Appendix C.2 Procedures for Laboratory Analysis of Surface Dust Loading Samples	Annual
Threshold Friction Velocity for coal piles and exposed areas	US EPA AP42 Chapter 13.2.5	Annual
Dust Extinction Moisture Level (DEM[1]) (ROM and product coal)	AS 4156.6 – 2000 Coal Preparation Part 6: Determination of dust/moisture relationship for coal	One off (for each coal type)

Notes: [1] DEM is defined as the moisture level at which dustiness is reduced to a level of 10 (i.e. minor dust emissions expected during bulk handling operations)

Table 5.3: Site specific control efficiencies

<table>
<tr><th>Parameter</th><th>Measurement Method / Standard</th><th>Frequency</th></tr>
<tr><td rowspan="2">Site Specific Watering Control Effectiveness</td><td>Mobile emissions monitoring device for unpaved roads. Method uses equipment designed to make direct measurements of dust concentrations as a result of vehicle traffic on the roadway as it travels. The system was developed by PAEHolmes for ACARP (publication pending).</td><td>Seasonal</td></tr>
<tr><td>

Control Efficiency determined by linear relationship between control efficiency and moisture content of surface, shown below.



Moisture Ratio (M) as defined by US EPA AP 42 Chapter 13.2.2 Unpaved Roads:

$$M = \frac{Moisture\ content\ of\ watered\ road}{Moisture\ content\ of\ unwatered\ road}$$

Moisture Content determined by:

ASTM D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))

</td><td>Seasonal</td></tr>
</table>

6 REFERENCES

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APPENDIX A: EMISSION FACTOR EQUATIONS

Table A1: Emission factors for mining activities

Activity Code	Activity Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
1.01	Vegetation removal with scrapers						
2.01	Topsoil removal with scrapers	kg/t	0.029	No data, assumed to be zero	No data, assumed to be zero	AP-42 11.9.7 Table 11.9-4	-
2.02	Topsoil removal with bulldozers/excavators	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	-
2.03	Topsoil loading and unloading	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	Equation for aggregate storage piles
2.04	Topsoil hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
3.01	Overburden drilling	kg/hole	0.59	0.52 × TSP (PM_{10} ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	0.03 × TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	AP-42 11.9.7 Table 11.9-4	-
3.02	Overburden blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 × TSP	0.03 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.03	Overburden draglines	kg/bcm	$0.0046 \times \frac{d^{1.1}}{M^{0.3}}$	$0.002175 \times \frac{d^{0.7}}{M^{0.3}}$	0.017 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.04	Overburden bulldozing (ripping, pushing, clean-up)	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.05	Overburden loading and unloading	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	-

Activity Code	Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
3.06	Overburden hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
4.01	Coal drilling	kg/hole	0.59	0.52 × TSP (PM_{10} ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	0.03 × TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	AP-42 11.9.7 Table 11.9-4	-
4.02	Coal blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 × TSP	0.03 × TSP	AP-42 11.9.7 Table 11.9-2	-
4.03	Coal bulldozing (ripping, pushing, clean-up)	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.4}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9.7 Table 11.9-2	-
4.04a 4.04b 4.04c	Coal truck loading and unloading	kg/t	$\frac{0.58}{M^{1.2}}$	$\frac{0.75 \times 0.0596}{M^{0.9}}$	0.019 × TSP	AP-42 11.9.7 Table 11.9-2	-
4.05	Coal hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
4.06	Coal transfer operations	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	-
4.07	Coal screening	kg/t	0.0125	0.0043	No data, assumed to be zero	AP-42 11.19.2 Table 11.19.2-1	-
4.08	Coal crushing	kg/t	0.0027	0.0012	No data, assumed to be zero	AP-42 11.19.2 Table 11.19.2-2	-

Activity Code	Activity Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
4.09	Coal bulldozing (ROM stockpiles)	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.4}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9.7 Table 11.9-2	-
4.10	Coal bulldozing (product stockpiles)	-	-	-	-	-	Included in equation for wind erosion on active coal stockpiles
5.01	Wind erosion on exposed areas, overburden dumps	kg/ha/h	0.1	0.5 × TSP (0.5 from AP-42 13.2.5)	0.075 × TSP (0.075 from AP-42 13.2.5)	AP-42 11.9.7 Table 11.9-4[(a)]	-
5.02	Wind erosion on active coal stockpiles	kg/ha/h	1.8 × u	0.5 × TSP (0.5 from AP-42 13.2.5)	0.075 × TSP (0.075 from AP-42 13.2.5)	AP-42 11.9.7 Table 11.9-2	-
6.01	Grading roads	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP-42 11.9.7 Table 11.9-2	-
7.01	Rehab bulldozing	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	Bulldozing overburden & front-end loaders on overburden

