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Charbon Colliery

Site Specific Particulate Matter Control

Best Practice Assessment

Report Number 630.10284.00200-R1

6 February 2012

Charbon Coal Pty Ltd
PO Box 84
Kandos NSW 2848

Version: Revision 1

Charbon Colliery

Site Specific Particulate Matter Control

Best Practice Assessment

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630.10284.00200	Revision 1	6 February 2012	Gary Graham Kirsten Lawrence Martin Doyle	Gary Graham Kirsten Lawrence Martin Doyle	Gary Graham

EXECUTIVE SUMMARY

Background

Charbon Coal Pty Ltd owns and operates the Charbon Colliery, near Kandos, NSW. Current coal extraction operations at Charbon Colliery were approved on 7 September 2010 and the conditions of approval include air quality criteria to ensure that dust emissions generated by the Colliery do not cause additional exceedances of air quality criteria in the surrounding area.

Ongoing air quality monitoring surrounding the Colliery confirms that all measures of air quality required within the Project Approval (TSP, PM_{10} and dust deposition) are well below the specified criteria. Additionally, in the last 12 months, Charbon Colliery has had no complaints relating to dust nuisance.

Given the above, it is considered reasonable to conclude that current dust emission controls employed at the site are sufficient to manage the potentially dust-emitting sources at the site to a level where they are not creating any dust nuisance or health related issues in the surrounding area.

Pollution Reduction Program

In August 2011, the NSW Office of Environment and Heritage (OEH) required, through a Pollution Reduction Program, that Charbon Coal provides a report which examines in detail the potential measures that could be employed to further reduce particulate emissions from the Colliery. This is part of a larger program which aims to reduce particulate emissions from the coal mining industry as a whole in NSW.

Emissions were required to be quantified using United States Environmental Protection Agency approved emission factors without controls applied. Emission controls currently in place at the Charbon Colliery were identified, and the control efficiency afforded by each applied measure, obtained through a literature review, were applied to these emissions to provide an estimate of current TSP, PM_{10} and $PM_{2.5}$ emission loads.

Particulate emission sources at the site were ranked according to the scale of emissions over a one year period with the top four sources identified and taken forward for further investigation. The study guidelines required that additional control options were identified for the top four sources, with the feasibility of implementing each control option to be assessed with consideration to implementation costs, regulatory requirements, environmental impacts, safety implications and compatibility with current processes and any proposed future developments.

Following this feasibility assessment, a timeframe for implementation of particulate management measures was required to be provided.

Findings

This report has followed the requirements of the NSW Office of Environment and Heritage with the four major sources of particulate emissions being identified as:

- Wind erosion sources;
- Road haulage sources;
- Dumping of Run of Mine coal; and
- Bulldozer activity on coal.

EXECUTIVE SUMMARY

A literature review of the international best practice measures which could be employed to reduce emissions from these sources was performed. Notwithstanding cost, in total, twelve measures were identified as being feasible for implementation at the Charbon Colliery. Following consideration of cost, and cost effectiveness, four measures were identified as being practical for further investigation, trial and potential implementation.

Ongoing Actions and Implementation Timeframe

The measures identified for implementation at the Charbon Colliery are:

- The use of chemicals on unpaved haul routes to reduce wheel generated dust.
- Revegetation of areas susceptible to wind erosion;
- The application of gravel on areas susceptible to wind erosion;
- The installation of wind breaks or earth bunds to deflect wind from erodible areas; and

Charbon Colliery already implements some of the above measures on certain parts of the mining lease. This report has identified that wider implementation of these measures would result in the emission of a significantly lower quantity of particulate emissions. If all four of the above measures were applied on all appropriate areas, a total of 3,000 tonnes of PM_{10} could be avoided being emitted over the next five years which represents a site-wide reduction of 60%. It is noted that this review has been performed based on a 5 year horizon, rather than 10 years as per OEH requirements, because the Colliery is only permitted to operate until 2017.

In summary, Charbon Coal commits within this report to the following:

- Further trials of dust suppressant chemicals on the Western Open Cut to 3rd Entry ROM haul road and if successful, will investigate the widespread implementation of the control measure across the other haul roads.
- Revegetation of open areas already occurs in a progressive manner at Charbon Colliery, however a commitment is made to revegetate additional areas on an as needs basis to avoid wind erosion of disturbed areas.
- A trial of gravel application and the installation of fences or earth bunds will be performed in an area of open cut coal mining in 2012 and if successful in reducing wind erosion, a wider trial will be implemented in 2013.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS

FIGURES

APPENDICES

This document forms one part of a two-part submission. This document comprises the main report of the submission, and is accompanied by a stand-alone document entitled *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment – Appendix 1* (ref: 630.10284.00200R1A1 which contains the cost information.

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) was commissioned by Charbon Coal Pty Ltd (a subsidiary of Centennial Coal) to perform this assessment, which has included a site inspection, emissions estimation and the identification, quantification and justification of control measures for the site. The study was performed in accordance with the *Coal Mine Particulate Matter Control – Best Practice: Site Specific Determination Guideline*[1] issued by OEH in November 2011.

The findings of this assessment are presented in the following report for submission to OEH.

This document forms one part of a two-part submission. This document comprises the main report of the submission, and is accompanied by a stand-alone document entitled *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment – Appendix 1* (ref: 630.10284.00200R1A1 which contains the cost information. This submission has been prepared into this format to comply with the New South Wales (NSW) Office of Environment and Heritage (OEH) specifications as stipulated in the Licence Variation Condition U.3.

1.1 Background

In 2010, the NSW OEH commissioned a detailed review of particulate matter (PM) emissions from coal mining activities in the Greater Metropolitan Region (GMR) of NSW. This review was completed in 2011 and one of the key recommendations of the study was that each mine should carry out a site-specific determination of best management practice. This recommendation has been adopted by the OEH through the implementation of the "*Dust Stop*" program.

The Dust Stop program aims to ensure that the most reasonable and practical particulate control options are implemented by each coal mine. Under this program, all coal mines in NSW are required to prepare a report that compares their current operation with international best practice. Mines are also required to report on the practicability of implementing each best practice measure and for any measures found to be practicable are required to provide a timetable for implementation. Once complete, copies of each report will be available on the mine's website.

The Dust Stop program is being implemented through pollution-reduction programs (PRPs) as operating conditions under the Environmental Protection Licence (EPL). A PRP was issued to Charbon Colliery in August 2011 requiring that a Site Specific Particulate Matter Control Best Practice Assessment be prepared for the site.

1.2 Guidance

OEH has provided guidance on the general structure and methodology of the assessment report. For clarification, the guidance provided has been reproduced in **Appendix A**.

Briefly, the process that is required is indicated below. For each required step in the procedure, reference has been provided to the relevant sections in this assessment report:

1.	Identify, quantify and justify existing measures that are being used to minimise particle emissions	**Section 2**
2.	Identify, quantify and justify best practice measures that could be used to minimise particle emissions	**Section 3**
3.	Evaluate the practicability of implementing these best practice measures	**Section 4**
4.	Propose a timeframe for implementing all practicable best practice measures	**Section 5**

[1] http://www.environment.nsw.gov.au/resources/air/20110813coalmineparticulate.pdf

1.3 Description of the Coal Mine

The annual quantities of coal and overburden currently produced at Charbon Colliery are presented in **Table 1** . This assessment has been prepared based upon this throughput, which is consistent with the Air Quality Impact Assessment prepared for the operations (SLR Consulting, 2011).

Also presented in **Table 1** are the silt and moisture contents of the coal and overburden.

Table 1 Quantities and Characteristics of Extracted Material

Material	Quantity Extracted (tonnes per annum)	Silt Content (%)	Moisture Content (%)
Coal	1,200,000	6	10
Overburden	4,200,000 *	5	10

* Overburden associated with 600,000 tonnes of open cut coal extraction at a strip ratio of 7:1.

Silt and moisture contents of coal and overburden at the site have not been assessed within a laboratory, although it is considered that the values presented in **Table 1** are generally typical of coal mining operations, and are within the appropriate ranges provided in the US EPA AP-42, Chapter 11.9 '*Western Surface Coal Mining'* document.

Coal is currently extracted from four areas at Charbon Colliery:

- Southern Open Cut (abbreviated to SOC in some tables), at approximately 400,000 tonnes per annum.
- Western Open Cut (abbreviated to WOC in some tables), at approximately 200,000 tonnes per annum.
- Charbon Underground (abbreviated to CU in some tables), at approximately 400,000 tonnes per annum.
- Western Underground (abbreviated to WU in some tables), at approximately 200,000 tonnes per annum.

Coal from the Southern Open Cut is extracted using a combination of bulldozer, front end loader (FEL) and excavator and loaded onto haul trucks. These haul trucks travel the 3.5 km haul route north to the Third Entry ROM where coal is stockpiled. Coal extracted in the Charbon Underground surfaces on a conveyor at the 2-3 Trunk ROM. Coal from the Southern Open Cut is added to a conveyor at the Third Entry ROM, via a Bradford Breaker and is transported underground to reach the surface at the 2-3 Trunk ROM. All coal from the Southern Open Cut and Charbon Underground is then fed onto another conveyor, which transports it underground to the CHPP.

Coal extracted in the Western Open Cut and Western Underground is loaded onto semi-trailer trucks and is transported 1.4 km via road to the 2-3 Trunk ROM where it is stockpiled, loaded onto the conveyor system and conveyed underground to the CHPP.

Once at the CHPP, all coal is crushed, washed and screened, with coarse rejects directly loaded into a 12 tonne tipper from an 80 tonne coarse reject bin and hauled to the Reject Emplacement Area (REA). Product coal is transported via conveyor to the ROM stockpile located in the middle of the rail loop and loaded either onto semi-trailer trucks for distribution by road, or via a loader to train wagons for distribution by rail.

Waste rock generated by open cut mining is loaded onto haul trucks and hauled to in-pit dump locations.

No blasting is currently occurring at the Project Site and coal is excavated using a combination of FEL and excavator only.

Figure 1 and **Figure 2** present graphically the coal and overburden extraction, transport, processing and placement procedures performed at Charbon Colliery.

Figure 1 Coal Extraction, Transport and Processing – Charbon Colliery

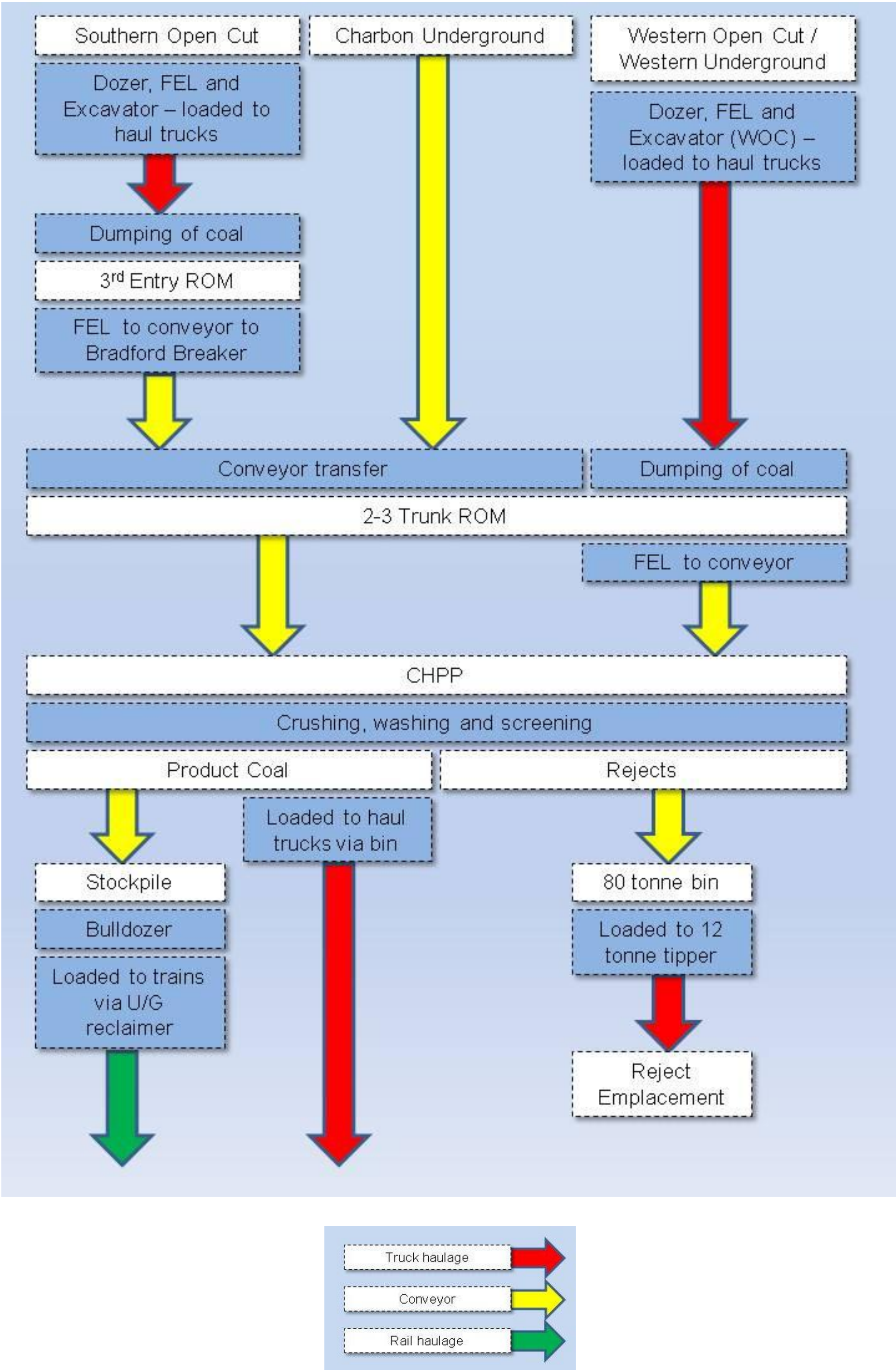
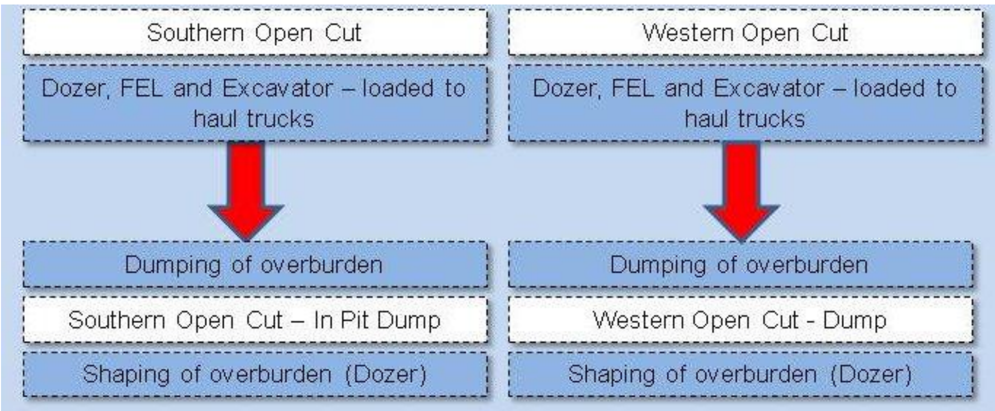
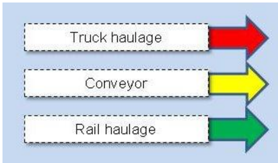


Figure 2 Overburden Extraction, Transport and Placement





1.4 Project Approval Conditions

Project Approval Conditions for the Charbon Colliery under Section 75J of the *Environmental and Planning Assessment Act 1979*, dated 7 September 2010 include air quality criteria to ensure that the dust emissions generated by the Colliery do not cause additional exceedances of air quality criteria. These criteria are outlined in **Table 2** and are not to be exceeded at any residence on privately owned land, or on more than 25% of any privately owned land.

