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Metropolitan Colliery

Site Specific Particulate Matter Control

Best Practice Assessment

Report Number 610.11105.02000

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Metropolitan Coal Pty Ltd

Parkes Street, Helensburgh, NSW

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Site Specific Particulate Matter Control

Best Practice Assessment

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EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR Consulting) was commissioned by Metropolitan Collieries Pty Ltd (a subsidiary of Peabody Energy Australia) to perform this assessment, which has included a site inspection, emissions estimation and the identification, quantification and justification of particulate 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 New South Wales (NSW) Environment Protection Authority (EPA) in November 2011. The NSW EPA is part of the NSW Office of Environment and Heritage (OEH).

Pollution Reduction Program

In 2011, the NSW EPA required, through a Pollution Reduction Program (PRP), that Metropolitan Colliery provide a report which examines in detail the potential measures which could be employed to further reduce particulate emissions from the mine. 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 Metropolitan Colliery were identified, and the control efficiency afforded by each applied measure obtained through a literature review and site specific data.

Particulate emission sources were ranked according to the scale of emissions over a one year period with sources contributing to 95% of total site Total Suspended Particulate (TSP) emissions identified and taken forward for further assessment. The assessment required that additional controls were investigated, and the feasibility of implementing each control option was 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 study has identified the following control option as having the potential to reduce the total emission of particulates from the site:

- Implementation of water sprays during ROM bin loading

Through the use of the above control option, it is estimated that approximately 14.3 tonnes of PM_{10} could be abated over the implementation period of 10 years.

The analysis indicates that due to the constraints of the site location, or the current implementation of best practice measures, no further emissions controls are practicable for implementation at the Metropolitan Colliery.

Ongoing Actions and Implementation Timeframe

The implementation of the identified control measure has not been committed to at this time, as the control efficiency afforded by the measure has been taken from literature. Site specific measurements of the current emissions from the loading of the ROM bin are proposed as they will enable the identification of actual emissions prior to commitment to costly measures which may not realise the reductions calculated.

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

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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 *Metropolitan 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 Metropolitan Collieries Pty Ltd (a subsidiary of Peabody Energy Australia) to perform this assessment, which has included a site inspection, emissions estimation and the identification, quantification and justification of particulate control measures for the site. The study was performed in accordance with the *Coal Mine Particulate Matter Control – Best Practice: Site Specific Determination Guideline*[2] issued by New South Wales (NSW) Environment Protection Authority (EPA) in November 2011. The NSW EPA is part of the NSW Office of Environment and Heritage (OEH).

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

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 *Metropolitan Colliery, Site Specific Particulate Matter Control Best Practice Assessment – Appendix 1* (ref: 610.11105.02000 R1A1) which contains the cost information. This submission has been prepared into this format to comply with the NSW EPA specifications as stipulated in the company's Environmental Protection Licence, Condition U1.

1.1 Background

In 2010, the NSW EPA 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 its key recommendations was that each mine should carry out a site-specific determination of best management practice with regard to PM emissions. This recommendation has been adopted by the EPA 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 operational PM controls with international best practice. In addition, mines are required to report on the practicability of implementing each best practice measure and provide a timetable for the implementation of any measure found to be practicable. This information is to be made available on the mine's website (www.peabodyenergy.com.au).

The Dust Stop program has been enacted via Pollution Reduction Programs (PRPs) incorporated into the Environmental Protection Licences (EPL) of coal mines. The PRP requiring the development of a Site Specific Particulate Matter Control Best Practice Assessment was issued to Metropolitan Colliery in December 2011.

1.2 Guidance

EPA has provided guidance on the methodology to be used to prepare the assessment report and its structure. This guidance is 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**

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

Supplementary to the aforementioned guidance, on 8 May 2012, EPA held a workshop for coal mining companies and their consultants to further elaborate on the expectations of the EPA with regard to the assessment report. In summary, EPA conveyed that compliance with air quality criteria was not grounds to refrain from the indentification and implementation of further particulate control measures at coal mines. Furthermore, although the EPA guidance document identifies that the top four emission sources should be assessed, professional judgement is required to ensure that the assessment includes a significant proportion of total site emissions.

1.3 Description of Activities

EPL 767 held by Metropolitan Collieries Pty Ltd (Metropolitan Coal) covers operations at the Metropolitan Colliery, located off Parkes Road, Helensburgh NSW.

Metropolitan Coal has an operational workforce of approximately 310 employees plus on-site contractors and an additional short-term construction workforce of approximately 100 employees. Metropolitan Coal extracts up to 2 million tonnes (t) per annum (Mtpa) of hard and semi-hard coking coal product and operates seven days per week, 24 hours per day. The majority of product coal (approximately 90%) is transported by train to the Port Kembla Terminal for shipping to domestic and overseas customers. Overseas customers include Japan, India, South America and Europe. A minor portion of the product coal is transported by truck to the Corrimal and Coalcliff Coke Works for domestic use.

Longwall mining of the Bulli Seam commenced in 1995. Metropolitan Coal is currently mining Longwall 21. Underground mining operations are supported by Metropolitan Coal's surface facilities which include administration buildings, workshops, bath houses, ablution facilities, haul roads, access roads, fuel and consumables storages, hardstand areas, a Coal Handling and Preparation Plant (CHPP), stockpiles (including run-of-mine [ROM] coal, product coal and coal reject stockpiles), underground coal emplacement plant, and associated coal handling infrastructure (for example conveyors, transfer points and buffer bins).

In June 2009, Metropolitan Coal received approval from the NSW Government for the Metropolitan Coal Project (the Project). The Project comprises continuation, upgrade and extension of underground coal mining operations and surface facilities at the existing Metropolitan Mine. Key components of the Project include increasing saleable coal production from 1.5 Mtpa to 2.8 Mtpa, upgrading the CHPP and associated facilities, on-site underground emplacement of coal reject material within completed sections of the mine, installation of a new men and materials drift, installation of a new electrical substation and upgrade of supporting infrastructure systems including ventilation, gas and water management.

In summary, activities at the colliery include:

- Coal receipt – raw coal is brought to the surface and is conveyed directly into the CHPP for processing or transferred to the ROM coal stockpile.
- ROM coal is conveyed to the CHPP where it is crushed, screened and washed.
- Product coal is conveyed to the product stockpile where:
    - The majority (approximately 90%) is transported by train to Port Kembla Terminal for shipping to domestic and overseas customers.
    - The remaining portion is transported by truck to the Corrimal and Coalcliff Coal Works for domestic use.
- CHPP reject material is transported by truck to Glenlee Washery which is owned and operated by SADA Services Pty Ltd or is emplaced underground via the underground emplacement plant.

These operational activities are discussed in more detail below.

1.3.1 Recent Upgrades

The Metropolitan Colliery currently processes up to approximately 2 Mtpa of ROM coal. The quantities of coal processed in 2011 are presented in **Table 1** along with the silt and moisture contents of the coal.

Table 1 Average Quantities and Characteristics of Coal Processed

Destination	Quantity Delivered (tonnes per annum)	Silt Content (%)	Moisture Content (%)
Port Kembla Terminal	1,311,556	8.8	12.0
Corrimal and Coalcliff Coke Works	155,246		
Reject	298,070	7.5	9.0
Total	**1,935,595**		

This assessment has been prepared based upon a throughput of 2 Mtpa although Project Approval has recently been granted for an increase in coal extraction to approximately 3.2 Mtpa. This assessment is performed on the current coal extraction rate although all findings are appropriate for increased coal extraction, given the nature of activities occurring onsite.

1.4 Project Approval Conditions

Metropolitan Colliery's Project Approval (08_0149) includes 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/m^3	
Particulate matter <10 µm (PM_{10})	Annual	30 µg/m^3	
	24 hour	50 µg/m^3	
		Maximum increase in deposited dust level	**Maximum total deposited dust level**
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

1.5 Environmental Licence Conditions

The EPA regulates the operations conducted at Metropolitan Colliery through an EPL issued under the *Protection of the Environment Operations Act 1997* (POEO Act). Metropolitan Coal's EPL (767) 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.

Metropolitan Colliery operates a complaints recording and management system as part of their over-arching management system and in accordance with Condition 5 of the EPL.

There have been no complaints to date in 2012 regarding dust/air quality. Furthermore, there were no complaints regarding air quality issues in 2011. Two complaints relating to dust were received in 2010.

Given the low number of complaints relating to dust nuisance, it is reasonable to consider that current dust emission controls and management measures employed at the site are sufficient to manage the potentially dust-emitting sources.

EPA do not have any current Notices issued to Metropolitan Colliery relating to air quality.

1.6 Environmental Performance

Metropolitan Coal operates an air quality monitoring program for PM_{10} and dust deposition in accordance with the requirements of both Project Approval 08_0149 and EPL 767.