Where:

S = mean vehicle speed (km/h)
M = material moisture content (%)
U = mean wind speed (m/s)
W = mean vehicle weight (tonnes)
s = material silt content (or surface silt content in unpaved roads) (%). Silt is the fraction of particles smaller than 75 μm in diameter in the road surface material.
A = horizontal area (m^2)
d = drop height (m)

(a) An alternative method for the estimation of wind erosion from exposed areas is contained within AP-42 Chapter 13.2.5. The method takes into account site specific wind data, site-specific erodible material properties (threshold friction velocity, particle size distribution of the material eroded) and the frequency of material disturbance. Notwithstanding the data intensiveness of this approach, exercises in applying this method in mines to date has resulted in little or no wind initiated dust lift-off emissions being predicted from active mine sites. As such, the AP-42 Chapter 11.9.7 approach has been adopted. This is considered both conservative and applicable to the estimation of wind erosion emissions over the longer term.

APPENDIX B: MINE ACTIVITY DATA

Information required for emissions inventory calculation

1. VEGETATION CLEARANCE AND REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Scraping and removing vegetation	Intensity	$N_{Scrape,Veg}$	Number of scrapers	3	-
		$A_{Scrape,Veg}$	Area stripped	45.9	ha/year

2. TOPSOIL (AND SUBSOIL) REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Stripping with scrapers	Emission factor	$N_{Strip,Topsoil}$	Number of scrapers stripping topsoil	3	-
		$w_{Strip,Topsoil}$	Amount of material stripped	390432	tonnes/year
OR Stripping with bulldozers/excavators	Intensity	$N_{Strip,Topsoil}$	Number of dozers stripping topsoil	-	-
		$T_{Strip,Topsoil}$	Time spent by each dozer on topsoil	-	hours/year
	Emission factor	$s_{Strip,Topsoil}$	Silt content of topsoil	10	%
		$M_{Strip,Topsoil}$	Moisture content of topsoil	2.5	%
Loading and emplacing	Intensity	$w_{Load,Topsoil}$	Amount topsoil handled		tonnes/year
	Emission factor	$U_{Load,Topsoil}$	Average wind speed	2.3	m/s
		$M_{Load,Topsoil}$	Moisture content of topsoil	2.5	%
Hauling topsoil	Intensity	$w_{Haul,Topsoil}$	Amount topsoil handled		tonnes/year
	Emission factor	$wt_{Haul,Topsoil}$	Weight per trip (vehicle payload)		tonnes
		$L_{Haul,Topsoil}$	Length of return trip		km
		$W_{Haul,Topsoil}$	Mean gross vehicle weight for hauling topsoil		tonnes
		$s_{Haul,Topsoil}$	Silt content of haul road	2	%

3. OVERBURDEN (AND INTERBURDEN) REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Drilling	Intensity	$N_{Drill,OB}$	Number of holes drilled per year	19159	holes/year
Blasting	Intensity	$N_{Blast,OB}$	Number of blasts per year	73	blasts/year
	Emission factor	$A_{Blast,OB}$	Area per blast	12000	m^2/blast
Draglines	Intensity	$V_{Drag,OB}$	Volume of material	-	m^3
	Emission factor	$d_{Drag,OB}$	Drop distance	-	m
		$M_{Drag,OB}$	Moisture content of overburden	2.5	%
Loading and emplacing	Intensity	$w_{Load,OB}$	Overburden amount handled	16064785	BCM/year
		$d_{Load,OB}$	Density of overburden	2.2	tg/m^3
	Emission factor	$U_{Load,OB}$	Average wind speed	2.3	m/s
		$M_{Load,OB}$	Moisture content of overburden	2.5	%
Hauling OB	Intensity	$w_{Haul,OB}$	Overburden amount hauled	16064785	BCM/year
		$d_{Haul,OB}$	Density of overburden	2.2	t/m^3
	Emission factor	$wt_{Haul,OB}$	Weight per trip (vehicle payload)	130	tonnes
		$L_{Haul,OB}$	Length of return trip	3.6	km
		$W_{Haul,OB}$	Gross vehicle weight	250	tonnes
		$s_{Haul,OB}$	Silt content of haul road	10	%
Bulldozing	Intensity	$N_{Dozer,OB}$	Number of bulldozers working on overburden	3	-
		$T_{Dozer,OB}$	Time spent by each bulldozer on overburden	1575	hours/year
	Emission factor	$s_{Dozer,OB}$	Silt content of overburden	10	%
		$M_{Dozer,OB}$	Moisture content of overburden	2.5	%

