FINAL REPORT

MOOLARBEN COAL PARTICULATE MATTER CONTROL BEST PRACTICE POLLUTION REDUCTION PROGRAM

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A PEL Company

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1 INTRODUCTION

1.1 Background

In December 2010, NSW Office of Environment and Heritage (OEH) published the draft best practice document '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*' (hereafter called 'the Best Practice Report'). This document was finalised in June 2011, though no significant changes were made from the draft (**Donnelly et al., 2011**).

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

The Coal Mine Particulate Matter Control Best Practice PRP has been attached to the Moolarben Coal Environmental Protection Licences (EPL 12932) as varied in August 2011 to incorporate the PRP.

A copy of the PRP as attached to the OEH EPL 12932 is included in **APPENDIX A** and a copy of the 'Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline' is included in **APPENDIX B.**

In summary the requirements of the PRP are:

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

   a. Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity using USEPA AP-42 emission estimation techniques for both uncontrolled emissions (with no particulate matter controls in place) and controlled emissions (with current particulate matter controls in place);

   b. Rank the controlled emission estimates for TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity from highest to lowest.

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

2. Identify, quantity and justify measures could be used to minimise particle emissions:

   a. For each of the top four activities identified in Step 1(c) identify the measures that could be implemented to reduce emissions.

   b. For each of the top four activities identified in Step 1(c) estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity following the application of the measures identified in Step 2 (b).

3. Evaluate the practicability of implementing these best practice measures:

   a. For each of the best practice measures identified in Step 2(a), assess the practicability associated with their implementation, by taking into consideration:
      i. Implementation status;

ii. Regulatory requirements;
iii. Environmental impacts;
iv. Safety implications; and
v. Compatibility with current processes and proposed future developments.

b. Identify those best practices that will be implemented at the premises to reduce particle emissions.

4. Propose a timeframe for implementing all practicable best practice measures:
   a. For each of the best practice measures identified as being practicable in step 3(b), provide a timeframe for their implementation.

1.2 Mining activity and associated emission factors

The PRP defines mining activities as:

- Wheel generated particles 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;
- 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.

The relevant emission factors for each of these activities are presented in **APPENDIX C**.

Not all of these activities occur at Moolarben Coal. **Section 2** presents the calculated emissions for the activities relevant to Moolarben Coal.

2 EXISTING MEASURES USED TO MINIMISE PARTICLE EMISSIONS

2.1 Estimated baseline emissions

TSP, PM_{10} and $PM_{2.5}$ emission estimates have been calculated for mining activities that occurred during September 2010 – August 2011 at Moolarben Coal mine, using the relevant USEPA AP-42 emission factors as listed in **APPENDIX C** estimates have been made with no particulate matter controls in place (uncontrolled) as well as with current particulate matter controls in place (controlled). A summary of the emissions without dust controls is provided in **Table 2.1**.

Table 2.1: Summary of particulate matter emissions with no controls in place (tonnes/y)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Hauling unsealed roads	5,323	1,235	123
Wind erosion OB area	86	43	6
Blasting	32	17	2
Bulldozers on coal	516	123	11
Trucks unloading OB	161	76	12
Bulldozers on OB	69	9	7
Wind erosion open areas	62	31	5
Wind erosion stockpiles	377	189	28
Trucks unloading coal	858	100	16
Loading coal stockpiles	4	2	0
Graders	179	63	6
Drilling	10	5	0
Material transfer coal	943	110	26
Train loading	4	2	0
Material transfer OB	161	76	12
Total	**8,786**	**2,080**	**256**

The distribution of the predicted uncontrolled emissions by activity for the TSP, PM_{10} and $PM_{2.5}$ size fractions by activity is shown graphically in **Figure 2.1**.