PM_{10} is measured by a High Volume Air Sampler (HVAS) and Tapered Element Oscillating Microbalance (TEOM). Dust Deposition Gauges (DDGs) are used to monitor deposited matter.

Total Solid Particulates (TSP) are not measured directly, instead the annual average concentrations are estimated from the PM_{10} measurements from the HVAS by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000).

Dust deposition monitoring has been performed at twelve sites since 2003, with ten sites currently active. Five are monitored for compliance with EPL 767, whilst the remaining five are maintained by Metropolitan Coal to guide operations and monitor performance of on-site dust controls.

A review of data collected from the DDGs in the Air Quality and Greenhouse Gas Management Plan (Revision No. AQMP-R01-D) shows the annual average dust deposition (insoluble solids) rate for all sites have been in the range of 0.6 grams per square metre per month (g/m^2/month) to 3.9 g/m^2/month, with two exceptions in 2009.

Monitoring results for dust deposition are presented in **Table 3** for the period 2010 and 2011.

Table 3 Monitoring Results for Dust Deposition – Metropolitan Colliery

		Annual Average Dust Deposition (Insoluble Solids - g/m^2/month)	
Location	**Site ID**	**2010**	**2011**
136 The Crescent (EPA ID 1/H)	DG1	2.1	1.0
28 Old Station Road (EPA ID 2)	DG2	1.0	1.0
Mine Entrance (EPA ID 3)	DG3	2.9	2.2*
Helensburgh Golf Course (EPA ID 4)	DG4	1.7	1.5
83 Parkes Street (EPA ID 5)	DG5	1.0	1.0
55 Parkes Street (EPA ID 6)	DG6	0.6	0.8
32 Old Station Road	DG7	0.6	1.7
88 Parkes Street	DG8	1.9	1.6
Helensburgh Public School	DG9	1.1	1.0
Helensburgh Private School	DG10	1.1	1.6

* An elevated average of 6.8 g/m^2/month was contaminated by a 1 month value of 52 g/m^2/month which was considere to be sample contamination and has been removed. The corrected value of 2.2 g/m^2/month has been reported.

PM_{10} monitoring using a HVAS commenced in May 2007, whilst the TEOM has been operational since December 2010. The HVAS provides an average PM_{10} concentration for a specific 24-hour period, on a six-day cycle while the TEOM allows for continuous measurement of PM_{10} concentrations, at five-minute intervals (real-time monitoring).

The Metropolitan Coal TEOM is set up with automatic alarming, with the Manager - Environment and Community notified by SMS and email of any trigger level being reached.

Monitoring results for PM_{10} and TSP are presented in **Table 4** for the period 2007 to 2011 and demonstrate that for PM_{10}, compliance with the Project Approval Conditions is being achieved at the monitoring site.

Table 4 Monitoring Results for Particulate Matter – Metropolitan Colliery

Pollutant	Averaging Period	Monitoring Results	Criterion	Compliance
Total suspended particulate matter (TSP)[1]	Annual	**37.5 µg/m³ (**2007 – May to Dec) **37.5 µg/m³** (2008) **45.0 µg/m³** (2009 – Jan to May) **80.0 µg/m³** (2010 – Jan to Mar)[2] **57.5 µg/m³** (2010 – Jan to Mar excluding non-mining related elevated results) **27.5 µg/m³** (2011– Jan to Dec)	90 µg/m³	✓
Particulate matter <10 µm (PM_{10})	Maximum 24 hour	**36.0 µg/m³ (**2007 – May to Dec) **30.0 µg/m³** (2008) **35.0 µg/m³** (2009 – Jan to May) **66.0 µg/m³** (2010 – Jan to Mar)[2] **38.0 µg/m³** (2010 – Jan to Mar excluding non-mining related elevated results) **71.9 µg/m³** (2011 Jan to Dec) **31.0 µg/m³** (2011 Jan to Dec excluding non-mining related elevated results)	50 µg/m³	✓
	Annual	**15 µg/m³** (2007 – May to Dec) **15 µg/m³** (2008) **18 µg/m³** (2009 – Jan to May) **32 µg/m³** (2010 – Jan to Mar) **23 µg/m³** (2010 – Jan to Mar excluding non-mining related elevated results) **11 µg/m³** (2011– Jan to Dec)	30 µg/m³	✓

Note: (2007) relates to period May to December

1. The TSP concentrations were calculated from annual PM_{10} HVAS results. Assumed that 40% of TSP is PM_{10}.
2. The HVAS is located on a large grassed double block and a maintenance contractor uses a small tractor to move the lawn and a weed eater to trim back along fence lines. It is suspected this activity takes place bi-monthly on a Thursday, whereas all other data are significantly below this criteria.

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 Metropolitan Colliery. **Table 5** presents a summary of the AP-42 reference sections for the various emission factors used in this assessment report. **Appendix B** outlines the emission factors used for each activity occurring at Metropolitan Colliery.

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

Emissions Source	AP-42 Chapter	Notes
Miscellaneous Transfer Points (including conveying)	-	NPI Emission Factor in Section 1.1.16 Adopted
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 trucks	Chapter 11.9 Western Surface Coal Mining (1998)	
Loading coal to trains	Chapter 11.9 Western Surface Coal Mining (1998)	
Wheel generated particulates on unpaved roads	Chapter 13.2.2 Unpaved Roads (2006)	

Table 6 Annual Activity Data for Material Handling Operations

Operation/Activity	Number	Activity Rate (Annual)	Units	Notes
COAL				
Conveyor from Underground and other associated transfer points	6	12,000,000	tonnes	All ROM transferred to primary and secondary crushing which occurs underground, before being conveyed to CHPP or ROM Stockpile on surface
Dumping of ROM coal to ROM Stockpile		600,000	tonnes	Assumed 30% of ROM to ROM Stockpile, 70% to CHPP
Front end loader on ROM coal Stockpile		1,710	hrs	
Loading ROM to ROM Bin (for CHPP)		600,000	tonnes	
Tertiary Crushing		2,000,000	tonnes	
Screening		2,000,000	tonnes	
Dumping of Product Coal to Stockpile		1,680,000	tonnes	ROM minus 320,000 tonnes reject material
Front End Loaders on Product Coal	3	3,252	hrs	
Loading coal to Trucks		168,000	tonnes	10% of Product loaded to Trucks
Loading Coal to Trains		1,512,000	tonnes	90% of Product loaded to Trains
Dumping of CHPP Rejects to Coarse Reject Stockpile		320,000	tonnes	
Front end loader on Coarse Reject Stockpile		890	hrs	
Loading trucks with Coarse Rejects		320,000	tonnes	

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 EPA, 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), and **Table 8** (wind erosion sources).

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 (%)
Stockpile Area Haul Road	680	13	3,536	50	3
Truck Wash to Island Haul Road	80	10	416	50	3
Top Administration Area Road	200	8	2,550	2	3

Table 8 Annual Activity Data for Wind Erosion Sources

Open Area	Total Area (ha)	Active Area (ha)	Emission Factor Applied to Active Area	Notes
ROM Stockpile	0.1	0.1	Active Storage Pile AP-42 Chapter 11.9	Coal stockpiles
Product Stockpile	2.16	2.16	Active Storage Pile AP-42 Chapter 11.9	Coal stockpiles
Rejects Stockpile	0.02	0.02	Active Storage Pile AP-42 Chapter 11.9	Coal stockpiles