Table 2 Impact Assessment Criteria for Particulate Matter and Dust Deposition

Pollutant	Averaging Period	Criterion	
Total suspended particulate matter (TSP)	Annual	90 µg/m³	
Particulate matter <10 µm (PM_{10})	Annual	30 µg/m³	
	24 hour	50 µg/m³	
		Maximum increase in deposited dust level	**Maximum total deposited dust level**
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

1.5 Environmental Licence Conditions

The OEH regulates the operations conducted at Charbon Colliery through an Environmental Protection Licence issued under the Protection of the Environment Operations Act 1997 (POEO Act). Environmental Protection Licence number 528 (Charbon Coal Pty Ltd) contains the following conditions in relation to dust (with the exception of the requirements in condition U1, which are considered within this report):

O3.1 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

O3.2 Haulage trucks entering and leaving the premises that are carrying loads must be covered at all times, except during loading and unloading. The tailgates of all haulage trucks leaving the premises must be securely fixed prior to loading or immediately after unloading to prevent loss of material.

Charbon Colliery operates a complaints recording and management system as part of their over-arching management system and in accordance with Condition M4 of the EPL. In the last 12 months, Charbon Colliery has had no complaints relating to dust nuisance, and as such it is considered reasonable that current dust emission controls employed at the site are sufficient to manage the potentially dust-emitting sources to not create any dust nuisance issues.

Haulage trucks entering and leaving the colliery are checked to ensure that they are securely closed and covered.

OEH do not have any current Notices issued to Charbon Colliery.

1.6 Environmental Performance

Considering the requirements of both the Project approval and EPL, Charbon Colliery operates an air quality monitoring program for TSP, PM_{10} and dust deposition. PM_{10} and TSP monitoring is performed at the Nioka residence, to the west of the Southern Open Cut. Dust deposition monitoring is performed at a total of five locations surrounding the Colliery. Data for the recently installed dust gauge DM-Craze have not been used within this report to assess compliance with Project and EPL conditions given the limited data available to date (three measurements over the most recent three months).

Monitoring results for PM_{10} and TSP are presented in **Table 3** for the period 6 February 2010 to 27 January 2012 and demonstrate that for both PM_{10} and TSP, compliance with the Project Approval Conditions is being achieved at the monitoring site.

Table 3 Monitoring Results for Particulate Matter – Charbon Colliery

Pollutant	Averaging Period	Monitoring Results	Criterion	Compliance
Total suspended particulate matter (TSP)	Annual	**16.7 µg/m³** (2010) **16.1 µg/m³** (2011)	90 µg/m³	✓
Particulate matter <10 µm (PM_{10})	Annual	**7.9 µg/m³** (2010) **8.7 µg/m³** (2011)	30 µg/m³	✓
	24 hour	**21.2 µg/m³** (2010) **19.0 µg/m³** (2011)	50 µg/m³	✓

Note: (2010) relates to period 6 February 2010 to 7 February 2011
(2011) relates to period 13 February 2011 to 13 January 2012

Monitoring results for dust deposition are presented in **Table 4** for the period 18 January 2010 to 13 January 2012. These results demonstrate that for dust deposition, compliance with the Project Approval Conditions is also being achieved.

Table 4 Monitoring Results for Dust Deposition – Charbon Colliery

Pollutant	Averaging Period	Monitoring Results	Maximum increase in deposited dust level	Maximum total deposited dust level	Compliance
Deposited dust	Annual	DM-South – **0.7 g/m²/month** (2010) DM-South - **1.2 g/m²/month** (2011) DM-West – **0.6 g/m²/month** (2010) DM-West – **0.3 g/m²/month** (2011) Nioka – **0.5 g/m²/month** (2010) Nioka – **0.6 g/m²/month** (2011) Pit Top – **0.9 g/m²/month** (2010) Pit Top – **0.7 g/m²/month** (2011)	2 g/m²/month	4 g/m²/month	✓

Note: (2010) relates to period 18 January 2010 to 16 December 2010
(2011) relates to period 14 January 2011 to 15 December 2011

2 IDENTIFICATION OF EXISTING CONTROL MEASURES & EMISSION ESTIMATION

1. *Identify, quantify and justify existing measures that are being used to minimise particle emissions*

1.1 Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity. This estimate must:

- *Utilise USEPA AP-42 emission estimation techniques (or other method as approved in writing by the EPA),*
- *Calculate uncontrolled emissions (with no particulate matter controls in place), and*
- *Calculate controlled emissions (with current particulate matter controls in place).*

Notes: These particulate matter controls must be clearly identified, quantified and justified with supporting information. This means adding supporting information and evidence, including monitoring data, record keeping, management plans and/or operator training.

1.2 Using the results of the controlled emission estimates generated from Step 1.1, rank the mining activities according to the mass of TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity per year from highest to lowest.

1.3 Identify the top four mining activities from step 1.2 that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.

2.1 Estimation of Baseline Particulate Emissions

In the estimation of baseline emissions of particulate matter, United States Environmental Protection Agency (USEPA) AP-42, *Compilation of Air Pollutant Emission Factors* estimation techniques have been utilised, as prescribed in the methodology presented in **Appendix A** and reproduced above.

AP-42 Chapter 11 (Mineral Products Industry) and AP-42 Chapter 13 (Miscellaneous Sources) have been referenced to estimate emissions from mining activities occurring at the Charbon Colliery. **Table 5** presents a summary of the AP-42 reference sections for the various emission factors used in this assessment report.

Table 5 Particulate Emissions Sources and Relevant USEPA AP-42 Emission Factors

Emissions Source	AP-42 Chapter	Notes
Bulldozing coal	Chapter 11.9 Western Surface Coal Mining (1998)	
Front end loaders and excavators on coal	Chapter 11.9 Western Surface Coal Mining (1998)	
Material transfer of coal by conveyor		
Loading coal stockpiles	Chapter 11.9 Western Surface Coal Mining (1998)	
Wind erosion of coal stockpiles	Chapter 11.9 Western Surface Coal Mining (1998)	
Coal crushing	Chapter 11.24 Metallic Minerals Processing (1982)	Adopted in the NPI in absence of coal specific factors
Coal screening	Chapter 11.24 Metallic Minerals Processing (1982)	
Loading coal to trains	Chapter 11.9 Western Surface Coal Mining (1998)	
Loading coal to trucks	Chapter 11.9 Western Surface Coal Mining (1998)	
Bulldozing overburden	Chapter 11.9 Western Surface Coal Mining (1998)	
Front end loaders and excavators on overburden	Chapter 11.9 Western Surface Coal Mining (1998)	
Loading and dumping of overburden	Chapter 11.9 Western Surface Coal Mining (1998)	
Wind erosion of overburden	Chapter 11.9 Western Surface Coal Mining (1998)	
Wheel generated particulates on unpaved roads	Chapter 13.2.2 Unpaved Roads (2006)	
Graders operating on unpaved roads / overburden	Chapter 11.9 Western Surface Coal Mining (1998)	

Note: No above ground blasting occurs at Charbon Colliery

Appendix B outlines the emission factors used for each activity occurring at Charbon Colliery.

A discussion of the annual activity related to each action and the subsequent calculated emission rates of TSP, PM_{10} and $PM_{2.5}$ are provided in **Section 2.1.1**. As required by the OEH, emissions are presented firstly as uncontrolled emissions, and secondly as emissions with controls currently employed in place.

2.1.1 Activity Data

Annual activity data for the activities presented in **Table 5** are provided in **Table 6** (material handling), **Table 7** (road haulage), **Table 8** (grading operations), and **Table 9** (wind erosion sources).

Table 6 Annual Activity Data for Material Handling Operations

Operation/Activity	Number	Activity Rate (Annual)	Units	Notes
COAL				
Excavators / Front End Loaders on Coal	1	1,021,219	tonnes	FEL on coal at CHPP - 21,219 tonnes Plus 100% of coal from SOC, WOC and WU (1,000,000 tonnes)
Bulldozers on Coal	6	6,920	hrs	3,000 hrs at CHPP 3,920 hrs in all other areas
Trucks Dumping Coal	-	800,000	tonnes	Coal from Southern Open Cut at 3rd Entry ROM (400,000 tonnes) Coal from Western Open Cut and Western Underground at 2-3 trunk ROM (400,000 tonnes)
Bradford Breaker	1	400,000	tonnes	All coal from Southern Open Cut (400,000 tonnes)
Conveyor Transfer Points	3	1,600,000	tonnes	All coal from Southern Open Cut to conveyor at 3rd Entry ROM (400,000 tonnes) All coal from Charbon Underground transfer at 2-3 Trunk ROM (400,000 tonnes) All coal from Southern Open Cut transfer at 2-3 Trunk ROM (400,000 tonnes) All coal from Western Open Cut and Western Underground to conveyor at 2-3 Trunk ROM (400,000 tonnes)
Primary Crushing		1,200,000	tonnes	
Screening		1,200,000	tonnes	
Loading Coal to Trains		864,000	tonnes	Equals 75% of extracted coal (25% rejects)
Loading Coal to Trucks		54,000	tonnes	94% of Product Coal loaded to trains 6% of Product Coal loaded to trucks
Trucks Dumping Rejects		282,000	tonnes	Equals 25% of extracted coal (75% product)
OVERBURDEN				
Excavators / Front End Loaders on Overburden	3	4,200,000	tonnes	Total handled
Bulldozers on Overburden	6	11,760	hrs	Total hours
Trucks dumping Overburden	-	4,200,000	tonnes	Total dumped

Table 7 Annual Activity Data for Road Haulage Operations

Haul Road Name	Length (m)	Width (m)	VKT per year	Mean Vehicle Weight (tonnes)	Silt Content (%)
SOC to 3rd Entry ROM	3,500	12	11,532	442.2	5
SOC to in pit dump	400	12	37,250	118.6	5
WOC to 2-3 Trunk ROM	1,400	10	13,661	442.2	5
WOC to in pit dump	300	12	6,954	118.6	5
Product trucks	1,600	10	16,640	25	5
REA tailings	300	10	1,095	442.2	5

Table 8 Annual Activity Data for Grading Operations

Number	Hours of Operation per Year	Mean Vehicle Speed (km/hr)
2	100	3

Table 9 Annual Activity Data for Wind Erosion Sources

Open Area	Total Area (ha)	Active Area (ha)	Emission Factor Applied to Active Area	Notes
Southern Open Cut	125	12.5	Active Storage Pile AP-42 Chapter 11.9	Includes overburden dump
Western Open Cut	9	1.8	Active Storage Pile AP-42 Chapter 11.9	Includes overburden dump
3rd Entry ROM	1	1	Active Storage Pile AP-42 Chapter 11.9	Includes coal stockpiles
2-3 Trunk ROM	1	1	Active Storage Pile AP-42 Chapter 11.9	Includes coal stockpiles
CHPP	4	4	Active Storage Pile AP-42 Chapter 11.9	Includes coal stockpiles
REA Tailings	18	1	Active Storage Pile AP-42 Chapter 11.9	

It is noted that the most appropriate emission factor for wind erosion from non-coal sources (SOC and WOC) would be that contained in the AP-42 Industrial Wind Erosion Chapter 13.2.5. However, when annual emissions due to wind erosion from these sources are calculated using this methodology and the threshold friction velocity for overburden of 1.02 (as quoted in Table 13.2.5-2 of AP-42) they are estimated to be zero. Using a more conservative threshold friction velocity of 0.5 (similar to fine coal dust on a concrete pad) results in total annual emissions of TSP to be 0.9 kg/ha/yr. Both of these emission estimates are considered to be unrealistic for open, disturbed areas. Therefore, the emission factor for active storage piles (AP-42 Chapter 11.9) has been adopted for all wind erosion sources in this report (refer **Appendix B**).