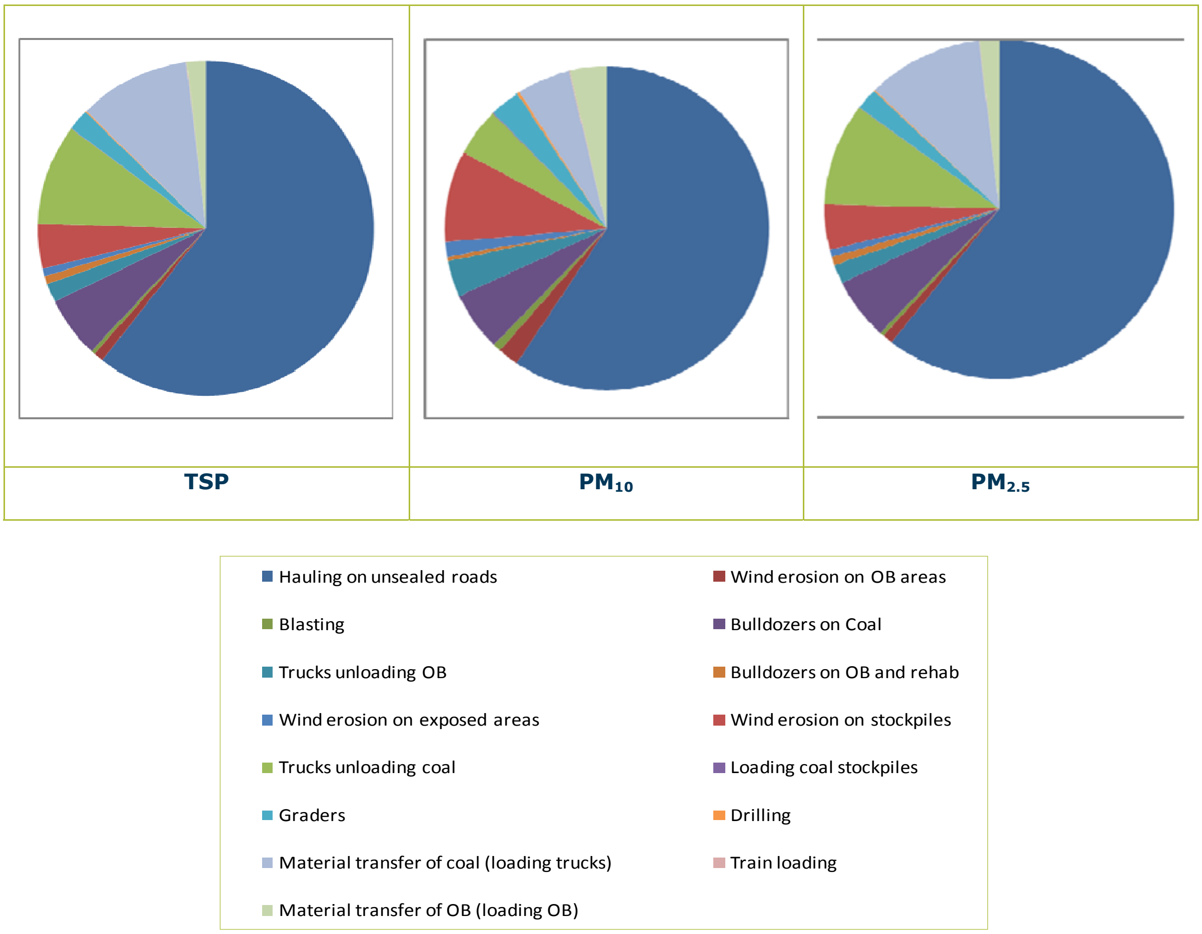


Figure 2.1: Annual uncontrolled emissions by activity

Emissions were then recalculated taking into account various control factors for the dust controls that Moolarben Coal have in place. These controls, as well as the control factor applied, are listed in **Table 2.2**.

The control factors adopted are the default values contained within the Best Practice Report (**Donnelly et al., 2011**).

Table 2.2: Summary of current dust controls and level of control applied

Mining Activity	Control measure currently in place	Level of control applied
Drilling	Water sprays while drilling	70%
Hauling (surface treatment)	Water carts operating at 2 $L/m^2/h$	75% [a]
Wind Erosion (spoil)	Vegetation on 30% of area	21% [b]
Dozers at CHPP	Travel routed and materials moist	50%
Wind Erosion (all stockpiles)	Water sprays	50%
Unloading ROM coal at stockpile/hopper	Water sprays on dump pad	50%
Rehandle ROM coal at stockpile/hopper	Enclosed dump hopper (3 sides and a roof) and water sprays	85%
Loading coal to trains	Telescopic chute with water sprays	75%

Notes:

(a) Value consistent with Donnelly et al., 2011. Further discussion and refinement of this value is provided within Section 4.3.