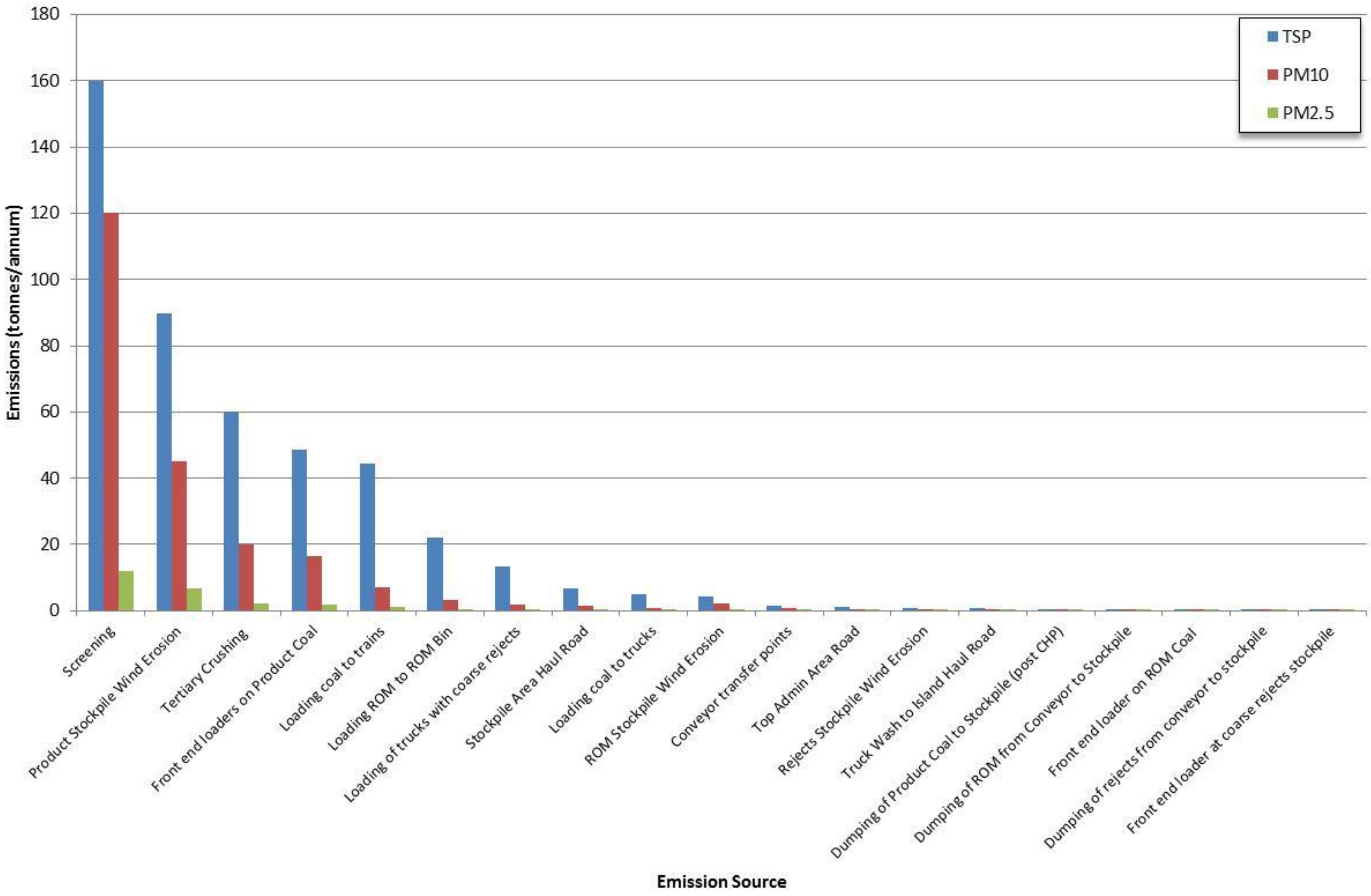
2.1.2 Uncontrolled Particulate Emissions

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 activities occurring at Metropolitan Colliery are presented in **Table 9** and graphically in **Figure 1**.

Table 9 Uncontrolled Annual Particulate Emissions – Metropolitan Colliery

Emission Source	TSP Emissions (tonnes/year)	PM_{10} Emissions (tonnes/year)	$PM_{2.5}$ Emissions (tonnes/year)
Material Handling – Coal			
Dumping of Product Coal to Stockpile (post CHP)	0.2	0.1	0.01
Front end loaders on Product Coal	48.5	16.6	1.7
Conveyor transfer points	1.5	0.7	0.1
Tertiary Crushing	60.0	20.0	2.0
Screening	160.0	120.0	12.0
Loading coal to trucks	4.9	0.8	0.1
Loading coal to trains	44.5	7.2	1.1
Dumping of ROM from Conveyor to Stockpile	0.1	0.03	0.003
Front end loader on ROM Coal	0.1	0.01	0.001
Loading ROM to ROM Bin	22.0	3.4	0.4
Dumping of rejects from conveyor to stockpile	0.0	0.0	0.0
Front end loader at coarse rejects stockpile	0.0	0.0	0.0
Loading of trucks with coarse rejects	13.3	2.0	0.3
Coal Stockpiles			
ROM Stockpile Wind Erosion	4.2	2.1	0.3
Product Stockpile Wind Erosion	89.9	45.0	6.7
Rejects Stockpile Wind Erosion	0.8	0.4	0.1
Road Haulage			
Stockpile Area Haul Road	6.6	1.5	0.2
Truck Wash to Island Haul Road	0.8	0.2	0.02
Top Admin Area Road	1.1	0.3	0.03
TOTAL	**458.4**	**220.2**	**24.9**

Figure 1 Uncontrolled Annual Particulate Emissions – Metropolitan 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 Metropolitan Colliery. A summary of the existing control measures identified as currently being implemented at the Metropolitan Colliery is provided below. Additional details are provided in the following sections. The emission controls applied currently at Metropolitan Colliery and observed during the audit are presented in **Table 10**.

Table 10 Particulate Emission Controls Currently Applied at Metropolitan Colliery

Source	Control Measure	Comments	Supporting Material / Comments
Dumping to Product Stockpile	Water sprays	On an as needs basis	Sighted during site audit
Dumping to ROM Stockpile	Water sprays	On an as needs basis	Sighted during site audit
Conveyors	Water sprays	On an as needs basis	Sighted during site audit
Crushing and Screening	CHPP Enclosed		Sighted during site audit – refer **Figure C1** in Appendix C
Haul Roads	Watered	On an as needs basis	No watering occurred during site audit, however water truck, filling point were observed and evidence that water truck had been used sighted – moist haul roads
Coarse Rejects Stockpile	Gantry lowered to minimise drop height		
Product and ROM Stockpiles	Water Sprays	Automatic and Manual water sprays	Sighted during site audit – refer **Figure C2** and **Figure C3** in Appendix C
	Natural vegetation windbreaks		Sighted during site audit and photographed
Truck loading	Trucks covered prior to site exit	These covers are automatic	Covering of truck sighted during site audit, once truck loading completed, automatic cover activated by driver.

The applicable control efficiencies of each of the controls identified in **Table 10** are presented in **Table 11**. Application of these controls results in the emissions presented in **Table 12** and **Figure 2**. A comparison of total emissions by source are presented in **Figure 3**.

Table 11 Control Factors Assumed for Existing Control Measures

Emission Source	Control Measure	Control Factor (%)	Source
Dumping to Product Stockpile	Water sprays	50	Katestone (2010)
Dumping to ROM Stockpile	Water sprays	50	Katestone (2010)
Front end loader on product stockpile	Operating on moist coal	50	Katestone (2010)
Conveyors	Water sprays	50	Katestone (2010)
Crushing and Screening	CHPP Enclosed Wet Process	70 100	NPI (2011)
Haul Roads	Watered	50	NPI (2011)
Coarse Rejects Stockpile	Gantry lowered to minimise drop height	25	Katestone (2010)
Product and ROM Stockpiles	Water Sprays	50	Katestone (2010)
	Natural vegetation windbreaks	30	Katestone (2010)
	3-sided enclosure	75	Katestone (2010)
Truck loading	Trucks covered prior to site exit	-	-

Both the product and ROM stockpiles at the Metropolitan Colliery are effectively shielded on three sides, one side by the sandstone escarpment and on two other sides by vegetation. A control factor of 75% has been applied to reflect this situation.

Table 12 Controlled Annual Particulate Emissions – Metropolitan Colliery

Emission Source	TSP Emissions (tonnes/year)	PM_{10} Emissions (tonnes/year)	$PM_{2.5}$ Emissions (tonnes/year)
Material Handling – Coal			
Dumping of Product Coal to Stockpile (post CHP)	0.1	0.05	0.005
Front end loaders on Product Coal	24.3	8.3	0.8
Conveyor transfer points	0.7	0.35	0.035
Tertiary Crushing	0.0	0.0	0.0
Screening	0.0	0.0	0.0
Loading coal to trucks	2.5	0.4	0.06
Loading coal to trains	22.2	3.6	0.5
Dumping of ROM from Conveyor to Stockpile	0.04	0.02	0.002
Front end loader on ROM Coal	0.05	0.008	0.001
Loading ROM to ROM Bin	17.6	2.9	0.3
Dumping of rejects from conveyor to stockpile	0.02	0.009	0.001
Front end loader at coarse rejects stockpile	0.04	0.005	0.001
Loading of trucks with coarse rejects	13.3	1.98	0.25
Coal Stockpiles			
ROM Stockpile Wind Erosion	0.4	0.18	0.03
Product Stockpile Wind Erosion	7.9	3.9	0.59
Rejects Stockpile Wind Erosion	0.83	0.42	0.062
Road Haulage			
Stockpile Area Haul Road	0.66	0.15	0.015
Truck Wash to Island Haul Road	0.08	0.018	0.002
Top Admin Area Road	0.11	0.026	0.003
TOTAL	**90.8**	**22.3**	**2.7**