3. COAL REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Bulldozers ripping/pushing/clean-up	Intensity	$N_{Dozer,Coal}$	Number of dozers working on coal removal	1	-
		$T_{Dozer,Coal}$	Time spent by each dozer on coal removal	945	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	10	%
		$M_{Dozer,Coal}$	Moisture content of coal	8	%
Drilling	Intensity	$N_{Drill,Coal}$	Number of holes drilled per year	0	holes/year
Blasting	Intensity	$N_{Blast,Coal}$	Number of blasts per year	0	blasts/year
	Emission factor	$A_{Blast,Coal}$	Area per blast	0	m^2/blast
All truck loading and unloading operations (*e.g.* ROM coal > trucks, ROM coal > stockpile, ROM coal > hopper, *etc.*)	Intensity	$w_{Load,Coal}$	Total weight loaded and unloaded	1657518	tonnes/year
	Emission factor	$M_{Load,Coal}$	Moisture content of coal	8	%
Hauling Coal	Intensity	$w_{Haul,Coal}$	Coal amount hauled	1657518	tonnes/year
	Emission factor	$wt_{Haul,Coal}$	Weight per trip (vehicle payload)	74	tonnes
		$L_{Haul,Coal}$	Length of return trip	3.4	km
		$W_{Haul,Coal}$	Gross vehicle weight	165	tonnes
		$s_{Haul,Coal}$	Silt content of ROM coal	10	%
All material transfer operations (*e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor,	Intensity	$w_{Trans,Coal}$	Weight handled/transferred	1614342	tonnes/year
		$N_{Trans,Coal}$	Number of handling, transfer points	6	-
	Emission factor	$U_{Trans,Coal}$	Average wind speed	2.3	m/s
		$M_{Trans,Coal}$	Moisture content of coal	8	%
Screening	Intensity	$w_{Screen,Coal}$	Amount Coal screened	41717	tonnes/year
Crushing	Intensity	$w_{Crush,Coal}$	Amount Coal Crushed	1614342	tonnes/year
Bulldozing on ROM stockpiles	Intensity	$N_{Dozer,Coal}$	Number of dozers working on stockpiles	1	-
		$T_{Dozer,Coal}$	Time spent by each dozer on stockpiles	562	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	10	%
		$M_{Dozer,Coal}$	Moisture content of coal	8	%
Bulldozing on product stockpiles	Intensity	$N_{Dozer,Coal}$	Number of dozers working on stockpiles	0	-
		$T_{Dozer,Coal}$	Time spent by each dozer on stockpiles	0	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	10	%
		$M_{Dozer,Coal}$	Moisture content of coal	8	%

4. WIND EROSION

Activity	Calculation	Variable	Variable description	Value	Units
Exposed areas, including overburden dumps	Intensity	$a_{Expos.,Wind}$	Surface area	239	ha
Active coal stockpiles	Intensity	$a_{Active,Wind}$	Surface area	6	ha
	Emission factor	$s_{Active,Wind}$	Silt content	10	%
		$p_{Active,Wind}$	No. of days with rainfall > 0.25 mm	76	days
		$f_{Active,Wind}$	% of time with wind speed > 5.4 m/s	4.2	%

5. ROAD GRADING

Activity	Calculation	Variable	Variable description	Value	Units
Road grading	Intensity	N_{Grade}	Number of graders employed at site	2	-
		T_{Grade}	Utilisation Rate (or hours of operation)	90	%
	Emission factor	S_{Grade}	Mean vehicle speed	7.5	km/h

6. REHABILITATION

Activity	Calculation	Variable	Variable description	Value	Units
Bulldozing on rehab	Intensity	$N_{Dozer,Rehab}$	Number of dozers working on rehab	0	-
		$T_{Dozer,Rehab}$	Time spent by each dozer on rehab	0	hours/year
		$A_{Dozer,Rehab}$	Area of active rehab	0	ha
	Emission factor	$s_{Dozer,Rehab}$	Silt content	10	%
		$M_{Dozer,Rehab}$	Moisture content	2.5	%
Scrapers on rehab	Emission factor		Number of scrapers replacing topsoil	4	-
			Amount of material replaced	0	tonnes/year
Bulldozing on rehab (final trim)	Intensity		Number of dozers working on rehab	0	-
			Time spent by each dozer on rehab	0	hours/year
			Area of active rehab	0	ha
	Emission factor		Silt content	10	%