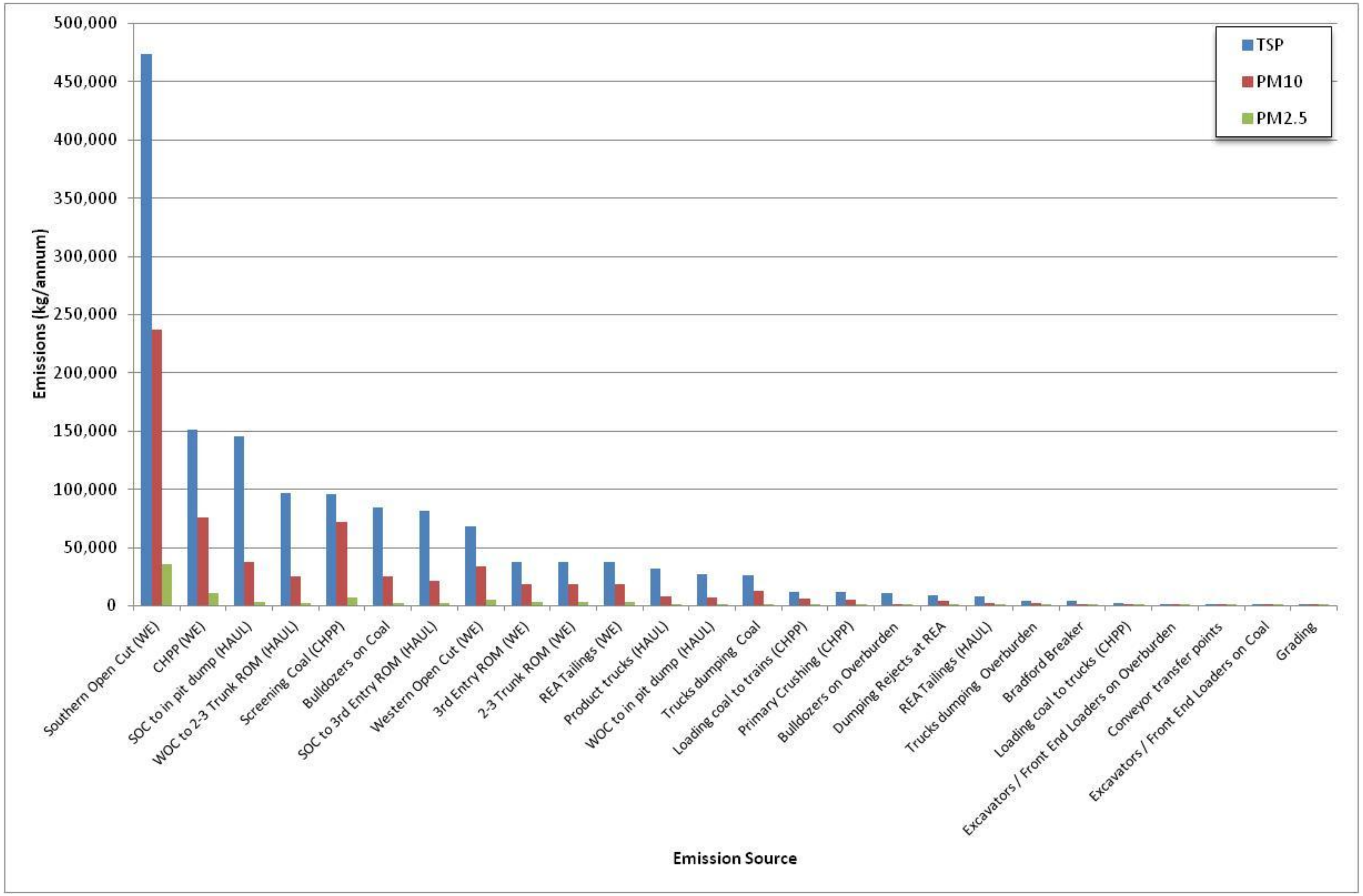
2.1.2 Uncontrolled Particulate Emissions

Using the emission factors calculated in **Appendix B** and the annual activity data presented in **Section 2.1.1**, the annual (uncontrolled) particulate emissions from Charbon Colliery are presented in **Table 10** and graphically in **Figure 3**.

Table 10 Uncontrolled Annual Particulate Emissions – Charbon Colliery

Emission Source	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)
Material Handling - Coal			
Excavators / Front End Loaders on Coal	142	67	10
Bulldozers on Coal	84,205	25,629	2,563
Trucks dumping Coal	26,400	13,200	1,320
Bradford Breaker	4,000	1,600	160
Conveyor transfer points	223	105	11
Primary Crushing	12,000	4,800	480
Screening	96,000	72,000	7,200
Loading coal to trains	12,096	6,048	605
Loading coal to trucks	1,976	304	30
Dumping Rejects at REA	9,306	4,653	465
Material Handling - Overburden			
Excavators / Front End Loaders on Overburden	585	277	42
Bulldozers on Overburden	10,572	1,767	177
Trucks dumping Overburden	4,200	2,100	210
Road Haulage			
SOC to 3rd Entry ROM	81,634	20,976	2,098
SOC to in pit dump	145,849	37,476	3,748
WOC to 2-3 Trunk ROM	96,705	24,849	2,485
WOC to in pit dump	27,228	6,996	700
Product trucks	32,334	8,308	831
REA tailings	7,751	1,992	199
Grading			
Graders	57	25	2
Open Areas			
Southern Open Cut	473,513	236,756	35,513
Western Open Cut	68,186	34,093	5,114
3rd Entry ROM	37,881	18,941	2,841
2-3 Trunk ROM	37,881	18,941	2,841
CHPP	151,524	75,762	11,364
REA Tailings	37,881	18,941	2,841
TOTAL	**1,460,129**	**636,605**	**83,849**

Figure 3 Uncontrolled Annual Particulate Emissions – Charbon Colliery



2.2 Existing Control Measures

As part of this assessment, a site audit was conducted in January 2012 to identify and verify the current dust control measures being implemented at Charbon Colliery. A summary of the existing control measures identified as currently being implemented at the Charbon Colliery is provided below. Additional details are provided in the following sections.

The Air Quality Management Plan (May 2011) identifies a number of particulate control measures which are implemented at Charbon Colliery. These are reproduced in **Table 11**. The actual emission controls applied currently at Charbon Colliery are presented in **Table 12**.

Table 11 Existing Control Measures Implemented at the Site

Source	Control Measures	Observations during Audit on 12/01/12
Wind-Blown Dust Sources		
Areas disturbed by mining operations	Disturb only the minimum area necessary for mining; Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden dumping; and Regular assessment of meteorological conditions should be made to identify conditions which would be unfavourable in terms of dust levels to the west of the site.	In progress rehabilitation and final rehabilitated landform observed - refer **Figure E1** in **Appendix E**
Coal Handling Facilities	Maintain coal-handling areas in a moist condition using water carts or alternative means to minimise wind-blown and traffic generated dust.	Coal generally moist on stockpile following washing – refer **Figure E2** in **Appendix E**
Coal Stockpiles	Automatic sprays on all stockpiles where practical to be installed.	Infrastructure but not operation observed – no coal processing or mining occurring on day of audit
Mine-Generated Dust Sources		
Haul Road Dust	Water all roads and trafficked areas using water cart to minimise the generation of dust; Clearly define edges of all haul roads with marker posts or equivalent to control their locations, especially crossing larger overburden emplacement areas; Enforce speed limits on all on-site vehicles to minimise wheel-generated dust; and Reduce speed on haul roads during high winds.	No mining occurring on day of audit, however roads were watered – refer **Figure E3** in **Appendix E**
Minor Roads	Development of minor roads will be limited where possible and locations monitored; Enforce speed limits on all on-site vehicles to minimise wheel-generated dust; Minor roads used regularly for access will be watered; and The use of dust suppressant will be explored, where practical, for minor roads.	Not Observed
Topsoil Stockpile	Soil stockpiles not required for more than three months would be revegetated.	Not Observed
Coal Handling and Preparation Plant	Conveyors will be shielded on top and a minimum of one side, and automatic	Shielded conveyors observed – refer **Figure E4** in **Appendix E** (at CHPP)

	sprays will be fitted at transfer points; Use of a water cart as required.	
Processing Area	Fit water sprays at key transfer points.	Not Observed
Plant and Equipment	All plant and equipment installed at the mine will be maintained and operated in a proper and efficient condition.	Not Observed
Excessive Dust Events[1]		
Haul Roads	Deployment of additional water cart movements to control haul road dust; and Relocation of exposed haul truck routes.	Excessive dust event not observed
Overburden Emplacement Areas	Relocation or modification of exposed operations such as topsoil removal or overburden dumping	Excessive dust event not observed
Areas disturbed by Mining Operations	Where relocation is not possible temporary halting of activities and resuming when weather conditions have improved will be assessed.	Excessive dust event not observed
Haul Roads	Deployment of additional water cart movements to control haul road dust; and Relocation of exposed haul truck routes.	Excessive dust event not observed

Note 1: An excessive dust event includes prolonged visual dust in a particular area or following receipt of dust monitoring results in exceedance of the project criteria.

Table 12 Particulate Emission Controls Currently Applied at Charbon Colliery

Source	Control Measure	Comments	Supporting Material / Comments
Wheel generated particulates on unpaved roads	Use of well-defined haul routes		
	Speed limits on haul roads	A 40 km per hour speed limit is enforced on all haul roads	
	Watering by water trucks		Refer **Figure E3** in **Appendix E**
	Dust suppressant in trial	Charbon Colliery applied the EDC dust suppressant (magnesium chloride) on the road between the Western Open Cut and 2-3 Trunk ROM. 16,000 L were applied over two applications approximately 2 months apart in August 2011. This trial has been successful and Charbon Colliery will consider using more of this product on other strategic haul roads	Stretch of road on which suppressant applied was observed to result in significantly less dust generation than other roads at the Colliery.
Bradford Breaker	Enclosed		Refer **Figure E5** in **Appendix E**
Coal crushing	Enclosed	CHPP is enclosed	Refer **Figure E4** in **Appendix E**
Coal Screening	Enclosed		
Material transfer of coal	Water sprays on conveyors		
Train loading	Underground reclaimer		

The applicable control efficiencies of each of the controls identified in **Table 12** are presented in **Table 13**.

Table 13 Control Factors Assumed for Existing Control Measures

Emission Source	Control Measure	Control Factor (%)	Source
Haul Roads	Use of well-defined haul routes	-	-
	Speed limits on haul roads	57.5	Katestone (2010)
	Watering by water trucks	50	Katestone (2010)
	Dust suppressant on Western Open Cut to 2-3 Trunk Haul Road	82	Katestone (2010)
Bradford Breaker	Enclosed	70	NPI (2011)
Coal Crushing	Enclosed	70	NPI (2011)
Coal Screening	Enclosed	70	NPI (2011)
Material Transfer of Coal	Water sprays on conveyors	50	Katestone (2010)
Train Loading	Underground reclaimer	70	NPI (2011)

In addition to the dust management measures identified above, a progressive rehabilitation program is also undertaken at the Charbon Colliery (refer **Appendix D**). Short term and long term measures are outlined with objectives in relation to air quality concerned with the minimisation of wind induces erosion. **Figure 4** presents the area marked for rehabilitation in 2012, bounded by a yellow line.

Figure 4 Charbon Colliery Rehabilitation Area – Autumn 2012

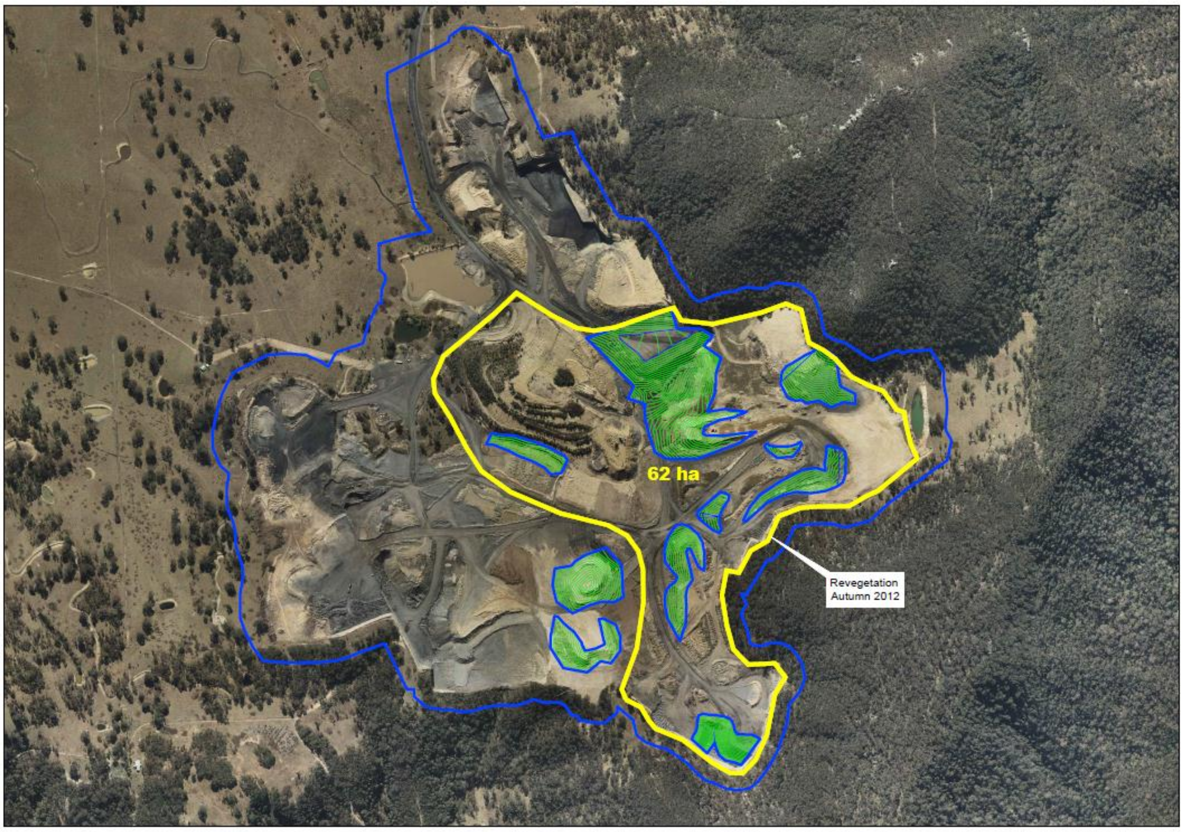


Table 14 Controlled Annual Particulate Emissions – Charbon Colliery

Emission Source	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)
Material Handling - Coal			
Excavators / Front End Loaders on Coal	142	67	10
Bulldozers on Coal	84,205	25,629	2,563
Trucks dumping Coal	26,400	13,200	1,320
Bradford Breaker	1,200	480	48
Conveyor transfer points	111	53	5
Primary Crushing	3,600	1,440	144
Screening	28,800	21,600	2,160
Loading coal to trains	3,629	1,814	181
Loading coal to trucks	1,976	304	30
Dumping Rejects at REA	9,306	4,653	465
Material Handling - Overburden			
Excavators / Front End Loaders on Overburden	585	277	42
Bulldozers on Overburden	10,572	1,767	177
Trucks dumping Overburden	4,200	2,100	210
Road Haulage			
SOC to 3rd Entry ROM	17,347	4,457	446
SOC to in pit dump	30,993	7,964	796
WOC to 2-3 Trunk ROM	3,699	950	95
WOC to in pit dump	5,786	1,487	149
Product trucks	6,871	1,766	177
REA tailings	1,647	423	42
Grading			
Graders	57	25	2
Open Areas			
Southern Open Cut	473,513	236,756	35,513
Western Open Cut	68,186	34,093	5,114
3rd Entry ROM	37,881	18,941	2,841
2-3 Trunk ROM	37,881	18,941	2,841
CHPP	151,524	75,762	11,364
REA Tailings	37,881	18,941	2,841
TOTAL	**1,047,992**	**493,889**	**69,577**