Figure 2 Controlled Annual Particulate Emissions – Metropolitan Colliery

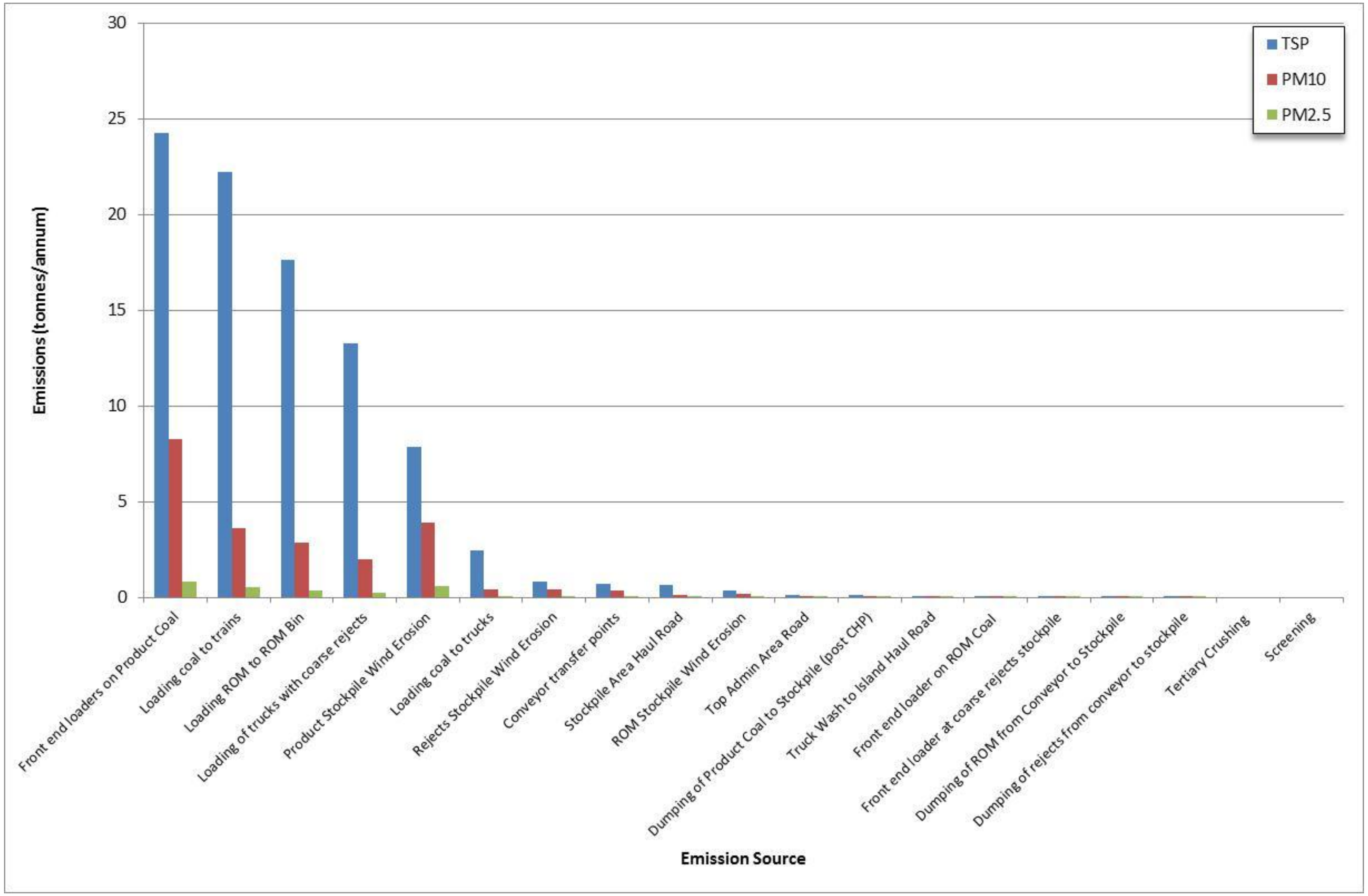
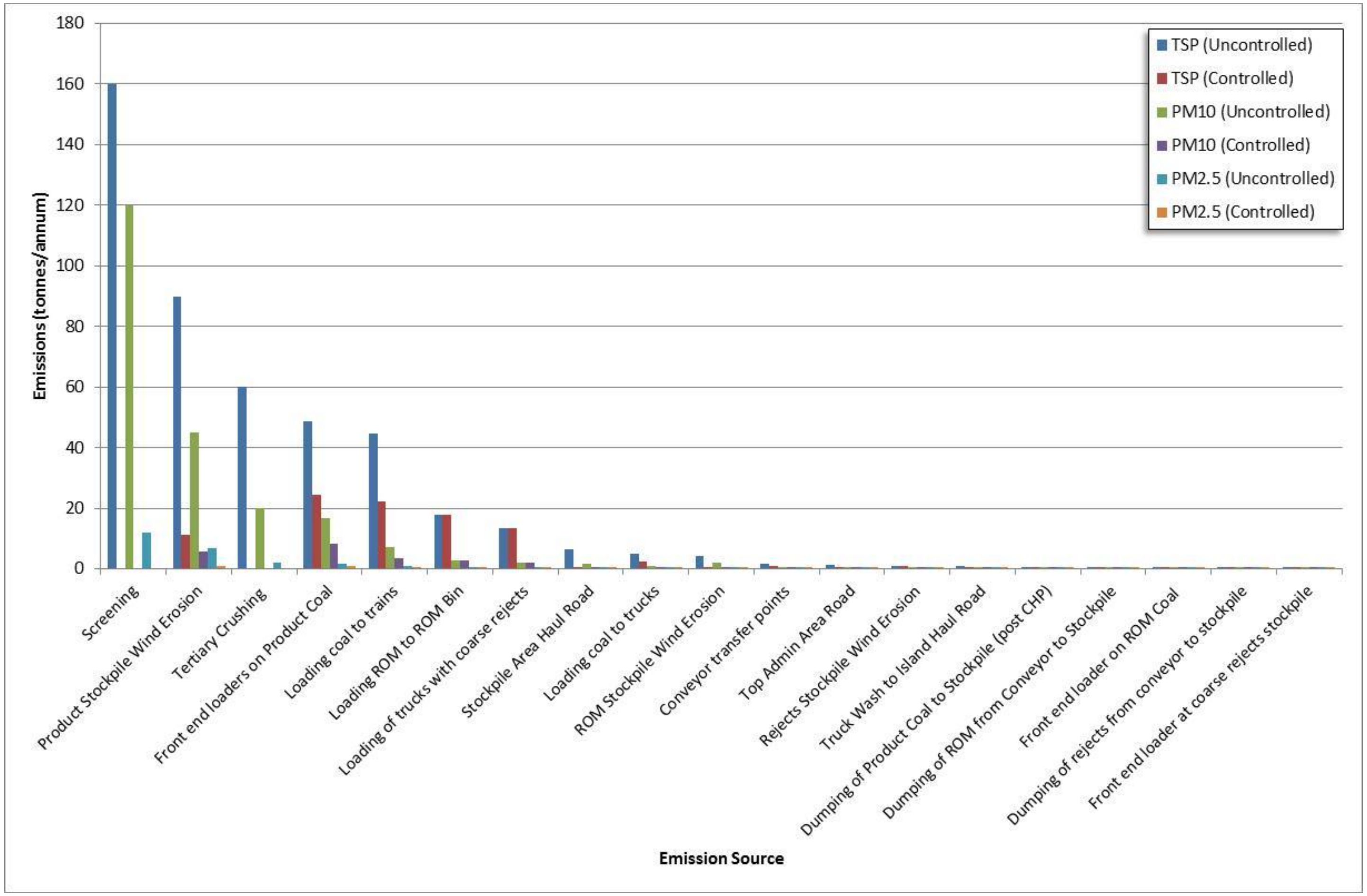


Figure 3 Comparison of Uncontrolled versus Controlled Particulate Emissions – Metropolitan Colliery

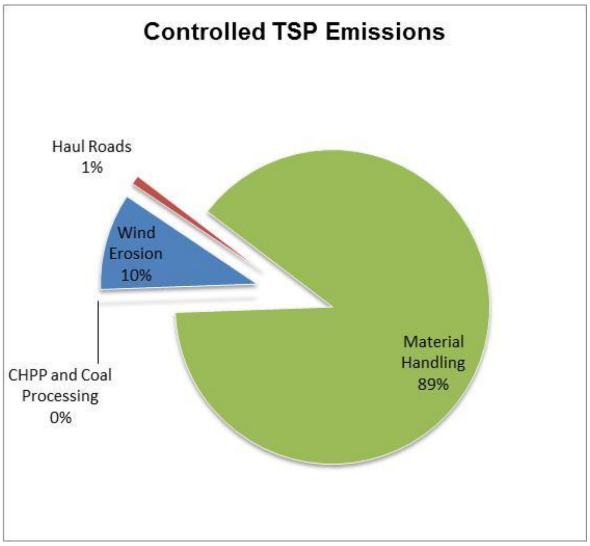


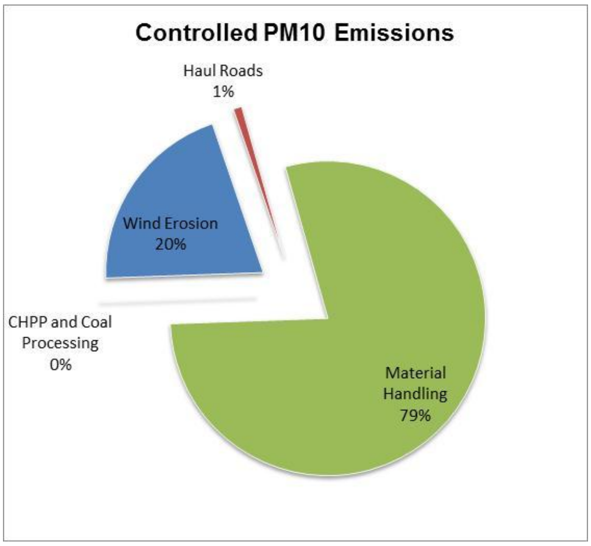
Particulate emissions are presented by source group (wind erosion, haul roads, material handling and CHPP and coal processing operations) in **Table 13** and in **Figure 4**.