(b) Derived as 30% control to 70% of exposed surface areas.

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

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

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Hauling unsealed roads	1,534	309	31
Wind erosion OB area	68	34	5
Blasting	32	17	2
Bulldozers on coal	383	91	8
Trucks unloading OB	161	76	12
Bulldozers on OB	69	9	7
Wind erosion open areas	62	31	5
Wind erosion stockpiles	189	94	14
Trucks unloading coal	429	50	8
Loading coal stockpiles	4	2	0
Graders	179	63	6
Drilling	3	2	0
Material transfer coal	871	102	17
Train loading	1	0	0
Material transfer OB	161	76	12
Total	**4,146**	**954**	**127**

The distribution of the predicted controlled emissions by activity for the TSP, PM_{10} and $PM_{2.5}$ size fractions by activity is shown graphically in **Figure 2.2**.

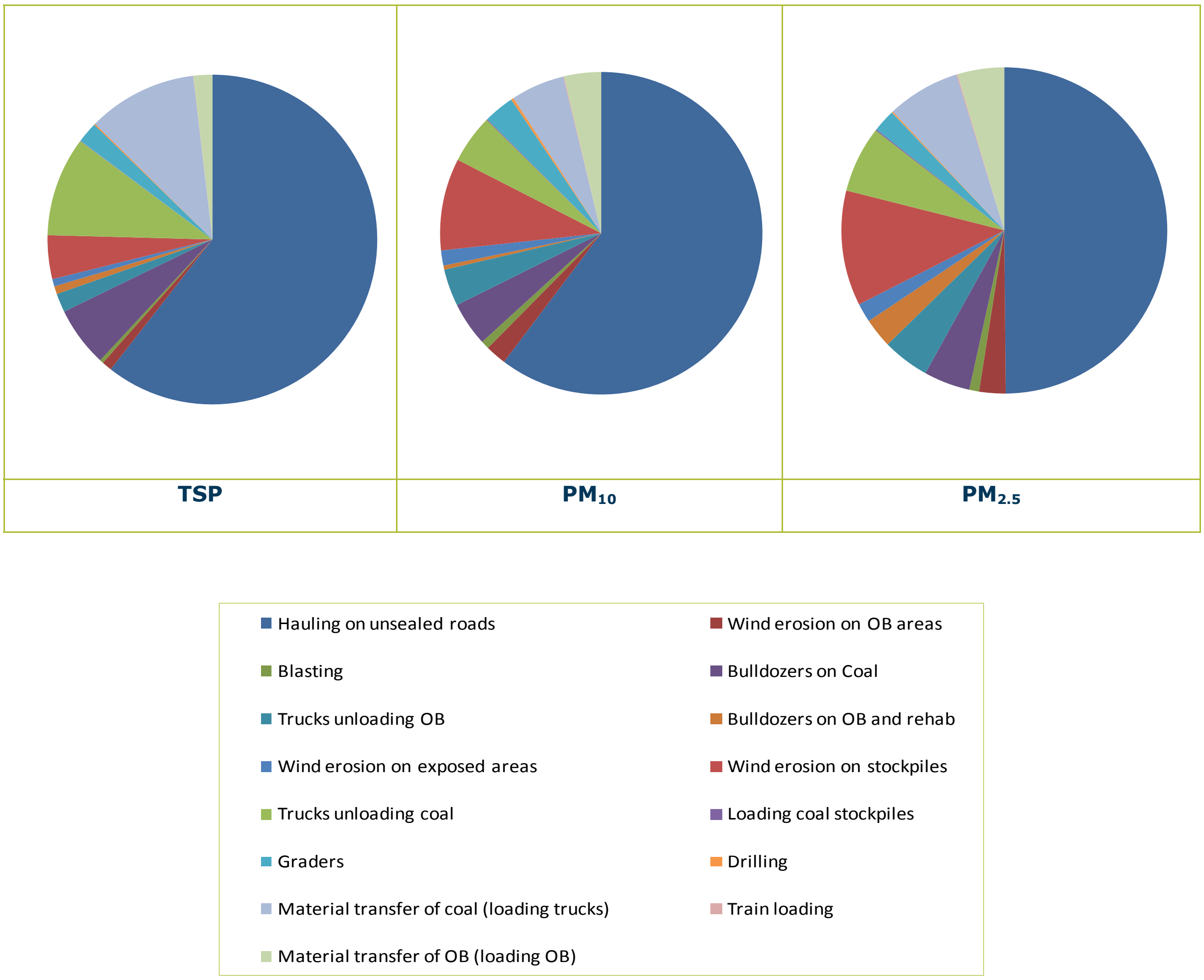


Figure 2.2: Annual controlled emissions by activity

2.2 Activities Rank

This section uses the information calculated and presented in **Section 2.1**, and ranks the activities in terms of both annual mass emission and predicted impact. Ranking by annual mass emission is a relatively straight forward exercise once the activities have been identified and emissions calculated, and these results are presented in **Section 2.2.1**.

However, it does not necessarily follow that the activities that emit the largest mass of particulate matter will cause the greatest impact at a particular residence. For example, a high dust generating activity that is geographically remote from sensitive receptors may not rank highly in terms of impact.

It is thus important to evaluate whether a simple ranking according to quantum of emission represents an appropriate tool in prioritising and optimising potential dust control options.

Therefore, although it is not specifically stated in the Guideline, PAEHolmes have undertaken some preliminary modelling to determine which activities may cause the greatest impacts at the nearest residences. The results of this exercise are presented in **Section 2.2.2**.

2.2.1 Ranking by mass