Figure 5 Controlled Annual Particulate Emissions – Charbon Colliery

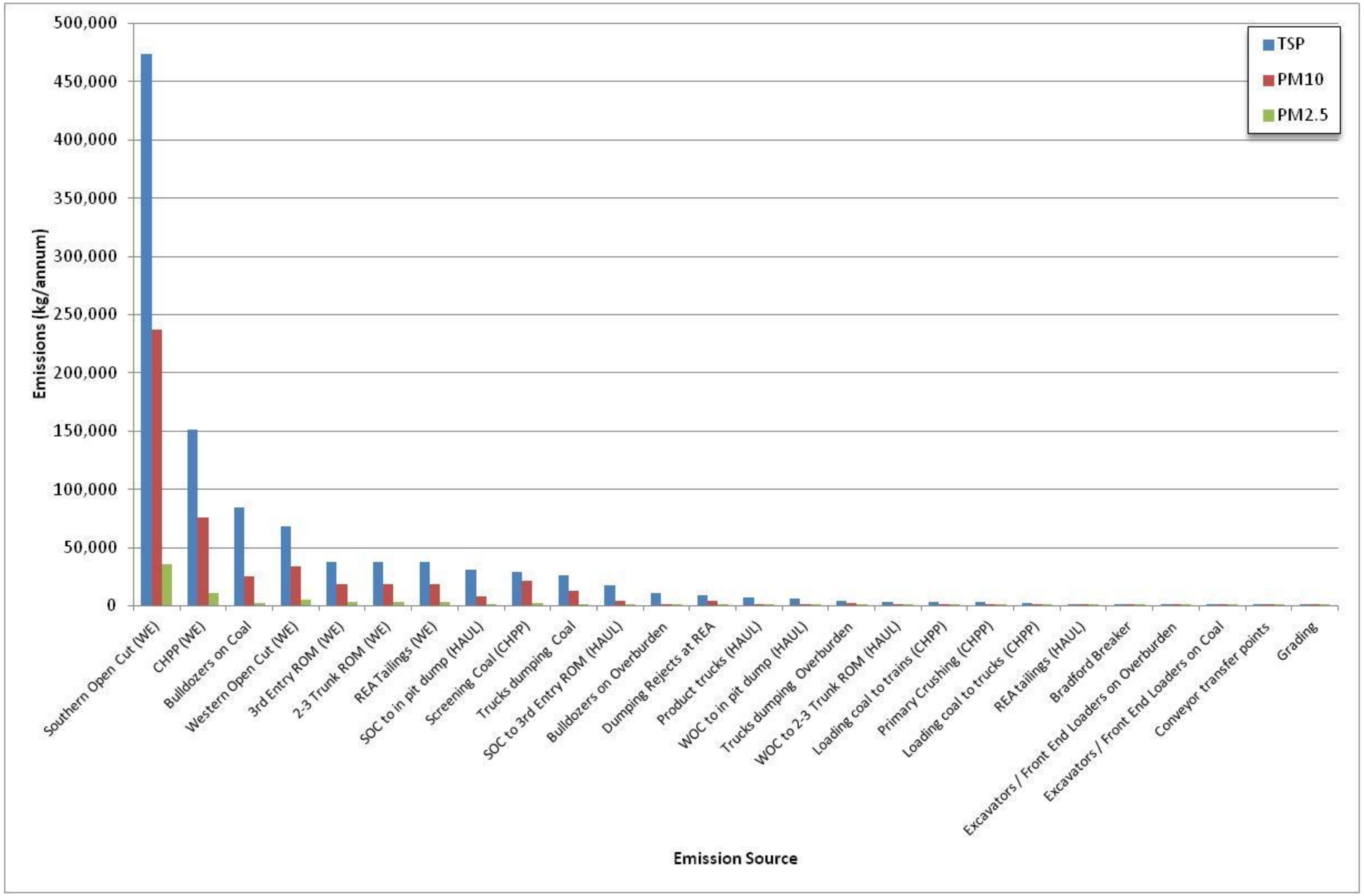
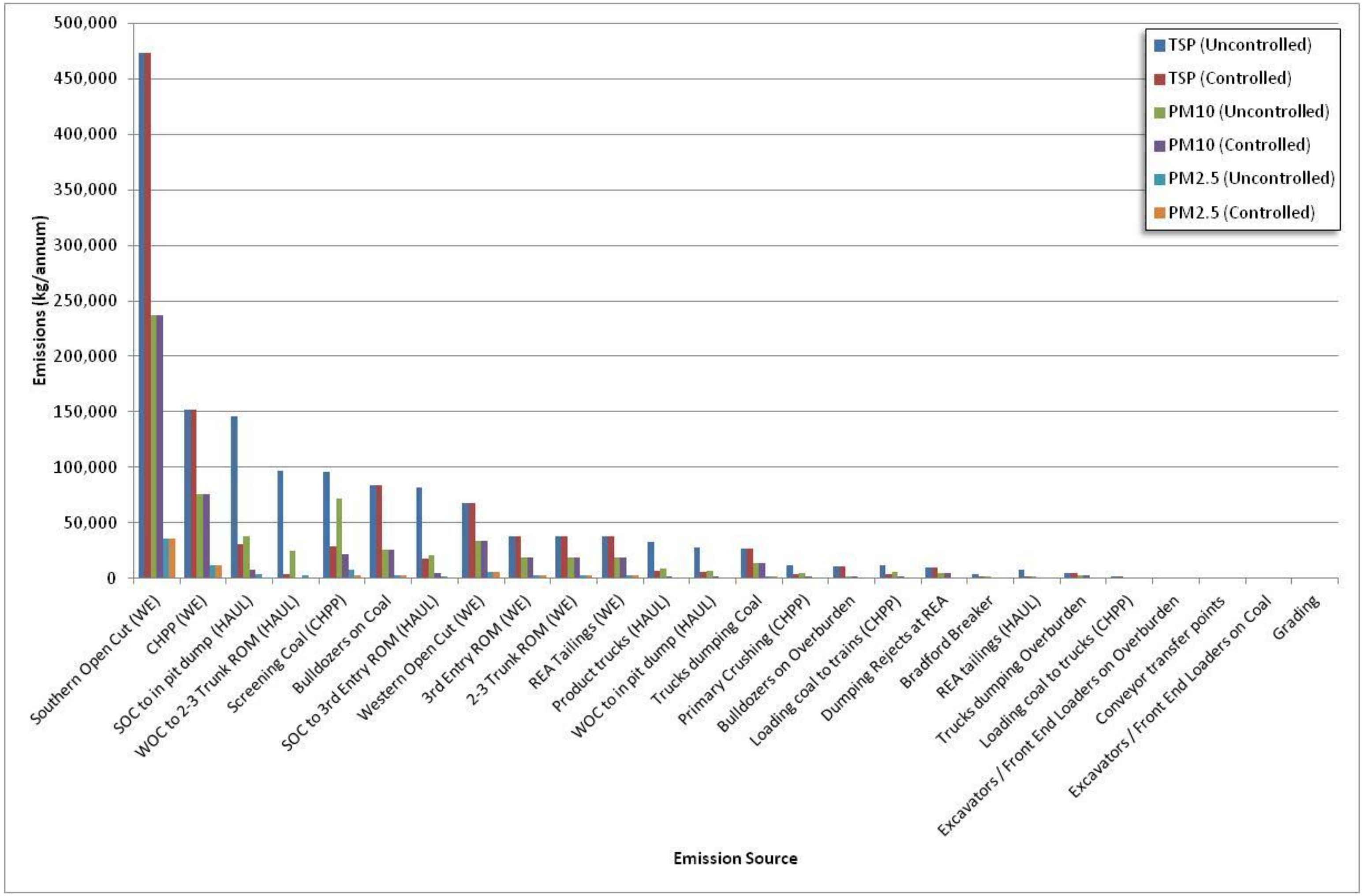


Figure 6 Comparison of Uncontrolled versus Controlled Particulate Emissions – Charbon Colliery



A comparison of the total emissions by source are presented in **Figure 6** Particulate emissions are presented by source group (wind erosion, haul roads, material handling and extraction and CHPP and coal processing operations) in **Table 15.**

Table 15 Comparison of Uncontrolled and Controlled Particulate Emissions

Emission Source Group	Uncontrolled Emissions (kg/annum)			Controlled Emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion	806,865	806,865	403,433	403,433	60,515	60,515
Haul Roads	391,559	66,400	100,623	17,072	10,062	1,706
Material Handling and Extraction	135,633	135,521	47,798	47,746	4,798	4,792
CHPP and Coal Processing	126,072	39,205	84,752	25,638	8,475	2,564
TOTAL	**1,460,129**	**1,047,992**	**636,605**	**493,889**	**83,849**	**69,577**

2.3 Ranking of Mining Activities and Identification of Top Four PM Sources

Following the application of the particulate control measures (see **Table 13**) to uncontrolled particulate emissions presented in **Table 10**, **Table 16** presents the ranking of all individual emission sources in terms of annual emissions of TSP, PM_{10} and $PM_{2.5}$. Where rankings are not equal, the highest of the three rankings is used as the final ranking for the source although inevitably this may provide some sources with the same ranking.

For the purposes of this report, a broader view of emissions sources has been taken, and groups of the same type of emission source have been taken to be one source. For example, wind erosion has been identified as a major source of emissions in several areas but ‘wind erosion’ in general has been taken to be one source. In relation to the control of particulate matter, this approach is considered reasonable as control methods may be applicable to control emissions for all individual sources within that source group. Based on this approach, the final rankings indicate that the top four ranked emission sources at Charbon Colliery are

- Wind erosion
- The operation of bulldozers on coal (CHPP and open cut areas)
- Road haulage operations
- Trucks dumping coal

Table 16 Ranking of PM Sources Based on Controlled Emissions of TSP, PM_{10} & $PM_{2.5}$

Activity	Rank of Particulate Emissions			
	TSP	PM_{10}	$PM_{2.5}$	Overall
Southern Open Cut (WE)	1	1	1	1
CHPP (WE)	2	2	2	2
Bulldozers on Coal	3	4	7	3
Western Open Cut (WE)	4	3	3	3
3rd Entry ROM (WE)	5	6	4	4
REA Tailings (WE)	6	8	6	6
2-3 Trunk ROM (WE)	7	7	5	5
SOC to in pit dump (HAUL)	8	10	10	8
Screening	9	5	8	5
Trucks dumping Coal	10	9	9	9
SOC to 3rd Entry ROM (HAUL)	11	12	12	10
Bulldozers on Overburden	12	15	15	12
Dumping Rejects at REA	13	11	11	11
Product trucks (HAUL)	14	16	16	14
WOC to in pit dump (HAUL)	15	17	17	16
Trucks dumping Overburden	16	13	13	13
WOC to 2-3 Trunk ROM (HAUL)	17	19	19	17
Loading coal to trains (CHPP)	18	14	14	16
Primary Crushing	19	18	18	18
Loading coal to trucks (CHPP)	20	22	23	21
REA tailings (HAUL)	21	21	21	22
Bradford Breaker	22	20	20	19
Excavators / Front End Loaders on Overburden	23	23	22	21
Excavators / Front End Loaders on Coal	24	24	24	24
Conveyor transfer points	25	25	25	25
Grading	26	26	26	26

3 POTENTIAL CONTROL MEASURES

> ***2. Identify, quantify and justify best practice measures that could be used to minimise particle emissions***
>
> *2.1 For each of the top four activities identified in step 1.3, identify the measures that could be implemented to reduce emissions, taking into consideration:*
> - *The findings of Katestone (June 2011) "NSW coal mining benchmarking study – international best practice measures to prevent and/or minimise emissions of particulate matter from coal mining",*
> - *Any other relevant published information, and*
> - *Any relevant industry experience from either Australia or overseas.*
>
> *2.2 For each of the top four activities identified in step 1.3, estimate the emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity after applying the measures identified in step 2.1.*
>
> *Current particulate matter controls being used at the mine must be clearly identified, quantified and justified. This means adding supporting information and evidence, including monitoring data, recorded keeping, management plans and/or operator training.*

3.1 Wind Erosion

3.1.1 Exposed Areas and Overburden Emplacements

To control the generation and/or propagation of particulate emissions due to wind erosion, the following techniques are recommended, including those identified in Katestone, 2011:

- Minimise pre-strip areas as far as practicable
- Minimise out of pit dumping and maximise in pit dumping to ensure that overburden dumps have shielding from the prevailing wind
- Paving – usually feasible for small areas in and around workshops
- Fencing, bunding or shelterbelts to reduce ambient wind speeds
- Adding gravel to the surface to reduce surface fines content and to reduce the surface wind speed
- Spillage clean up
- Watering
- Chemical suppressants
- Revegetation – use of vegetation as an interim measure to minimise emissions of particulate matter from areas that may be exposed for an extended period of time
- Rehabilitation – use of vegetation and land contouring to produce the final post-mining land form

A summary of the potential control measures for minimising particulate emissions from wind erosion in exposed areas, and their effectiveness, is provided in **Table 17**, reproduced from Katestone (2011).

Table 17 Best Practice Control Measures – Wind Erosion of Exposed Areas

Control Type	Control Measure	Effectiveness
Avoidance	Minimise pre-strip. EMP should specify a benchmark for optimal performance and report annually against benchmark	100% per m^2 of pre-strip avoided
Surface stabilisation	Watering	50%
	Chemical suppressants	70% 84%
	Paving and cleaning	>95%
	Apply gravel to stabilise disturbed open areas	84%
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	99%
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	30% 70-80%
	Vegetative ground cover	70%

SOURCE: Katestone (2011), Table 71

3.1.2 Coal Stockpiles

Stockpiles of coal provide a surface for the generation of wind-eroded material and the subsequent propagation of particulate matter emissions. In addition to stockpile dimensions, emissions generated by wind erosion from stockpiles are also dependent on the frequency of disturbance of the exposed surface. Over time the surface of an undisturbed stockpile will become depleted of erodible material and emissions of particulate matter will reduce. However, the nature of ROM and product coal stockpiles is that they are frequently disturbed, causing fresh surface material to be exposed restoring the erosion potential (Katestone, 2011).