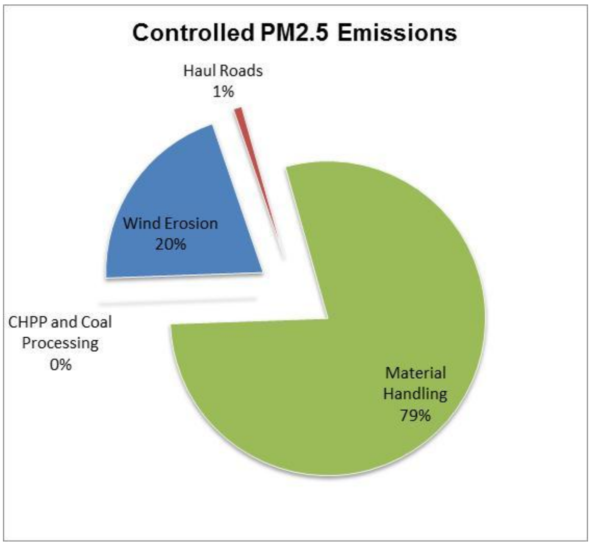
Table 13 Comparison of Uncontrolled and Controlled Particulate Emissions

Emission Source Group	Uncontrolled Emissions (tonnes/annum)			Controlled Emissions (tonnes/annum)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion	94.9	47.5	7.1	9.1	4.5	0.7
Haul Roads	8.4	2.0	0.2	0.8	0.2	0.0
Material Handling	130.7	30.3	3.5	80.9	17.6	2.0
CHPP and Coal Processing	220.0	140.0	14.0	0.0	0.0	0.0
TOTAL	**454.1**	**219.7**	**24.8**	**90.8**	**22.3**	**2.7**

Figure 4 Representation of Major Controlled Particulate Emission Sources – Metropolitan Colliery







2.3 Ranking of Mining Activities and Identification of Top PM Sources

EPA requirements for the assessment of particulate control measures is provided in **Appendix A**. This advice requires the top four controlled particulate emissions sources are assessed for the feasibility of further control measures being applied.

However, further advice from the EPA has indicated that these top four sources should represent a significant proportion of mine emissions. Within this report, the assessment of further control measures has been applied to all sources which cumulatively represent 97% of total site emissions (of TSP). These sources and emission totals are presented in **Table 14** in blue shading which cover the broad emission sources of wind erosion from the product stockpile, loading coal to trucks and trains and the operation of front-end-loaders on coal. Potential control measures to be applied to these sources are discussed in detail in **Section 3**.

Table 14 Controlled Particulate Emission Sources and % Contribution to Site Total

Activity	TSP Emissions (tonnes/year)	PM_{10} Emissions (tonnes/year)	$PM_{2.5}$ Emissions (tonnes/year)	Cumulative % Contribution to Total TSP Emissions
Front end loaders on Product Coal	24.3	8.3	0.8	27
Loading coal to trains	22.2	3.6	0.5	51
Loading ROM to ROM Bin	17.6	2.9	0.3	71
Loading of trucks with coarse rejects	13.3	2.0	0.3	85
Product Stockpile Wind Erosion	7.9	3.9	0.6	94
Loading coal to trucks	2.5	0.4	0.1	97
Rejects Stockpile Wind Erosion	0.8	0.4	0.1	98
Conveyor transfer points	0.7	0.3	0.03	98
Stockpile Area Haul Road	0.7	0.2	0.02	99
ROM Stockpile Wind Erosion	0.4	0.2	0.02	100
Top Admin Area Road	0.1	0.03	0.00	100
Dumping of Product Coal to Stockpile (post CHP)	0.1	0.05	0.00	100
Truck Wash to Island Haul Road	0.1	0.02	0.00	100
Front end loader on ROM Coal	0.1	0.01	0.00	100
Front end loader at coarse rejects stockpile	0.04	0.01	0.00	100
Dumping of ROM from Conveyor to Stockpile	0.04	0.02	0.00	100
Dumping of rejects from conveyor to stockpile	0.02	0.01	0.00	100
Tertiary Crushing	0.0	0.0	0.0	100

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.

The emission reductions quoted within this Section are generic published control factors which do not take into account the specific nature of operations at the Metropolitan Colliery. In the absence of costly site specific trials for each control measure being available, these generic factors are used to guide the selection of control measures which may be broadly appropriate for further investigation or application at the site.

Following an assessment of the feasibility of each measure (refer **Section 4**) some control measures are taken forward for an assessment of costs and benefits. Where a measure is identified as potentially providing particulate emissions reductions for a source at an acceptable cost, the implementation of the measure is committed to by Metropolitan Coal. A cost benefit analysis will be undertaken to determine whether control measures will be the subject of site specific trials prior to implementation or implemented directly. Trials are important to:

1 Confirm current particulate emissions from the source in question; and

2 Confirm the potential particulate emissions reductions following control measure implementation.

It is not considered to be appropriate to commit to widespread implementation of potentially costly and ineffective particulate control measures on the basis of non-site specific data.

Trials of each control measure will be implemented within 6 months of report submission, and a reassessment of the likely emission reductions afforded by each measure will be performed. Such reassessment will include field trials and comprehensive data collection and analysis.

Where measures are still identified as providing significant emission reductions at acceptable cost following these field trials, these will be implemented on a wider scale.

3.1 Front End Loaders on Product Coal

Katestone (2011) and DSEWPC (2012) do not provide emission reduction factors for front end loaders operating on coal. **Table 15** presents control factors available in the literature for similar activities – bulldozers and scrapers. Keeping the travel routes and surface material moist is reported to provide a 50% reduction in emissions for these activities. In the absence of any factors available for front end loaders, it has been assumed that by using water sprays to ensure the Product Stockpile Area is kept moist when in use, that a reduction in emissions of 50% can be achieved.

Table 15 Best Practice Control Measures – Front End Loader on Coal

Source	Control Measure	Effectiveness	Source
Bulldozer	Keep travel routes and materials moist	50%	Katestone (2011)
Scraper on topsoil	Soil naturally or artificially moist	50%	DSEWPC (2012)

These control factors have been applied to the current operations at the Metropolitan Colliery and therefore, it is considered that for this particulate emission source, best practice is currently being implemented at the site. No further assessment of particulate control measures for this source are discussed further within this report.

3.2 Material Handling (Including Loading Trains and Trucks and Loading ROM Bin)

Loading trucks with product coal and coal rejects may give rise to particulate emissions as a result of the air turbulence induced by dropping of coal from height. Similarly, emissions may arise from loading the ROM bin through similar physical mechanisms. The effects of these processes 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 (where appropriate) to reduce the potential for entrainment in crosswinds.

A summary of the potential control measures for minimising particulate emissions from the loading of coal trucks and trains and coal bins, and their effectiveness, is provided in **Table 16** (DSEWPC, 2012). It is noted that the loading of coal to trucks and trains occurs by loader. Therefore, each control measure in **Table 16** may not be appropriate for both sources. This is discussed further in **Section 4**.

Table 16 Best Practice Control Measures – Loading Coal and Rejects to Trucks, Trains and Bins

Control Measure	Effectiveness
Enclosure	100%
Telescopic Chute with Water Spray	75%
Water sprays (currently applied for loading trains and trucks)	50%
Hooding with Cyclones	70%
Hooding with Scrubbers	85%
Hooding with Fabric Filters	83%

SOURCE: DSEWPC (2012), Table 4

It is noted that water sprays used on the stockpile area will also act to reduce emissions of particulate during the loading of trains and trucks by front end loader. This emission control has not been considered further within this report for these sources.