The calculated emissions from the current mining activities (controlled) listed in **Table 2.3** were ranked from highest to lowest according to their total mass. The rank of each activity differs depending on the particle size, and so three sets of results are presented in **Table 2.4**.

Table 2.4: Ranked activities by mass emissions (controlled)

Rank	Mining Activity	Emissions (t/y)
	TSP	
1	Hauling unsealed roads	1,534
2	Material transfer coal	871
3	Trucks unloading coal	429
4	Bulldozers on coal	383
5	Wind erosion stockpiles	189
6	Graders	179
7	Trucks unloading OB	161
8	Material transfer OB	161
9	Bulldozers on OB	69
10	Wind erosion OB area	68
11	Wind erosion open areas	62
12	Blasting	32
13	Loading coal stockpiles	4
14	Drilling	3
15	Train loading	1
	PM_{10}	
1	Hauling unsealed roads	309
2	Material transfer coal	102
3	Wind erosion stockpiles	94
4	Bulldozers on coal	91
5	Trucks unloading OB	76
6	Material transfer OB	76
7	Graders	63
8	Trucks unloading coal	50
9	Wind erosion OB area	34
10	Wind erosion open areas	31
11	Blasting	17
12	Bulldozers on OB	9
13	Loading coal stockpiles	2
14	Drilling	2
15	Train loading	0
	$PM_{2.5}$	
1	Hauling unsealed roads	31
2	Material transfer coal	17
3	Wind erosion stockpiles	14
4	Trucks unloading OB	12
5	Material transfer OB	12
6	Bulldozers on coal	8
7	Trucks unloading coal	8
8	Bulldozers on OB	7
9	Graders	6
10	Wind erosion OB area	5
11	Wind erosion open areas	5
12	Blasting	2
13	Loading coal stockpiles	0
14	Drilling	0
15	Train loading	0

2.2.2 Ranking by impact

To provide a ranking on the relative impact of these activities, the Industrial Source Complex (ISC) model has been used, and each activity modelled separately for a representative sample of the nearest sensitive receptors to the mine.

The receptors were selected as the closest non-mine related sensitive receptors to the mine operations in all key directions. The Ulan Public School was included because of the sensitivity of this receptor as opposed to its proximity.

Representative nearby sensitive receptors adopted for the purposes of this exercise are summarised in **Table 2.5** and shown spatially in **Figure 2.3**.