For existing stockpiles, the control measures identified in the literature to minimise particulate emissions include:

- Bypassing stockpiles to load directly into ROM bin or onto train
- Fencing, bunding or shelterbelts to reduce ambient wind speeds
- Watering to minimise lift-off with automatic control through continuous cycling and increased application based on meteorological conditions
- Chemical suppressants to bind loose fine surface material in response to adverse weather conditions
- Minimising residence time of coal in stockpiles
- Spillage clean-up
- Surface covering

Structures can be used to reduce emissions of particulate matter, such as earth walls (berms) or fences. Berms can act as a windbreak by preventing the erosive and drying effects of the wind. Berms can also reduce the amount of water and use of suppressants making it a cost-effective option in many cases. A study was conducted of the effectiveness of wind screens and determined that the most effective screens for reducing the wind speed had the following dimensions relative to the height of the stockpile (Katestone, 2011):

- Height: 1.25 times the height of the stockpile
- Width: 1.5 times the height of the stockpile
- Distance upwind: 2.0 times the height of the stockpile

Chemical binders and suppressants may be applied to the surface of stockpiles to enhance the cohesion of particles and reduce the potential for wind erosion. These binding agents are usually applied in solution and are sprayed onto the surface. Water sprays by themselves have been shown to offer in the region of 50% to 80% control efficiency. However, the effectiveness of spray additives is reduced by mechanical disturbance as it breaks the surface ‘crust’, which may be caused by stockpile working (i.e. the addition or removal of material), vehicle disturbance or the action of wild animals.

Wind breaks and screens offer an alternative to reduce wind erosion from stockpiled materials or areas with no vegetative cover. Recent studies have demonstrated a wide range of control efficiencies for screens and windbreaks, as summarised in Katestone 2011. Vegetative wind breaks are reported with control efficiency of 30% and wind screens and fences up to 80%. Studies regarding windbreak design and size have been shown to influence its effectiveness, particularly its relative height to the height of the stockpile, its distance downwind and its structural porosity (Katestone, 2011). Reducing the height of the stockpile may also offer a significant reduction in the wind erosion potential by reducing the wind speed over the stockpile surface.

The use of multiple controls, such as the use of chemical stabilisers and binders with wind breaks may offer enhanced dust control. Studies have reported a reduction in windblown dust emissions of up to 85% for up to 10 days of moderate to high wind speeds through the use of stabilisers and wind breaks (Katestone, 2011).

Similarly, stockpile size and orientation has been shown to affect the efficacy of wind breaks, with “smooth whaleback” profiles being more effective at reducing wind erosion than pointed stockpiles and orientation with the smallest face towards the prevailing wind offering increased protection from wind erosion. Studies suggest a control efficiency of 60% may be attributed to stockpile size, design and orientation.

A summary of the potential control measures for minimising particulate emissions from wind erosion from coal stockpiles, and their effectiveness, is provided in **Table 18** (Katestone, 2011).

Table 18 Best Practice Control Measures – Wind Erosion of Coal Stockpiles

Control Type	Control Measure	Effectiveness
Avoidance	Bypassing stockpiles	100% reduction in wind erosion for coal bypassing stockpiles
Surface stabilisation	Water spray	50%
	Chemical wetting agents	80-99% 85% 90%
	Surface crusting agent	95%
	Carry over wetting from load in	80%
Enclosure	Silo with bag house	100% 95-99% 99%
	Cover storage pile with a tarp during high winds	99%
Wind speed reduction	Vegetative wind breaks	30%
	Reduced pile height	30%
	wind screens/wind fences	>80% 75-80%
	Pile shaping/orientation	<60%
	Erect 3-sided enclosure around storage piles	75%

SOURCE: Katestone (2011), Table 72

3.2 Haul Roads

Options for the control of dust emissions from unpaved haul roads fall into the following three categories:

- Vehicle restrictions that limit the speed, weight or number of vehicles on the road
- Surface improvement by measures such as (a) paving or (b) adding gravel or slag to a dirt road
- Surface treatment such as watering or treatment with chemical dust suppressants

The applicability of the above factors varies significantly due to the costs of installing and operating the various options, the timing of the consideration (for example at planning stage or applied retrospectively when the mine is operating) and the scale of the mining operation. For example, vehicle restrictions that are considered at the mine planning phase might be relatively easy to apply. Replacing a high number of small haul trucks with a smaller fleet of larger trucks along with other considerations such as upward facing vehicle exhausts, may be easily achieved at the planning phase. However, application retrospectively during mine operation would represent a significant expenditure. Speed restrictions may offer an effective control, but may pose a logistical or economic constraint if it restricts the transport of materials, such as coal or overburden in the mine and may be difficult to manage and enforce.

Clearly, replacement of haul trucks with automated material handling systems, such as conveyors may offer a significant opportunity to reduce particulate emissions, if feasible.

The improvement of the road structure using non-sealed surfaces (such as gravelled surfaces) or substrata design (such as design to limit water penetration, pooling, camber and corners are easier to implement during the planning phases as they may require site layout considerations, such as the location of plant and processes to be altered. The use of non-sealed surfaces may require much greater frequency of maintenance, particularly during adverse weather conditions or heavily trafficked periods. Surface improvements may not be cost-effective with heavy haul vehicles that require high-grade engineered road structures to carry the load without disintegration.

Surface watering is a commonly applied control option, however the availability of water supplies may represent a significant constraint to its use, particularly during peak demand periods, such as high winds during prolonged dry periods. The use of chemical suppressants or surface binding agents offer enhanced dust control efficiency and may also reduce the volume of water required. In some instances, watering after the application of chemical suppressants may reduce the efficacy of the overall dust control. Generally, chemical additives and suppressants offer an improved efficiency than water but not in all situations (e.g. temporary roads).

A summary of the potential control measures for minimising particulate emissions from haul roads, and their effectiveness, is provided in **Table 19** (Katestone, 2011).

Table 19 Best Practice Control Measures - Haul Roads

Control Type	Control Measure	Effectiveness
Vehicle Restrictions	Reduction from 75 km/hr to 50 km/hr	40-75
	Reduction from 65 km/hr to 30 km/hr	50-85
	Grader speed reduction from 16 km/hr to 8 km/hr	75% [a]
Surface Improvements	Pave the surface	>90%
	Low silt aggregate	30%
	Oil and double chip surface	80%
Surface Treatments	Watering (standard procedure)	10-74%
	Watering Level 2 (>2 l/m²/hr)	75%
	Watering twice a day for industrial unpaved road	55%
	Hygroscopic salts	Av. 45% over 14 days
		82% within 2 weeks
	Lignosulphonates	66-70% over 23 days
	Polymer emulsions	70% over 58 days
	Tar and bitumen emulsions	70% over 20 days
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips	90t to 220t: 40% [a]
		140t to 220t: 20%[a]
		140t to 360t: 45% [a]
	Use conveyors in place of haul roads	>95% [a]

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

SOURCE: Katestone (2011), Table 66

As previously discussed, the use of a magnesium chloride based dust suppressant has been trialled on the Western Open Cut to 3rd Entry ROM haul road. Based upon the emission factors presented above, this affords an 82% reduction in particulate emissions. In the assessment of the effectiveness of control measures on haul roads, this trial (on WOC to 3rd Entry ROM road) has been taken into account (i.e. emission reductions have not been double counted).

3.3 Bulldozers on Coal

Katestone (2011) presents a comprehensive summary of an options appraisal conducted by Connell hatch for the control of particulate emissions from bulldozers at the RG Tanna Coal Terminal. Options considered in the study included:

- Minimising travel speed and travel distance.
- Stabilising bulldozer travel routes and use of water or suppressants on travel routes.
- Manage coal moisture to ensure coal is sufficiently moist when working.

- Modify design of the bulldozer to minimise emissions.

Based upon the data available, the emission of particulate from bulldozer operation can only be quantified by hours of operation, and not the speed of the vehicles.

A summary of the potential control measures for minimising particulate emissions from bulldozers, and their effectiveness, is provided in **Table 20** (Katestone, 2011).

Table 20 Best Practice Control Measures – Bulldozers

Control Measure		Effectiveness
Bulldozer	Minimise travel speed and distance	Not quantified
	Keep travel routes and materials moist	50%

SOURCE: Katestone (2011), Table 76

3.4 Trucks Dumping Coal

Trucks dumping coal may give rise to particulate emissions from the entrainment of particles in air during discharge. It is also recognised that discharging of trucks during high wind speed events is likely to give rise to more significant particulate emissions. The effects of this process may be controlled by a range of factors including a reduction in the drop height, the application of water sprays and through the erection of enclosures to reduce the potential for entrainment in crosswinds.

A summary of the potential control measures for minimising particulate emissions from trucks dumping coal, and their effectiveness, is provided in **Table 21** (Katestone, 2011).

Table 21 Best Practice Control Measures – Loading and Dumping ROM Coal

Control Type	Control Measure	Effectiveness
Avoidance	Bypass ROM stockpiles	50% reduction in dumping emissions for coal bypassing ROM stockpiles
Truck or loader dumping coal	Minimise drop height	Reduce from 10m to 5m: 30%
	Water sprays on ROM pad	50%
Truck or loader dumping to ROM bin	Water sprays on ROM bin or sprays on ROM pad	50%
	Three sided and roofed enclosure of ROM bin	70%
	Three sided and roofed enclosure of ROM bin plus water sprays	85%
	Enclosure with control device	90-98%

SOURCE: Katestone (2011), Table 95

3.5 Quantification of Potential Particulate Management Measures

Table 22 presents the emission control factors assumed in this assessment for the potential particulate management measures identified and **Table 23** presents the PM emission loads for each source if each potential control measure was applied.

Table 22 Control Factors Assumed for Potential Control Measures

Emission Source	Control Measure	Control Factor (%)	Source
Wind Erosion	Minimise pre-strip. EMP should specify a benchmark for optimal performance and report annually against benchmark	100% per m^2 of pre-strip avoided	Katestone (2011)
	Watering	50%	Katestone (2011)
	Chemical suppressants	70% 84%	Katestone (2011)
	Paving and cleaning	>95%	Katestone (2011)
	Apply gravel to stabilise disturbed open areas	84%	Katestone (2011)
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	99%	Katestone (2011)
	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	30% 70-80%	Katestone (2011)
	Vegetative ground cover	70%	Katestone (2011)
Haul Roads	Reduction from 75 km/hr to 50 km/hr	40-75	Katestone (2011)
	Reduction from 65 km/hr to 30 km/hr	50-85	Katestone (2011)
	Grader speed reduction from 16 km/hr to 8 km/hr	75% [a]	Katestone (2011)
	Pave the surface	>90%	Katestone (2011)
	Low silt aggregate	30%	Katestone (2011)
	Oil and double chip surface	80%	Katestone (2011)
	Watering Level 2 (>2 $l/m^2/hr$)	75%	Katestone (2011)
	Watering twice a day for industrial unpaved road	55%	Katestone (2011)
	Suppressants	84%	Katestone (2011)
	Hygroscopic salts	Av. 45% over 14 days	Katestone (2011)
		82% within 2 weeks	Katestone (2011)
	Lignosulphonates	66-70% over 23 days	Katestone (2011)
	Polymer emulsions	70% over 58 days	Katestone (2011)
	Tar and bitumen emulsions	70% over 20 days	Katestone (2011)
	Use larger vehicles rather than smaller vehicles to minimise number of trips	90t to 220t: 40% [a]	Katestone (2011)
		140t to 220t: 20%[a]	Katestone (2011)
		140t to 360t: 45% [a]	Katestone (2011)
	Use conveyors in place of haul roads	>95% [a]	Katestone (2011)
Bulldozers on coal	Minimise travel speed and distance	Not quantified	Katestone (2011)
	Keep travel routes and materials moist	50%	Katestone (2011)
Dumping of ROM coal	Bypass ROM stockpiles	50% reduction for coal bypassing ROM stockpiles	Katestone (2011)
	Minimise drop height	Reduce from 10m to 5m: 30%	Katestone (2011)
	Water sprays on ROM pad	50%	Katestone (2011)
	Water sprays on ROM bin or sprays on ROM pad	50%	Katestone (2011)
	Three sided and roofed enclosure of ROM bin	70%	Katestone (2011)
	Three sided and roofed enclosure of ROM bin plus water sprays	85%	Katestone (2011)
	Enclosure with control device	90-98%	Katestone (2011)

Table 23 Estimated Emissions – Potential Controls

Emission Source	Control Option	TSP (kg/year)	PM_{10} (kg/year)	$PM_{2.5}$ (kg/year)
Wind Erosion	Watering	403,433	201,716	30,257
	Chemical suppressants	242,060	121,030	18,154
	Paving and cleaning	40,343	20,172	3,026
	Apply gravel to stabilise disturbed open areas	129,098	64,549	9,682
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	8,069	4,034	605
	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	564,806	282,403	42,360
	Vegetative ground cover	242,060	121,030	18,154
Bulldozer on coal	Keep travel routes and materials moist	42,102	12,815	1,281
Haul Roads	Pave the surface	6,634	1,705	170
	Low silt aggregate	46,440	11,933	1,193
	Oil and double chip surface	13,269	3,409	341
	Watering Level 2 (>2 l/m²/hr)	16,586	4,262	426
	Hygroscopic salts *	11,276	2,897	290
	Lignosulphonates	15,259	3,921	392
	Polymer emulsions	19,903	5,114	511
	Tar and bitumen emulsions	19,903	5,114	511
	Use conveyors in place of haul roads	3,317	852	85
Dumping of ROM Coal	Bypass ROM stockpiles	42,102	12,815	1,281
	Minimise drop height	13,200	6,600	660
	Water sprays on ROM pad	18,480	9,240	924
	Water sprays on ROM bin or sprays on ROM pad	13,200	6,600	660
	Three sided and roofed enclosure of ROM bin	13,200	6,600	660
	Three sided and roofed enclosure of ROM bin plus water sprays	7,920	3,960	396
	Enclosure with control device	3,960	1,980	198
	Bypass ROM stockpiles	2,640	1,320	132

* Application of EDC dust suppressant (magnesium chloride) on all other haul roads (i.e. in addition to the haul road between the Western Open Cut and 2-3 Trunk ROM which has already been trialled)

A comparison of each control application against the original (with existing controls) emissions of particulate are presented in **Figure 7** (wind erosion), **Figure 8** (haul roads), **Figure 9** (bulldozer on coal) and **Figure 10** (dumping of coal).