Site personnel have noted that visible emissions of particulate are not noticeable and that emission factors for ROM bin loading may be over estimating particulate emissions from theis source. Metropolitan Coal propose to perform site specific tests to show the conservative nature of the application of this emission factor at Metropolitan (refer **Section 5**).

3.3 Product Stockpile Wind Erosion

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.
- 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 17** (Katestone, 2011).

Table 17 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 (currently applied)	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 (currently applied)	30%
	Reduced pile height	30%
	Wind screens/wind fences	>80% 75-80%
	Pile shaping/orientation	<60%
	Erect 3-sided enclosure around storage piles (currently applied)	75%

SOURCE: Katestone (2011), Table 72

Water sprays, vegetative wind breaks and effective 3-sided enclosures have been identified as controls which are currently in place to reduce particulate emissions from coal stockpile areas. These measures are not considered further within this report.

3.4 Quantification of Potential Particulate Management Measures

Table 18 presents the emission control factors assumed in this assessment for the potential particulate management measures identified and **Table 19** presents the PM emission loads for each source if each potential control measure was applied.

Table 18 Control Factors Assumed for Potential Control Measures

Emission Source	Control Measure	Control Factor (%)	Source
Wind Erosion of Product Stockpile	Bypassing stockpiles	100%	Katestone (2011)
	Chemical Wetting Agents	80-99% 85% 90%	Katestone (2011)
	Surface Crusting Agent	95%	Katestone (2011)
	Enclosure (silo with bag house)	100% 95-99% 99%	Katestone (2011)
	Cover storage pile with a tarp during high winds	99%	Katestone (2011)
	Reduced pile height	30%	Katestone (2011)
	Wind screens / wind fences	>80% 75-80%	Katestone (2011)
	Pile shaping / orientation	<60%	Katestone (2011)
Material Handling (Loading trains, trucks and ROM bin)	Enclosure	100%	DSEWPC (2012)
	Telescopic Chute with Water Spray	75%	DSEWPC (2012)
	Water sprays (currently applied for loading trains and trucks)	50%	DSEWPC (2012)
	Hooding with Cyclones	70%	DSEWPC (2012)
	Hooding with Scrubbers	85%	DSEWPC (2012)
	Hooding with Fabric Filters	83%	DSEWPC (2012)

Table 19 Estimated Emissions – Potential Controls

Emission Source	Control Option	TSP (tonnes/year)	PM_{10} (tonnes/year)	$PM_{2.5}$ (tonnes/year)
Wind Erosion of Product Stockpile	***Current controls***	***7.87***	***3.93***	***0.59***
	Bypassing stockpiles	0.00	0.00	0.00
	Chemical Wetting Agents	1.57	0.79	0.12
	Surface Crusting Agents	0.39	0.20	0.03
	Enclosure (silo with bag house)	0.39	0.20	0.03
	Cover storage pile with a tarp during high winds	0.08	0.04	0.01
	Reduced pile height	5.51	2.75	0.41
	Wind screens / wind fences	1.97	0.98	0.15
	Pile shaping / orientation	3.15	1.57	0.24
Material Handling (Loading Trains)	***Current controls***	***22.23***	***3.61***	***0.53***
	Enclosure	0.00	0.00	0.00
	Telescopic Chute with Water Spray	5.56	0.90	0.13
	Hooding with Cyclones	6.67	1.08	0.16
	Hooding with Scrubbers	3.33	0.54	0.08
	Hooding with Fabric Filters	3.78	0.61	0.09
Material Handling (Loading Trucks [Reject and Product])	***Current controls***	***15.76***	***2.38***	***0.31***
	Enclosure	0.00	0.00	0.00
	Telescopic Chute with Water Spray	3.94	0.60	0.08
	Hooding with Cyclones	4.73	0.71	0.09
	Hooding with Scrubbers	2.36	0.36	0.05
	Hooding with Fabric Filters	2.68	0.40	0.05
Material Handling (Loading ROM Bin)	***Current controls***	***17.64***	***2.87***	***0.34***
	Enclosure	0.00	0.00	0.00
	Telescopic Chute with Water Spray	4.41	0.72	0.08
	Water sprays	8.82	1.43	0.17
	Hooding with Cyclones	5.29	0.86	0.10
	Hooding with Scrubbers	2.65	0.43	0.05
	Hooding with Fabric Filters	3.00	0.49	0.06

A comparison of each control application against the original (with existing controls) emissions of particulate are presented in **Figure 5** (wind erosion of product stockpile), **Figure 6** (material handling [loading trains]), **Figure 7** (material handling [loading trucks]) and **Figure 8** (material handling [loading ROM Bin]).

Figure 5 Potential Reductions in PM Emissions due to Additional Controls - Wind Erosion of Product Stockpile

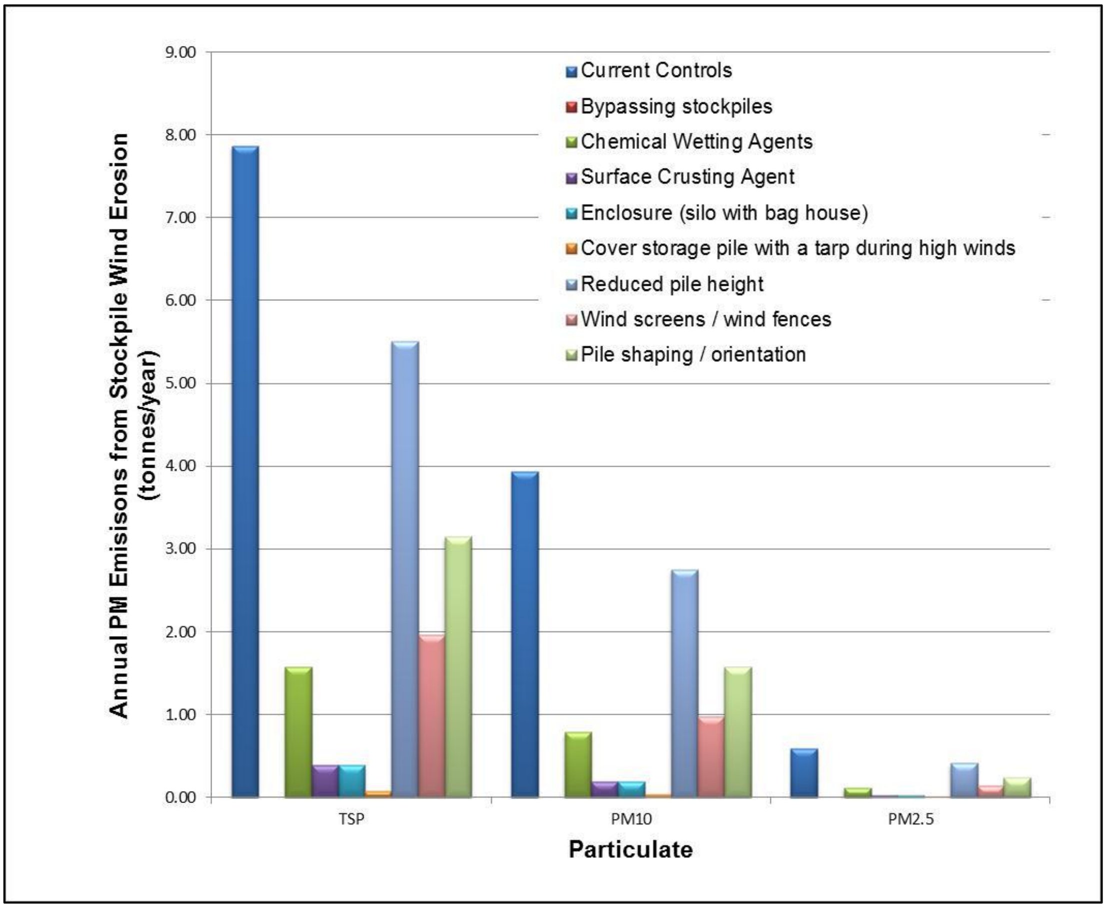


Figure 6 Potential Reductions in PM Emissions due to Additional Controls – Loading Trains