APPENDIX C: COSTING

Cost of Implementation for Larger Trucks

MINING ACTVITY	**Hauling on unsealed roads**											
Specific best practice measure	Use of Larger Trucks (140t - 220t) (20%)											
Mass emissions through application of best practice (tonnes/year)	TSP	628.0										
	PM10	134.4										
	PM2.5	13.4										
Current emissions (tonnes/year) - current control 75%	TSP	785.0										
	PM10	168.0										
	PM2.5	16.800										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	157										
	PM10	34										
	PM2.5	3										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Cat 793 x 4 - Assuming 4 additional 793's to the existing fleet	$ 16,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 16,000,000**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$ 16,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 16,000,000**
Labour costs including directly related on-costs (list each item)	parts x 4	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	$ 521,116	**$ 5,211,160**
	body repair x 4	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	$ 346,460	**$ 3,464,600**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)	tyres x 4	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	$ 815,200	**$ 8,152,000**
	fuel x 4	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	$ 4,695,552	**$ 46,955,520**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total material and other costs		**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 63,783,280**
Total costs		**$ 22,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 79,783,280**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 142,537	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	**$ 508,174**
	PM10	$ 666,022	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	**$ 2,374,502**
	PM2.5	$ 6,660,217	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	**$ 23,745,024**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$ 22,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 6,378,328**	**$ 79,783,280**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 142,537	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 40,626	$ 508,174
	PM10	$ 666,022	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 189,831	$ 2,374,502
	PM2.5	$ 6,660,217	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 1,898,312	$ 23,745,024

Cost of Implementation for Water Sprays on Stockpiles

MINING ACTVITY	Wind Erosion and Maintenance by Dozers - Coal Stockpiles											
Specific best practice measure	Water Sprays (50%)											
Mass emissions through application of best practice (tonnes/year)	TSP	10.6										
	PM10	4.1										
	PM2.5	0.2										
Current emissions (tonnes/year) - current control 0%	TSP	21.2										
	PM10	8.1										
	PM2.5	0.3										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	11										
	PM10	4										
	PM2.5	0										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	pipes, sprinklers, generator etc. incl. installation	$ 2,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 2,000,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$2,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,000,000**
Labour costs including directly related on-costs (list each item)	Maintence and operating costs	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	**$ 2,300,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total material and other costs		**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 2,300,000**
Total costs		**$2,230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 4,300,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 210,377	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	**$ 405,660**
	PM10	$ 550,617	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	**$ 1,061,728**
	PM2.5	$14,866,667	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	**$ 28,666,667**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$2,230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 4,300,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 210,377	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 21,698	$ 405,660
	PM10	$ 550,617	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 56,790	$ 1,061,728
	PM2.5	$14,866,667	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 28,666,667

Cost of Implementation for enclosing ROM hopper

MINING ACTVITY	Loading and dumping ROM coal to hopper											
Specific best practice measure	Enclosed Dump Hopper (3 sides and a roof) (70%)											
Mass emissions through application of best practice (tonnes/year)	TSP	16.7										
	PM10	2.4										
	PM2.5	0.3										
Current emissions (tonnes/year) - current control 50%	TSP	55.5										
	PM10	8.0										
	PM2.5	1.1										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	39										
	PM10	6										
	PM2.5	1										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)		$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 250,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 250,000**
Labour costs including directly related on-costs (list each item)	General Maintenance	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	**$ 50,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 50,000**
	Total costs	**$ 255,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 300,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 6,564	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	**$ 7,722**
	PM10	$ 45,536	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	**$ 53,571**
	PM2.5	$ 331,169	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	**$ 389,610**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$ 255,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 300,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 6,564	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 129	$ 7,722
	PM10	$ 45,536	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 893	$ 53,571
	PM2.5	$ 331,169	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 6,494	$ 389,610

Cost of Implementation for Wind Shielding on Conveyors

MINING ACTVITY	**Conveyors and Transfers**											
Specific best practice measure	Wind Shielding - roof and wall (70%)											
Mass emissions through application of best practice (tonnes/year)	TSP	0.0										
	PM10	0.0										
	PM2.5	0.0										
Current emissions (tonnes/year) - current control 40%	TSP	0.0										
	PM10	0.0										
	PM2.5	0.0										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	0										
	PM10	0										
	PM2.5	0										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Engineers investigation and drawings	$ 20,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 20,000**
	Hire of equipment	$ 20,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 20,000**
	supply materials and install	$ 250,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 290,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 290,000**
Labour costs including directly related on-costs (list each item)	maintenace	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	**$ 20,000**
	operational access to conveyor	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	**$ 350,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 370,000**
	Total costs	**$ 327,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 660,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
	PM10	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
	PM2.5	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$ 327,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 660,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	PM10	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	PM2.5	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Note: emissions were not estimated for wind erosion from conveyors, as emissions were expected to be minor. Therefore cost per tonne of PM suppressed could not be calculated.