Figure 7 Potential Reductions in PM Emissions due to Additional Controls - Wind Erosion

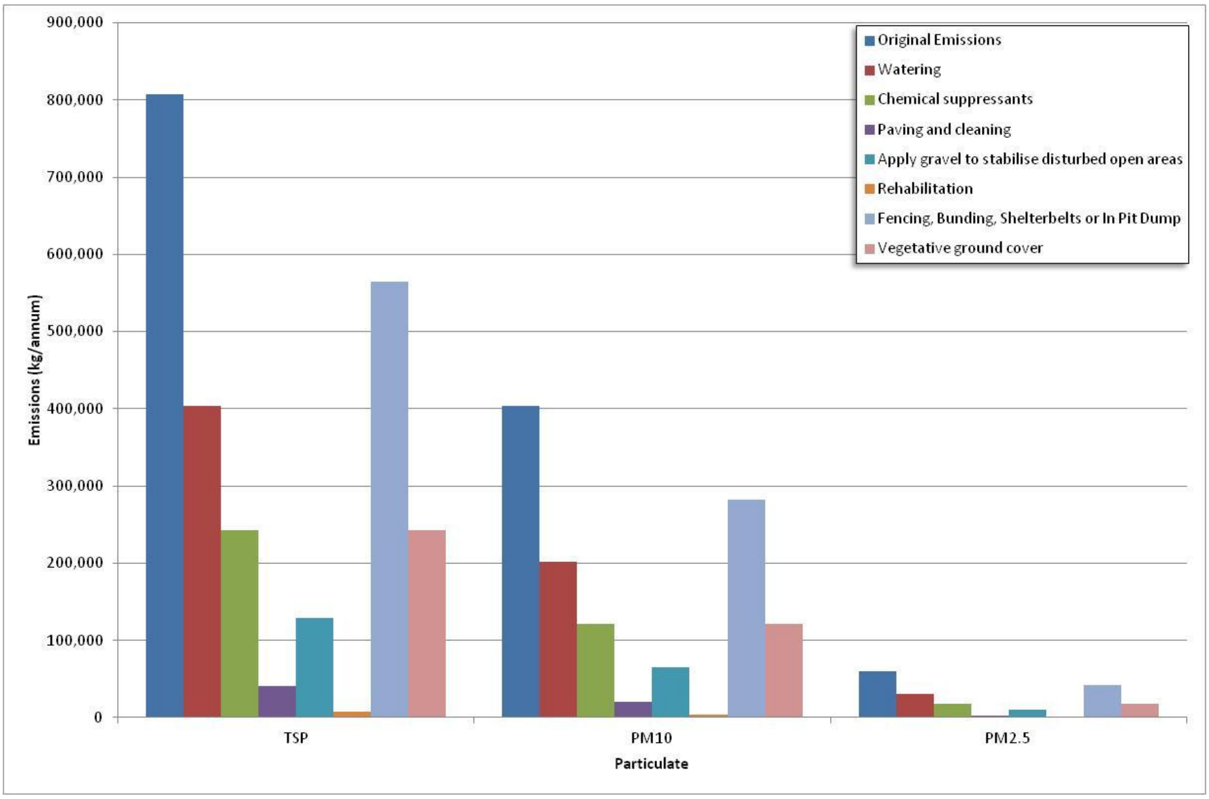


Figure 8 Potential Reductions in PM Emissions due to Additional Controls – Road Haulage

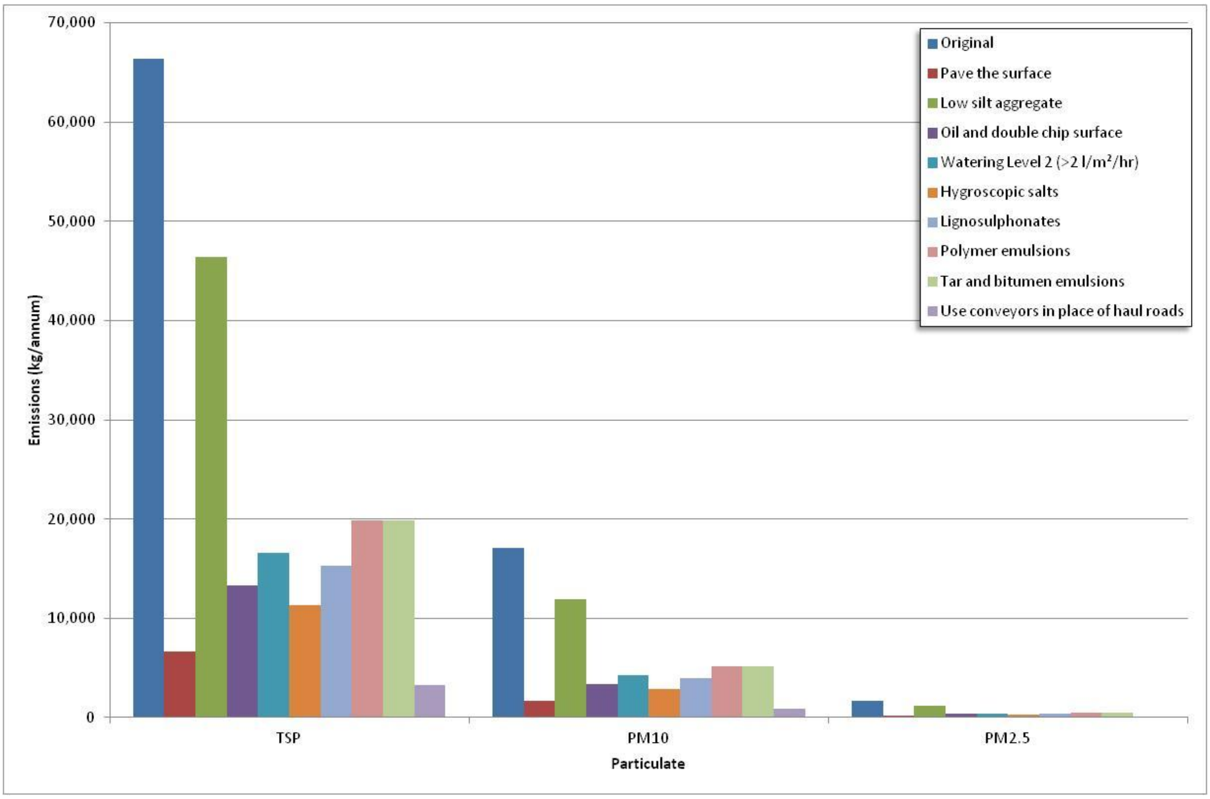


Figure 9 Potential Reductions in PM Emissions due to Additional Controls – Bulldozer on Coal

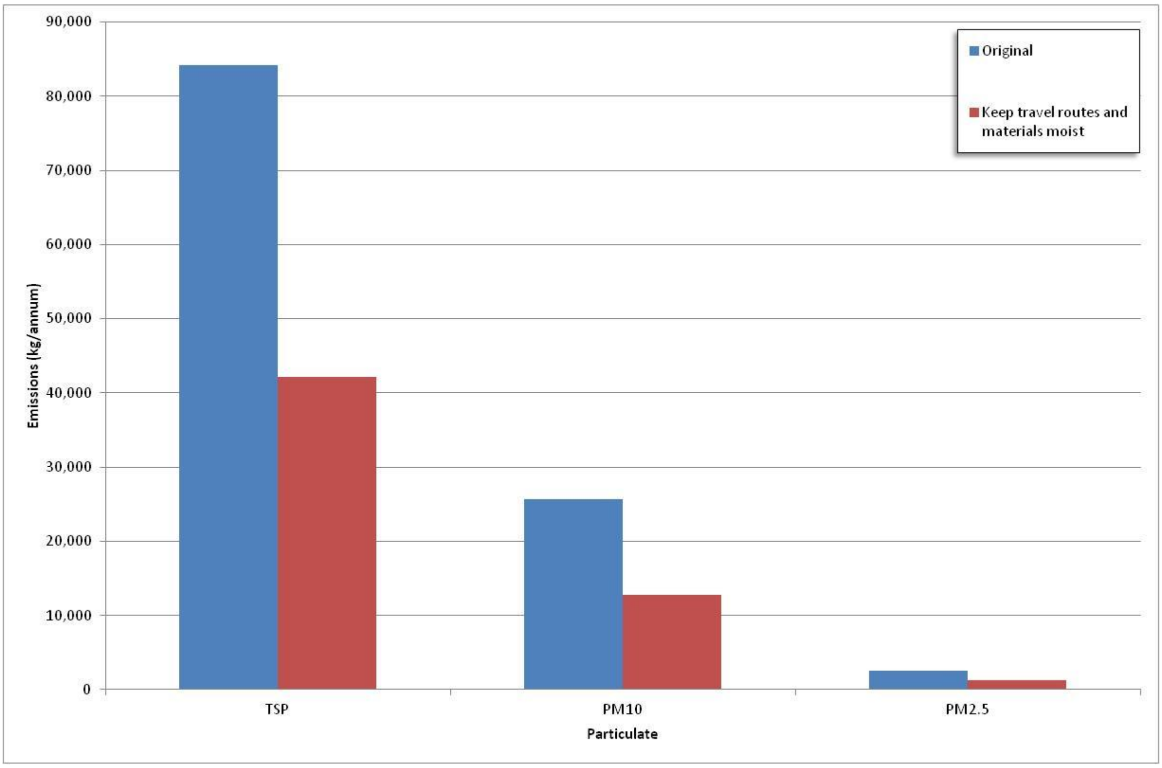
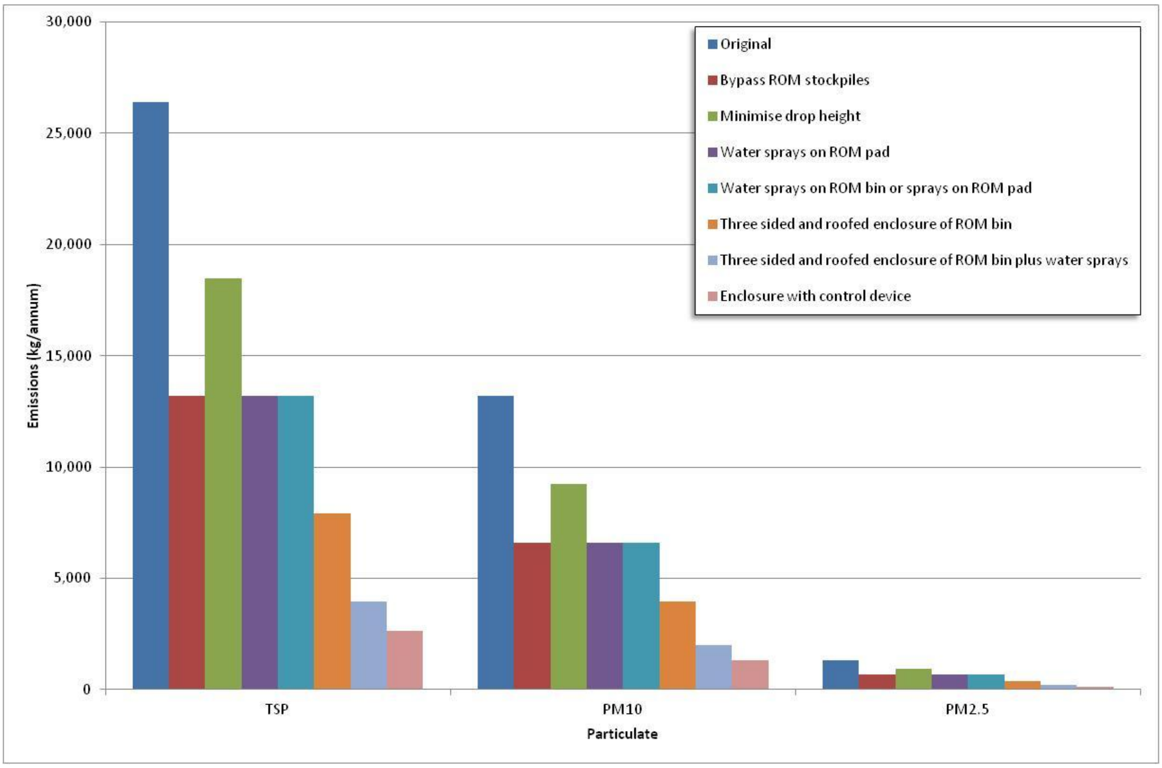


Figure 10 Potential Reductions in PM Emissions due to Additional Controls – Dumping of Coal



4 EVALUATION OF ADDITIONAL CONTROL MEASURES

> ***3. Evaluate the practicability of implementing these best practice measures***
>
> *3.1 For each of the best practice measures identified in step 2.1, assess how practicable each one is to implement by taking into consideration:*
> - *implementation costs;*
> - *regulatory requirements;*
> - *environmental impacts;*
> - *safety implications; and,*
> - *compatibility with current processes and proposed future developments.*
>
> *3.2 Identify those best practice measures that will be implemented at the premises to reduce particle emissions.*

As required by OEH, the practicability of implementing each of the particulate control options identified in **Section 3** is to be assessed with due consideration given to:

- implementation costs;
- regulatory requirements;
- environmental impacts;
- safety implications; and,
- compatibility with current processes and proposed future developments.

In summary, the control measures identified in **Section 3** for further evaluation are presented in **Table 24.**

Table 24 Summary of Potential Particulate Control Measures

Emission Source	Control Option
Wind Erosion	Watering
	Chemical suppressants
	Paving and cleaning
	Apply gravel to stabilise disturbed open areas
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.
	Fencing, bunding, shelterbelts or in-pit dump.
	Vegetative ground cover
Haul Roads	Pave the surface
	Low silt aggregate
	Oil and double chip surface
	Watering Level 2 (>2 $l/m^2/hr$)
	Watering grader routes
	Hygroscopic salts
	Lignosulphonates
	Polymer emulsions
	Tar and bitumen emulsions
	Use conveyors in place of haul roads
Bulldozer on Coal	Keep travel routes and materials moist
Dumping of ROM Coal	Bypass ROM stockpiles
	Minimise drop height
	Water sprays on ROM pad
	Water sprays on ROM bin or sprays on ROM pad
	Three sided and roofed enclosure of ROM bin
	Three sided and roofed enclosure of ROM bin plus water sprays
	Enclosure with control device

The following sections examine the measures that may constrain the implementation of the particulate control measures outlined in **Table 24,** namely the regulatory requirements, environmental impacts, safety implications and compatibility with current processes and future development.

Each measure is provided a risk rating (**low**, **medium** or **high**) which identifies the constraints which may result in the implementation of the measure not being practical at the Charbon Colliery. Where any of the four measures of practicability are rated as high, these measures are not taken forward for an assessment of cost implication and feasibility.

Section 4.1 examines the potential control measures identified for wind erosion sources, **Section 4.2** for haul roads sources, **Section 4.3** for the operation of bulldozers on coal and **Section 4.4** for the dumping of ROM coal.

In the assessment of cost implications, it is noted that Charbon Colliery is currently only approved to extract coal resource for the next 5 years. Therefore, all capital and operational costs associated with dust suppression measures have been assessed over a 5 year period only, and dust emissions are calculated to cease from years 6 to 10 of the required 10-year cost evaluation. The tables presenting the cost implications are presented in a stand-alone document labelled as **Appendix 1**, which accompanies this report.