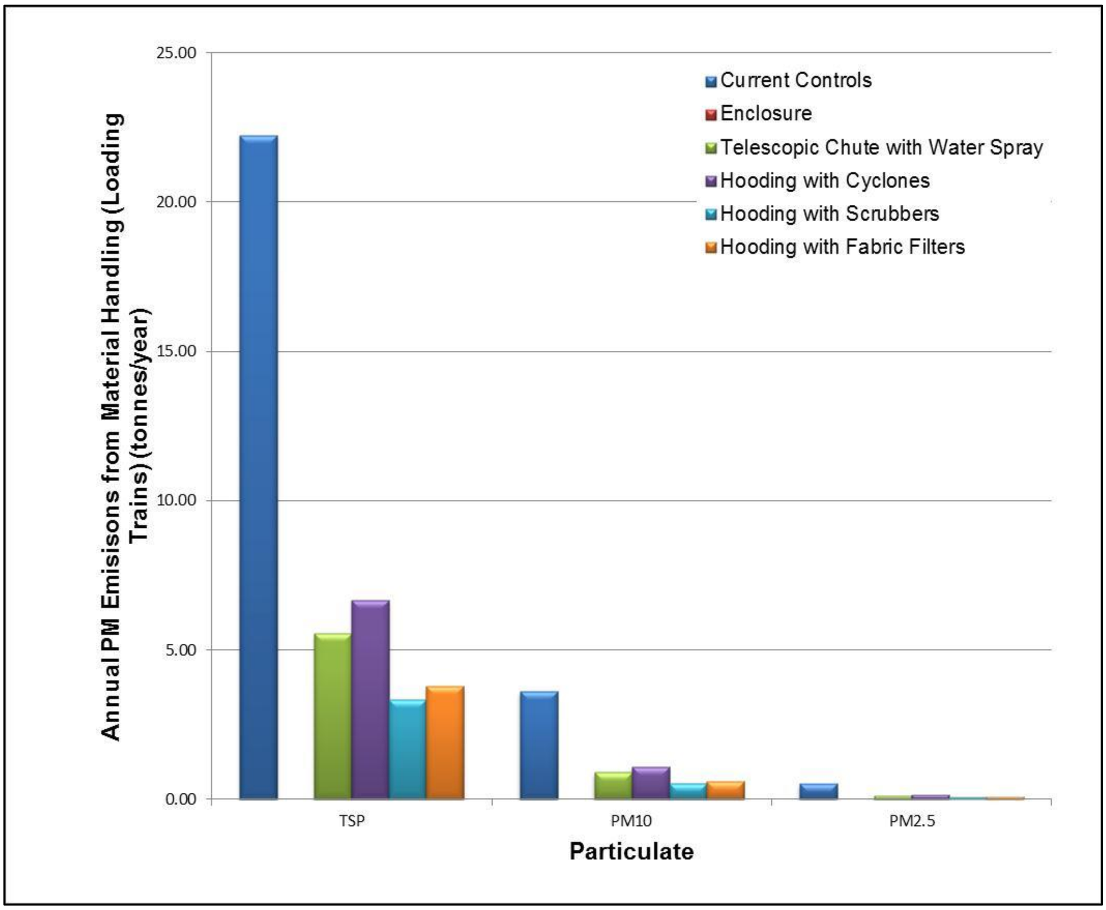


Figure 7 Potential Reductions in PM Emissions due to Additional Controls – Loading Trucks

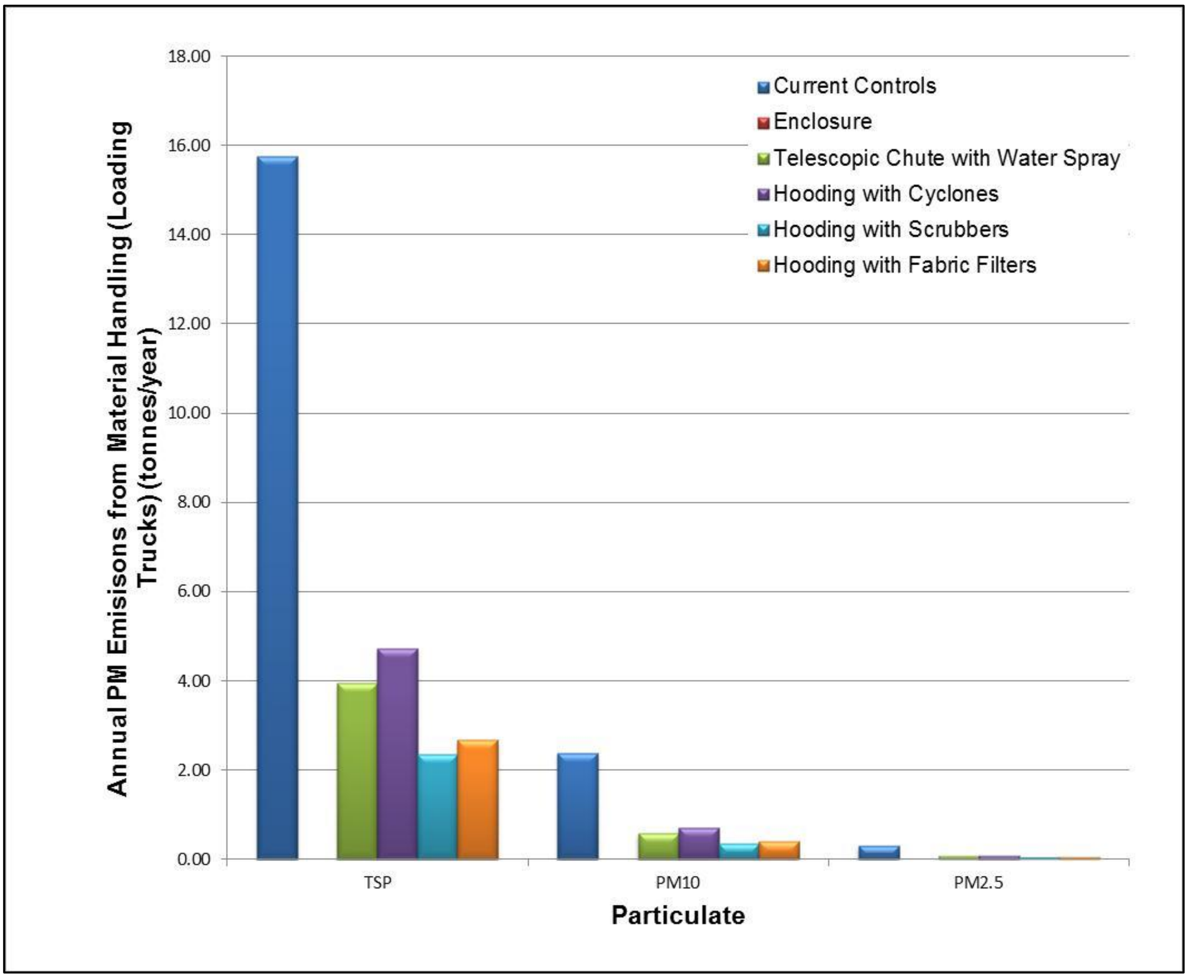
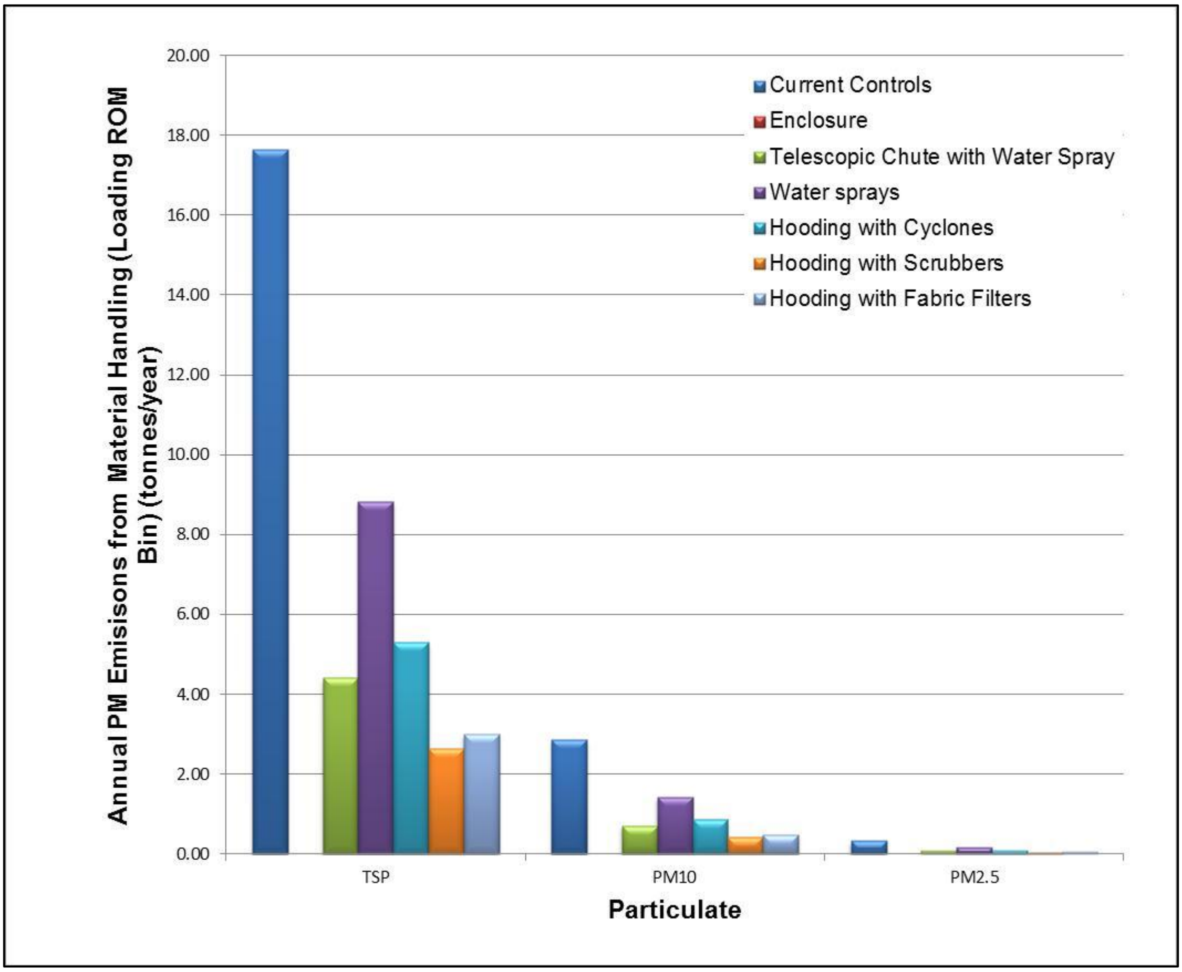