4.1 Evaluation Findings – Wind Erosion

4.1.1 Practicality of Implementation

Table 25 provides a discussion of the feasibility of control measures for wind erosion.

Table 25 Practicability of Implementing Control Measures on Wind Eroded Areas

Control Measure – Wind Erodible Areas	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Watering	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure electrical equipment is appropriately isolated. Ensure mists and sprays do not hinder mobile equipment operator vision	RISK = LOW Compatible	✓ Adopted potential measure **WE1**
Chemical suppressants	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto other areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Appropriate PPE required for water truck operative, and personnel involved in the mixing of suppressants with water (if required). If onsite storage required, appropriate signage required and emergency management plan required in event of spill/leakage	RISK = LOW Compatible	✓ Adopted potential measure **WE2**
Paving and cleaning	RISK = LOW None	RISK = MEDIUM Significant additional runoff is likely following paving which would require additional controls to be implemented within the stormwater and sediment management plans Post-mining C&I waste would be increased. Sustainability benefits of paving at this site are questionable	RISK = LOW Safety would likely be improved following paving as risk of accidents would be reduced. Speed restrictions would need to be closely monitored when vehicles are travelling on paved areas	RISK = HIGH Not compatible for regularly disturbed areas – paved areas would need to be constantly cleared and relaid	✘ Not considered further in this assessment

Control Measure – Wind Erodible Areas	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Apply gravel to stabilise disturbed open areas	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = LOW Generally compatible. As for paving, areas would need to be cleared and relaid on a continual basis, although gravel can be reused	✓ Adopted potential measure **WE3**
Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	RISK = LOW Currently undertaken	RISK = LOW None	RISK = LOW None	RISK = LOW Compatible	✓ Adopted potential measure **WE4***
Vegetative ground cover	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = LOW Compatible	✓ Adopted potential measure **WE4***
Fencing, bunding, shelterbelts or in-pit dump.	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = LOW Compatible	✓ Adopted potential measure **WE5**

NB * Measures combined with identical control factors, activity rates and risks

4.1.2 Implementation Costs

As required by OEH, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure;
- Labour costs;
- Material costs; and,
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure.

This information is presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* in the following tables:

- Table 1 Cost Implication Evaluation of Water Sprays (WE1)
- Table 2 Cost Implication Evaluation of Chemical Suppressants (WE2)
- Table 3 Cost Implication Evaluation of Gravel Application (WE3)
- Table 4 Cost Implication Evaluation of Rehabilitation / Revegetation (WE4)
- Table 5 Cost Implication Evaluation of Fencing, Bunding and Shelterbelts (WE5)

4.2 Evaluation Findings – Haul Roads

4.2.1 Practicality of Implementation

Table 26 provides a discussion of the feasibility of control measures for haul roads.

Table 26 Practicability of Implementing Control Measures on Haul Roads

Control Measure – Haul Roads	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Pave the surface	RISK = LOW Follow industry practice for the safe design of haul roads.	RISK = HIGH As part of mine development and rehabilitation, removal of the road will generate significant quantities of waste materials requiring disposal.	RISK = LOW Safety would likely be improved following paving as risk of accidents would be reduced. Speed restrictions would need to be closely monitored	RISK = HIGH Changes in pit locations etc would potentially require costly changes in haul road routes and repaving.	✘ Not considered further in this assessment
Low silt aggregate	RISK = LOW Follow industry practice for the safe design of haul roads.	RISK = MEDIUM As part of mine development and rehabilitation, removal of the road will generate significant quantities of waste materials requiring disposal.	RISK = LOW Safety may be compromised following application of gravelling as risk of accidents may be increased as risk of skidding increases. Speed restrictions would need to be closely monitored to ensure this is not an issue	RISK = LOW Compatible	✓ Adopted potential measure **HR1**
Oil and double chip surface	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = HIGH Very little information or data is available to support this control option, and as such it is not considered likely to represent best practice.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping.	RISK = LOW Compatible	✘ Not considered further in this assessment
Watering Level 2 (>2 l/m²/hr)	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping.	RISK = LOW Compatible	✓ Adopted potential measure **HR2**

Control Measure – Haul Roads	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Hygroscopic salts	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = LOW Compatible	✓ Adopted potential measure **HR3**
Ligno-sulphonates	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = LOW Compatible	✓ Adopted potential measure **HR4**
Polymer emulsions	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = LOW Compatible	✓ Adopted potential measure **HR5**

Control Measure – Haul Roads	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Tar and bitumen emulsions	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = HIGH Incompatible	✘ Not considered further in this assessment
Use conveyors in place of haul roads	RISK = LOW Already considered for existing conveyors	RISK = LOW Additional use of electricity offset and likely surpassed by reduction in diesel fuel use	RISK = LOW Already considered for existing conveyors	RISK = HIGH Changes in pit locations etc would potentially require costly changes in conveyor routes and infrastructure.	✘ Not considered further in this assessment

4.2.2 Implementation Costs

As required by OEH, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure;
- Labour costs;
- Material costs; and,
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure.

This information is presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* in the following tables:

- Table 6 Cost Implication Evaluation of Low Silt Aggregate Application (HR1)
- Table 7 Cost Implication Evaluation of Level 2 Watering (from Level 1 Watering) (HR2)
- Table 8 Cost Implication Evaluation of Hygroscopic Salts (HR3)
- Table 9 Cost Implication Evaluation of Lignosulphonates (HR4)
- Table 10 Cost Implication Evaluation of Polymer Emulsions (HR5)

4.3 Evaluation Findings – Bulldozer on Coal

4.3.1 Practicality of Implementation

Table 27 provides a discussion of the feasibility of control measures for bulldozers operating on coal.

Table 27 Practicability of Implementing Control Measures for Bulldozers Operating on Coal

Control Measure – Bulldozers	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Keep travel routes and materials moist with water sprays	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams Additional GHG emissions due to fuel consumption	RISK = MEDIUM Ensure road surface provides adequate traction for dozers to prevent slipping.	RISK = LOW to MEDIUM Partially compatible; excess moisture in coal product would result in moisture being transported offsite with financial implications to purchaser and transport provider. E.g. additional 2% moisture (w/w) in product would result in 2 tonnes of water being transported per 100 tonnes coal – additional trucks/wagons required to transport.	✓ Adopted potential measure **DO1**

4.3.2 Implementation Costs

As required by OEH, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure;
- Labour costs;
- Material costs; and,
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure.

This information is presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* in the following table:

- Table 11 Cost Implication Evaluation of Water Sprays on Bulldozers on Coal (DO1)

4.4 Evaluation Findings – Dumping of ROM Coal

4.4.1 Practicality of Implementation

Table 28 provides a discussion of the feasibility measures for dumping of ROM coal control measure.

Table 28 Practicability of Implementing Control Measures on Dumping of ROM Coal

Control Measure – Dumping of ROM Coal	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Bypass ROM stockpiles	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH ROM coal may not always be able to be handled at the CHPP, therefore ROM stockpiles would be required to store excess coal.	✘ Not considered further in this assessment
Minimise drop height	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Not appropriate for the site	✘ Not considered further in this assessment
Water sprays on ROM pad	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure electrical equipment is appropriately isolated. Ensure mists and sprays do not hinder mobile equipment operator vision	RISK = LOW Compatible	✓ Adopted potential measure **DC1***
Water sprays on ROM bin or sprays on ROM pad	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure electrical equipment is appropriately isolated. Ensure mists and sprays do not hinder mobile equipment operator vision	RISK = LOW Compatible	✓ Adopted potential measure **DC1***
Three sided and roofed enclosure of ROM bin	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Quantity of coal on ROM pad would make the installation of enclosure impractical	✘ Not considered further in this assessment
Three sided and roofed enclosure of ROM bin plus water sprays	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure electrical equipment is appropriately isolated. Ensure mists and sprays do not hinder mobile equipment operator vision	RISK = HIGH Quantity of coal on ROM pad would make the installation of enclosure impractical	✘ Not considered further in this assessment

Control Measure – Dumping of ROM Coal	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Enclosure with control device	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Quantity of coal on ROM pad would make the installation of enclosure impractical	✘ Not considered further in this assessment

NB * Measures combined with identical control factors, activity rates and risks

4.4.2 Implementation Costs

As required by OEH, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure;
- Labour costs;
- Material costs; and,
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure.

This information is presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* in the following table:

- Table 12 Cost Implication Evaluation of Water Sprays on ROM Pad (DC1)

4.5 Summary of Evaluation Findings

A summary of the evaluation process for each control measure identified in **Section 3** is presented in **Table 29**. Any control options rated as high risk for any of the feasibility considerations (regulatory considerations, environmental impacts, safety implications or site compatibility) have not been evaluated for their implementation costs, and are not presented in this summary table. Reference should be made to *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* **Table 13** for the assessment of costs.

Table 29 Summary of Control Options Evaluation

Emission Source	Control Measure	Cost/Benefit $/tonne PM_{10}	Regulatory Considerations	Environmental Impacts	Safety Implications	Site Compatibility
Wind erosion	WE1: Watering	see Appendix 1	Low	Low	Medium	Low
	WE2: Chemical suppressants	see Appendix 1	Low	Low	Medium	Low
	WE3: Gravel	see Appendix 1	Low	Low	Low	Low
	WE4: Revegetation	see Appendix 1	Low	Low	Low	Low
	WE5: Fencing/ bunding	see Appendix 1	Low	Low	Low	Low
Haul Roads	HR1: Low silt aggregate	see Appendix 1	Low	Medium	Low	Low
	HR2: Watering (lvl 2)	see Appendix 1	Low	Low	Medium	Low
	HR3: Hygroscopic salts	see Appendix 1	Low	Low	Medium	Low
	HR4: Lignosulphates	see Appendix 1	Low	Low	Medium	Low
	HR5: Polymer emulsions	see Appendix 1	Low	Low	Medium	Low
Bulldozer on coal	DO1: Water sprays	see Appendix 1	Low	Low	Medium	Low / Medium
Dumping of Coal	DC1: Water sprays on ROM pad	see Appendix 1	Low	Low	Medium	Low

4.1 Cost Curves

For each identified control measure evaluated as part of this process for the broad emission source groups ranked as being the top four particulate emission sources in **Table 16** (namely wind erosion, haul roads, bulldozer on coal and dumping of coal) a cost curve has been prepared to graphically display the relative effectiveness and relative cost of those controls. Displaying the collated data as a cost curve is a recognised industry-standard approach to visually identifying the preferential options.

This data is presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* **Figure 1 – PM_{10} Abatement Cost Curve.**

The width of the each bar indicates the particulate mitigation afforded by each measure, with the height of each bar indicating the cost per unit of mitigation. Therefore, a wide and short bar indicates a measure that could potentially (and relatively) provide a greater level of particulate mitigation at a lower cost. These are the measures that should be prioritised for further investigation.

4.2 Identification of Dust Control Measures for Charbon Mine

The methodology followed above is consistent with the broad outline methodology proposed by NSW OEH, which is reproduced in **Appendix A**.

Through the adoption of this procedure, Charbon Colliery's emissions of particulate matter have been quantified with and without the range of existing control measures implemented on-site, and the top four emitting sources identified.

The particulate control measures that are already implemented at Charbon Colliery are summarised in **Table 11** and **Table 12**. It is noted that through the implementation of these controls, the monitoring undertaken around the Colliery demonstrates that the air quality criteria outlined in Project Approval conditions (refer to **Table 2**) are not exceeded. In this regard, it may be determined that the current controls implemented at the Colliery are adequate in controlling the impact of the mining operations and demonstrates compliance with the Project Approval and EPL conditions concerning the control of particulate emissions.

The range of additional control options for the processes operated at Charbon Colliery has been investigated. All identified control options have been assessed to account for the risk associated with compliance with regulatory requirements, the potential environmental impacts, safety implications and their compatibility with current processes and future developments approved or anticipated at the Colliery. Through this initial screening, any options that were considered to be high risk for the above measures were discounted, resulting in a range of 12 measures for which the implementation costs were estimated. It is noted that the costs for the measures were calculated over a five year period (rather than ten as required in the OEH guidance) as it is anticipated that the Colliery would cease production within that period. The costings have been undertaken with reference to published and referenced data sources, experience or estimates from Centennial Coal and a range of assumptions. All assumptions have been provided for clarification and transparency.

The cost / benefit ratio of the control options are presented in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* **Table 13** and presented graphically in *Charbon Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* **Figure 1**. This analysis has identified the following control options as providing a significant potential to reduce the total emission of particulates from all sources at site at reasonable cost:

- The application of gravel to open areas to minimise wind erosion;
- Revegetation of open areas through seeding, implemented as part of these commitments and also under the commitments of the mine closure and ongoing rehabilitation plan;
- Consideration of the use of fences, bunds and shelterbelts to reduce wind shear across open areas to minimise wind erosion; and,
- The use of hygroscopic salts to control the emission of particulates from haul roads.

In regard to the use of hygroscopic salts, Centennial Coal has initiated a program of trialling the use of this control, and is considering a further trial on the Southern Open Cut to 3rd Entry ROM haul road.

Through the use of the above control options, it is estimated that approximately 3,000 tonnes of PM_{10} will be abated over the implementation period. Current annual emissions of PM_{10} have been calculated to be approximately 494 tonnes (refer **Table 14**) with the reduction options representing an emission reduction of approximately 60% over the period.

5 IMPLEMENTATION TIMEFRAME

4. Propose a timeframe for implementing all practicable best practice measures

4.1 For each of the best practice measures identified as being practicable in Step 3.2, provide a timeframe for their implementation.

The proposed implementation timeframe for the particulate mitigation measures is presented in **Figure 11** assuming that no further coal resource extraction is approved past the current anticipated 5 year horizon. A further timeframe is presented in **Figure 12** for a 10 year timeframe, which assumes that further resource extraction is approved. The appropriate process will be followed to gain approval for any additional resource extraction past the 5 year timeframe.