Figure 8 Potential Reductions in PM Emissions due to Additional Controls – Loading ROM Bin



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 EPA, 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
- Compatibility with current processes and proposed future developments.

In summary, the control measures identified in **Section 3** for further evaluation are presented in **Table 20.**

Table 20 Summary of Potential Particulate Control Measures

Emission Source	Control Option
Wind Erosion of Product Stockpile	Bypassing stockpiles
	Chemical Wetting Agents
	Surface Crusting Agent
	Enclosure (silo with bag house)
	Cover storage pile with a tarp during high winds
	Reduced pile height
	Wind screens / wind fences
	Pile shaping / orientation
Material Handling (Loading trains, trucks and ROM bin)	Enclosure
	Telescopic Chute with Water Spray
	Water sprays (currently applied for loading trains and trucks)
	Hooding with Cyclones
	Hooding with Scrubbers
	Hooding with Fabric Filters

The following sections examine the measures that may constrain the implementation of the particulate control measures outlined in **Table 20,** 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 Metropolitan 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 and **Section 4.2** for the loading of coal to trains, trucks and ROM bin.

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 of Product Stockpile

4.1.1 Practicality of Implementation

Table 21 provides a discussion of the feasibility of control measures for wind erosion of the product stockpile.

Table 21 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
Bypassing stockpiles	RISK = LOW None	RISK = LOW Improvements in dust emissions would be realised	RISK = LOW None	RISK = HIGH Not compatible. Product stockpile area is required for coal storage. Coal cannot be loaded continuously from the CHPP to trains and trucks.	✘ Not considered further in this assessment
Chemical wetting agents	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = MEDIUM 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 = HIGH Not compatible for regularly disturbed areas. Metropolitan Coal's stockpile is small compared with its production profile meaning that stockpiles are consistently turned over. This means application of wetting agents would need to be performed constantly.	✘ 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
Surface crusting agents	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = MEDIUM 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 = HIGH Not compatible for regularly disturbed areas. Metropolitan Coal's stockpile is small compared with its production profile meaning that stockpiles are consistently turned over. This means application of crusting agents would need to be performed constantly.	✘ Not considered further in this assessment
Enclosure (silo with bag house)	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Quantity of coal on Product Stockpile would make the installation of enclosure impractical	✘ Not considered further in this assessment
Cover storage pile with tarp during high winds	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Constant loading of Product Stockpile (24/7) would make the use of a tarp impractical	✘ Not considered further in this assessment
Reduced pile height	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Pile height is dictated by the quantity of coal mined and the speed at which it can be transported offsite. Minimisation of height is limited by the available footprint of the stockpile.	✘ Not considered further in this assessment
Wind screens / fences	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Wind fences cannot be installed on the surface of the stockpile as it is constantly disturbed. Installation at the edge of the stockpile is not compatible as area is required to be clear to allow train loading	✘ 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
Pile shaping / orientation	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Not compatible. Topographic constraints have curtailed the expansion of the colliery. This limits the potential for re-orientation or shaping of stockpiles, further reducing capacities which is untenable from a safety and production perspective.	✘ Not considered further in this assessment

4.1.2 Implementation Costs

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

- Estimated capital expenditure.
- Labour costs.
- Material costs.
- Potential cost savings.

However, no further particulate reduction measures have been identified as practicable for implementation at the Metropolitan Colliery, and therefore no cost benefit assessment has been performed.

4.2 Evaluation Findings – Loading Trains and Trucks and ROM Bin

4.2.1 Practicality of Implementation

Table 22 provides a discussion of the feasibility measures for control of particulate from loading of trains and trucks and the ROM Bin.

Table 22 Practicability of Implementing Control Measures for Coal Loading

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	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Enclosure is not practical due to the method of coal loading and area over which it occurs	✘ Not considered further in this assessment
Telescopic Chute with Water Sprays	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Given how trains and trucks are loaded over a wide area, not practical to install telescopic chute in a fixed location	✘ Not considered further in this assessment
Water sprays (currently implemented for loading trains and trucks)	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = LOW None	✓ Adopted potential measure **MH1** (for loading ROM Bin only)
Hooding with Cyclones	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Hooding requires enclosure which is not practical due to the method of coal loading and area over which it occurs	✘ Not considered further in this assessment
Hooding with Scrubbers	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Hooding requires enclosure which is not practical due to the method of coal loading and area over which it occurs	✘ Not considered further in this assessment
Hooding with Fabric Filters	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Hooding requires enclosure which is not practical due to the method of coal loading and area over which it occurs	✘ 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.
- 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 *Metropolitan Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* in the following table:

- Table 3 Cost Implication Evaluation of Water Sprays during ROM Bin Loading (MH1).

4.3 Summary of Evaluation Findings

A summary of the evaluation process for each control measure identified in **Section 4.1** and **Section 4.2** is presented in **Table 23**. 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 *Metropolitan Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)* **Table 1** for the assessment of costs.

Table 23 Summary of Control Options Evaluation

Emission Source	Control Measure	Cost/Benefit \$/tonne PM_{10}	Regulatory Considerations	Environmental Impacts	Safety Implications	Site Compatibility
Material Handling (Loading of ROM Bin)	MH1: Water Spray	see Appendix 1	Low	Low	Low	Low

4.4 Identification of Dust Control Measures for Metropolitan Colliery

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

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

The particulate control measures that are already implemented at Metropolitan Colliery are summarised in **Table 10**. 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. Furthermore, air quality monitoring results are well below the regulatory limits. 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.

A range of additional control options for the processes operated at Metropolitan Colliery have 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 only one measure for which the implementation costs were estimated.

The cost / benefit ratio of the control option is presented in *Metropolitan Colliery, Site Specific Particulate Matter Control Best Practice Assessment - Appendix 1 (Costs)*. This analysis has identified the control option of water spraying during ROM Bin loading may provide a significant potential to reduce the total emission of particulates from all sources at site at reasonable cost:

Through the use of the above control option, it is estimated that approximately 14.3 tonnes of PM_{10} could be abated over the implementation period of ten years.

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.*

It has been identified within this report that the implementation of water sprays during ROM bin loading has the potential to reduce particulate emissions at the Metropolitan Colliery. However, site experience indicates that visible emissions of particulate during ROM bin loading are not noticeable and therefore the efficacy of water sprays on the ROM bin is questioned, taking into account this site experience.

Prior to the installation of potentially costly water sprays on the ROM bin, Metropolitan Coal will perform site trials to identify whether emissions of particulate are increased during ROM bin loading and therefore, whether water sprays may act to reduce any emissions. It is envisaged that laboratory tests of coal (including but not limited to Dust Extinction Moisture [DEM] test of coal) may be performed to ascertain the moisture level at which bulk handling of coal would result in emissions of particulate. Furthermore, ambient concentrations of particulate may also be monitored pre, during and post ROM bin loading at a suitable location to determine whether any increase in concentrations is apparent during these loading operations.

If it identified that the ROM bin loading does result in increased emissions of particulate matter, water sprays will be installed within 6 months and post-commissioning testing will be performed to ensure that emissions are reduced. This testing will also allow the quantification of emission reduction.

6 REFERENCES

- 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.

- DSEWPC (2012), 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 Metropolitan 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 Metropolitan 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 24**.

Table 24 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 24** have been used within this report to calculate the emissions of $PM_{2.5}$ attributable to the activities occurring at Metropolitan 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 24**) 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 24**) 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 C1 Enclosed CHP

Figure C2 Water Spray on Product Stockpile

Figure C3 Water Spray on Product Stockpile