In **Figure 11** and **Figure 12**, the colours of each bar represent the following:

Red = Current trial or ongoing process
Green = Future trial
Blue = If trial successful, wider implementation

Figure 11 Five Year Dust Management Implementation Program

Figure 12 Ten Year Dust Management Implementation Program

6 REFERENCES

- Charbon Coal Pty Ltd (2011), Charbon Colliery Air Quality Management Plan.
- Charbon Coal Pty Ltd (2011), Charbon Colliery Rehabilitation Management Plan.
- Charbon Coal Pty Ltd (2011), Environmental Protection Licence 528.
- Katestone (2010), NSW Coal Mining Benchmarking Study - International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining.
- USEPA (1995), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- USEPA (1998), AP 42, Chapter 11.9 Western Surface Coal Mining, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (1982), AP 42, Chapter 11.24 Metallic Minerals Processing, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (2006), AP 42, Chapter 13.2.2 Unpaved Roads, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (2006), AP 42, Chapter 13.2.4 Aggregate Handling and Storage Piles, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- USEPA (2006), AP 42, Chapter 13.2.5 Industrial Wind Erosion, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- DCCEE (2011), National Pollutant Inventory Emission Estimation Technique Manual for Mining , Version 3, Australian Government Department of Sustainability, Environment, Water, Population and Communities.

7 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

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COAL MINE PARTICULATE MATTER CONTROL BEST PRACTICE – SITE SPECIFIC DETERMINATION GUIDELINE

PURPOSE OF THIS GUIDELINE

The purpose of this guideline is to provide detail of the process to be followed in conducting a site specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities.

This guideline also provides the required content and format of the report required for the Pollution Reduction Program "*Coal Mine Particulate Matter Best Practice - Assessment and Report*".

THE SITE SPECIFIC DETERMINATION PROCESS

In preparing the Report, the following steps must be followed, as a minimum:

1. ***Identify, quantify and justify existing measures that are being used to minimise particle emissions***
   1.1. Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity. This estimate must:
   - utilise USEPA AP42 emission estimation techniques;
   - calculate uncontrolled emissions (with no particulate matter controls in place); and
   - calculate controlled emissions (with current particulate matter controls in place).

   (Note: These particulate matter controls must be clearly identified, quantified and justified with supporting information).

   1.2. Using the results of the controlled emissions estimates generated from Step 1.1, rank the mining activities according to the mass of TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity per year from highest to lowest.

   1.3. Identify the top four mining activities from Step 1.2 that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.

2. ***Identify, quantify and justify best practice measures that could be used to minimise particle emissions***
   2.1. For each of the top four activities identified in Step 1.3, identify the best practice measures that could be implemented to reduce emissions taking into consideration:
   - the findings of Katestone (2010), *NSW Coal Mining Benchmarking Study - International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, Katestone Environmental Pty Ltd, Terrace 5, 249 Coronation Drive, PO Box 2217, Milton 4064, Queensland, Australia. http://www.environment.nsw.gov.au/resources/air/KE1006953coalminebmpreport.pdf ;
   - any other relevant published information; and
   - any relevant industry experience from either Australia or overseas.

   2.2. For each of the top four activities identified in Step 1.3, estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity following the application of the best practice measures identified in Step 2.1.

3. ***Evaluate the practicability of implementing these best practice measures***
   3.1. For each of the best practice measures identified in Step 2.1, assess the practicability associated with their implementation, by taking into consideration:
      - implementation costs;
      - regulatory requirements;
      - environmental impacts;
      - safety implications; and
      - compatibility with current processes and proposed future developments.

   3.2. Identify those best practice measures that will be implemented at the premises to reduce particle emissions.
4. ***Propose a timeframe for implementing all practicable best practice measures***
   4.1. For each of the best practice measures identified as being practicable in Step 3.2, provide a timeframe for their implementation.

REPORT CONTENT

The report must clearly identify the methodologies utilised and all assumptions made.

The report must contain detailed information justifying and supporting all of the information used in each step of the process. For example, in calculating controlled emissions in Step 1, current particulate matter controls being used at the mine must be clearly identified, quantified and justified with supporting information and evidence including monitoring data, record keeping, management plans and/or operator training etc**.**

In evaluating practicability in Step 3, the licensee must document the following specific information:

- estimated capital, labour, materials and other costs for each best practice measure on an annual basis for a ten year period. This information must be set out in the format provided in Appendix A;
- The details of any restrictions on the implementation of each best practice measure due to an existing approval or licence;
- Quantification of any new or additional environmental impacts that may arise from the application of a particular best practice measure, such as increased noise or fresh water use;
- The details of safety impacts that may result from the application of a particular best practice measure;
- The details of any incompatibility with current operational practices on the premises; and
- The details of any incompatibility with future development proposals on the premises.

REPORT FORMAT

The report must be structured according to the process outlined above and submitted in both electronic format as .PDF format and hard copy format in triplicate. All emission estimates, costs and supporting calculations must be submitted in electronic format as .XLS format.

ABBREVIATIONS AND DEFINITIONS

USEPA AP42 Emission Estimation Techniques – all of the following:

- USEPA (1995), *AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and

Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/index.html ;

- USEPA (1998), *AP 42, Chapter 11.9 Western Surface Coal Mining*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf ;
- USEPA (2006), *AP 42, Chapter 13.2.2 Unpaved Roads*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf ;
- USEPA (2006), *AP 42, Chapter 13.2.4 Aggregate Handling and Storage Piles*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf ; and
- USEPA (2006), *AP 42, Chapter 13.2.5 Industrial Wind Erosion*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0205.pdf .

PM_{10} – Particulate matter of 10 micrometres or less in diameter

$PM_{2.5}$ - Particulate matter of 2.5 micrometres or less in diameter

Mining Activities – means:

- Wheel generated particulates on unpaved roads
- Wind erosion of overburden
- Blasting
- Bulldozing Coal
- Trucks unloading overburden
- Bulldozing overburden
- Front-end loaders on overburden
- Wind erosion of exposed areas
- Wind erosion of coal stockpiles
- Unloading from coal stockpiles
- Dragline
- Front-end loaders on overburden
- Trucks unloading coal
- Loading coal stockpiles
- Graders
- Drilling
- Coal crushing
- Material transfer of coal
- Scrapers on overburden
- Train loading
- Screening; or
- Material transfer of overburden

TSP - Total Suspended Particulate Matter

Bulldozing coal

The emission factors for bulldozing coal are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/hr) = \frac{35.6(s)^{1.2}}{(M)^{1.3}}$$

$$PM_{10}\ (kg/hr) = \left(\frac{8.44(s)^{1.5}}{(M)^{1.4}}\right) \times 0.75$$

$$PM_{2.5}\ (kg/hr) = \left(\frac{35.6(s)^{1.2}}{(M)^{1.3}}\right) \times 0.022$$

Where M is equal to the coal moisture content and s is equal to the coal silt content as provided in **Table 1**.

Front end loaders and excavators on coal and overburden

Specific emission factors for the operation of front end loaders and excavators on coal and overburden are not provided within AP-42. However, a default factor for TSP of 0.018 kg/t is provided in Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998) for the activity of "truck loading by power shovel (batch drop)". The note provided with this figure however, encourages the user to make use of the predictive emission factor equations in Chapter 13 of AP-42 instead.

The quantity of particulate emissions (kg) generated by a batch drop process (per tonne) (e.g. a truck dumping to a storage pile, or loading out from a pile to a truck) may be estimated using the following expression:

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

Where EF is the emission factor for TSP, PM_{10} or $PM_{2.5}$, k is the aerodynamic size multiplier (0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$), U is the mean wind speed in m/s and M is the moisture content of coal and overburden (refer **Table 1**).

An average wind speed of 2.4 m/s has been adopted for the Charbon Colliery, based on onsite meteorological monitoring for calendar year 2008.

Material transfer of coal by conveyor

Specific emission factors for the transfer of material by conveyor at transfer points are not provided within AP-42. The Environment Australia Document "*National Pollutant Inventory for Mining (Version 3.0)*" (June, 2011) identifies that emissions of particulates at miscellaneous transfer points (including conveying) are estimated using the same emission factor as outlined in **Front end Loaders and excavators on coal** and this emission factor has been adopted within this report, using specific information for coal as outlined in **Table 1** of the main report.

Loading coal stockpiles

See **Front end Loaders and excavators on coal**.

Wind erosion of coal stockpiles and overburden/disturbed areas

The emission factors for wind erosion of coal stockpiles and overburden are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998) as discussed in **Section 2.1.1**.

$$TSP\ (kg/ha/hr) = 1.8u$$

Where u is equal to the wind speed (m/s). Hourly wind speed data from the Charbon Colliery for 8,760 hours monitored during 2008 has been adopted.

Based on this data, an emission rate of TSP of 37,882 kg/ha/yr has been applied within this assessment. This equates to an average emission rate of 4 kg/ha/hr.

As discussed in Section **2.1**, the application of the AP-42 emission factor equation relating to industrial wind erosion of overburden (Chapter 13.2.5) yielded unrealistic emissions when the threshold friction velocity for overburden (and coal dust) was applied. Therefore the emission factor for coal stockpiles has been applied to all areas subject to wind erosion.

No emission factors for PM_{10} are provided for this emission source within Table 11.9-2 of Chapter 11.9 of AP-42. An assumption that 50% of the TSP is emitted as PM_{10} has been adopted for the purposes of this assessment. This is in line with the PM_{10}/TSP ratio quoted within the "*National Pollutant Inventory for Mining (Version 3.0)*" (June, 2011) for wind erosion sources.

Certain emission factors contained within the US EPA emission factor handbook AP-42 do not contain emission factors for $PM_{2.5}$ as often, little validated research has been undertaken to assess the fraction of PM_{10} which would be emitted as $PM_{2.5}$ from the wide range of sources involved.

Limited research has been conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled *'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI, 2006). This document provides seven proposed $PM_{2.5}$/PM_{10} ratios for fugitive dust source categories as presented in **Table 30**.

Table 30 Proposed $PM_{2.5}$ / PM_{10} Particle Size Ratios

Fugitive Dust Source	AP-42 Section	Proposed $PM_{2.5}$ / PM_{10} Ratio
Paved Roads	13.2.1	0.15
Unpaved Roads	13.2.2	0.1
Aggregate Handling and Storage Piles	13.2.4	0.1
Industrial Wind Erosion	13.2.5	0.15
Open Area Wind Erosion	-	0.15

The $PM_{2.5}$ / PM_{10} ratios presented in **Table 30** have been used within this report to calculate the emissions of $PM_{2.5}$ attributable to the activities occurring at Charbon Colliery, where specific $PM_{2.5}$ emission factors or scaling factors are not provided.

Coal crushing and screening

Emission factors for coal crushing are not provided specifically in AP-42 but are taken from AP-42 Chapter 11.24 Metallic Minerals Processing (1982). This approach is also taken within the National Pollutant Inventory for Mining (Version 3.0, June 2011).

Of relevance to this report are emission factors relating to primary coal crushing of high moisture (>4% by weight) coal and coal screening. Default emission factors for TSP and PM_{10} are provided for coal crushing as:

$$TSP\ (kg/t) = 0.01$$

$$PM_{10}\ (kg/t) = 0.004$$

And for screening as:

$$TSP\ (kg/t) = 0.08$$

$$PM_{10}\ (kg/t) = 0.06$$

Loading coal to trains

The emission factors for loading coal to trains are taken from Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = 0.014$$

No PM_{10} or $PM_{2.5}$ emission factors are available for this source within AP-42, and as previously discussed, the PM_{10} emission factor is derived by applying a factor of 0.5 to the TSP emission factor whilst the emission factor for $PM_{2.5}$ is derived by applying the appropriate ratio of 0.1 (refer **Table 30**) to the PM_{10} emission factor. Resulting emission factors for PM_{10} and $PM_{2.5}$ are presented below.

$$PM_{10}\ (kg/t) = 0.007$$

$$PM_{2.5}\ (kg/t) = 0.0007$$

Loading coal to trucks

The emission factors for loading coal to trucks are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = \frac{0.58}{(M)^{1.2}}$$

$$PM_{10}\ (kg/t) = \frac{0.0596}{(M)^{0.9}} \times 0.75$$

$$PM_{2.5}(kg/t) = \frac{0.58}{(M)^{1.2}} \times 0.019$$

Where M equals the material moisture content as provided in **Table 1**.

Bulldozing overburden

The emission factors for bulldozing overburden are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/hr) = \frac{2.6(s)^{1.2}}{(M)^{1.3}}$$

$$PM_{10}\ (kg/hr) = \left(\frac{0.45(s)^{1.5}}{(M)^{1.4}}\right) \times 0.75$$

$$PM_{2.5}\ (kg/hr) = \left(\frac{2.6(s)^{1.2}}{(M)^{1.3}}\right) \times 0.105$$

Where M is equal to the coal moisture content and s is equal to the coal silt content as provided in **Table 1**.

Loading and dumping of overburden

The emission factors for loading and dumping of overburden are taken from Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = 0.001$$

No PM_{10} or $PM_{2.5}$ emission factors are available for this source within AP-42, and as previously discussed, the PM_{10} emission factor is derived by applying a factor of 0.5 to the TSP emission factor whilst the emission factor for $PM_{2.5}$ is derived by applying the appropriate ratio of 0.1 (refer **Table 30**) to the PM_{10} emission factor. Resulting emission factors for PM_{10} and $PM_{2.5}$ are presented below.

$$PM_{10}\ (kg/t) = 0.0005$$

$$PM_{2.5}\ (kg/t) = 0.00005$$

Wheel generated particulates on unpaved roads

The emission factors per vehicle kilometre travelled (VKT) for vehicles travelling on unpaved roads are taken from Chapter 13.2.2 of AP-42 (USEPA, 2006).

$$EF\ (kg/VKT) = k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b}$$

Where EF is the emission factor for TSP, PM_{10} or $PM_{2.5}$, k is the aerodynamic size multiplier (4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$), s is the silt content of the road (%) as taken from **Table 7**, W is the average weight of vehicles travelling on the road (in tonnes) and a and b are empirical constants (for TSP, a = 0.7 and 0.9 for PM_{10} and $PM_{2.5}$, b = 0.45 for TSP, PM_{10} and $PM_{2.5}$). A conversion from lb/VKT to kg/VKT is also applied where 1 lb = 281.9 g).

Graders operating on unpaved roads

The emission factors for graders is taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/VKT) = 0.0034 \times (S)^{2.5}$$

$$PM_{10}\ (kg/VKT) = 0.0056 \times (S)^{2.0} \times 0.6$$

$$PM_{2.5}\ (kg/VKT) = 0.0034 \times (S)^{2.5} \times 0.031$$

Where S is equal to the silt content of roads as provided in **Table 7**.

Supporting Photographs

Figure E1 Land Undergoing Rehabilitation

Figure E2 Coal Handling at Product Stockpile

Figure E2 Watered Haul Roads

Figure E4 Shielded Conveyors at CHPP

Supporting Photographs

Figure E5 Bradford Breaker

Dust Suppressant Brochures