Table 2.5: Selected sensitive receptors for modelling

Receptor	Easting	Northing	Owner
1	759764	6420796	Swords
2	765376	6431622	Imrie
3	756497	6420923	Whiticker
4	758435	6416631	Cox
5	758338	6425113	Ulan Public School

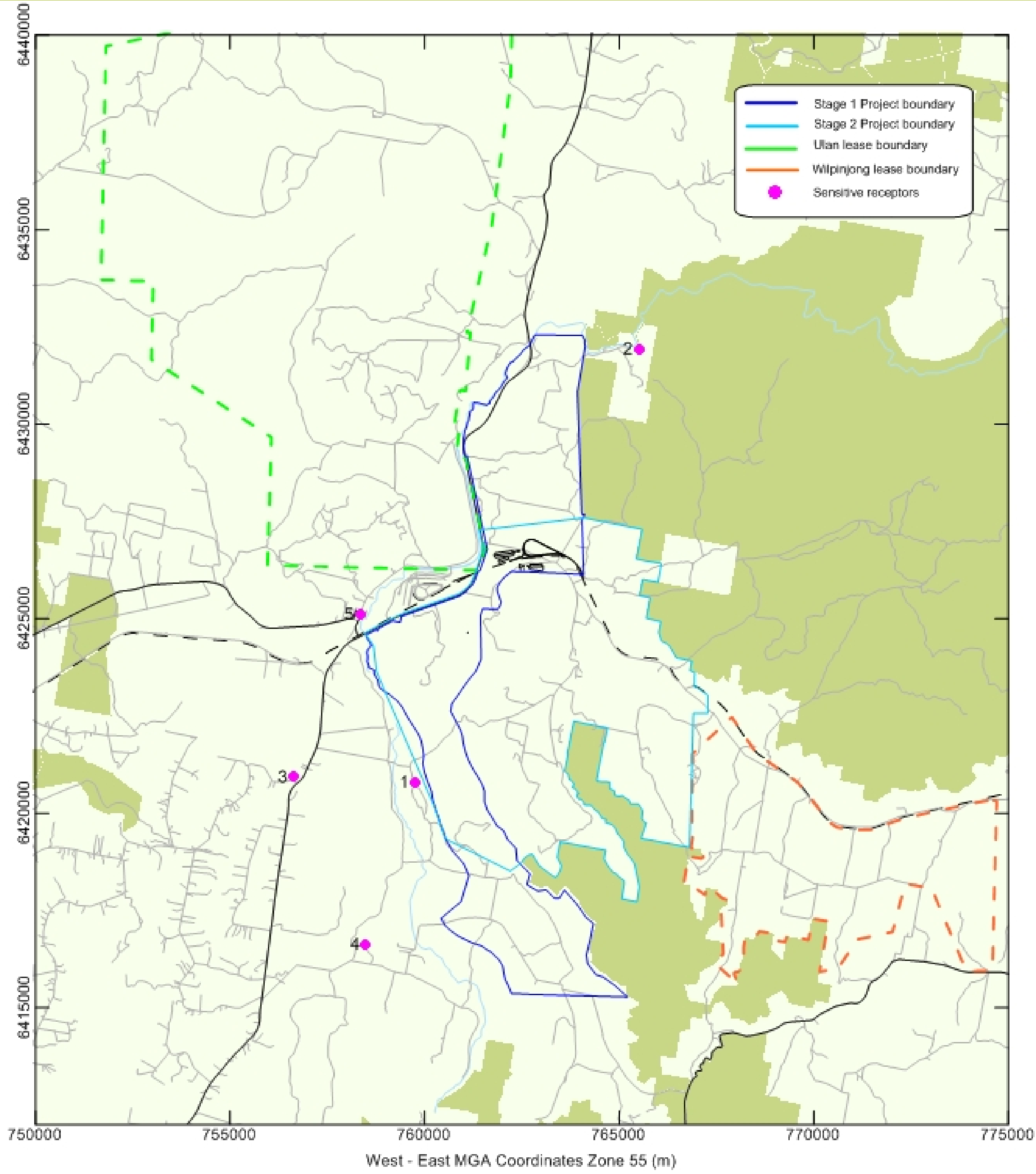


Figure 2.3: Location of nearest receptors used for impact ranking

The calculated emissions from the current mining activities listed in **Table 2.2** were modelled individually using ISC. Annual average ground level concentrations of TSP, PM_{10} and $PM_{2.5}$ were predicted at the nearest sensitive receptors (as shown in **Figure 2.3**) and the impacts ranked accordingly.

Figure 2.4, **Figure 2.5**, and **Figure 2.6** present the annual TSP, PM_{10} and $PM_{2.5}$ contributions of each mining activity predicted at each of the five receptors, in terms of relative impact at that location. The total predicted incremental annual impact at each receptor location is additionally annotated.

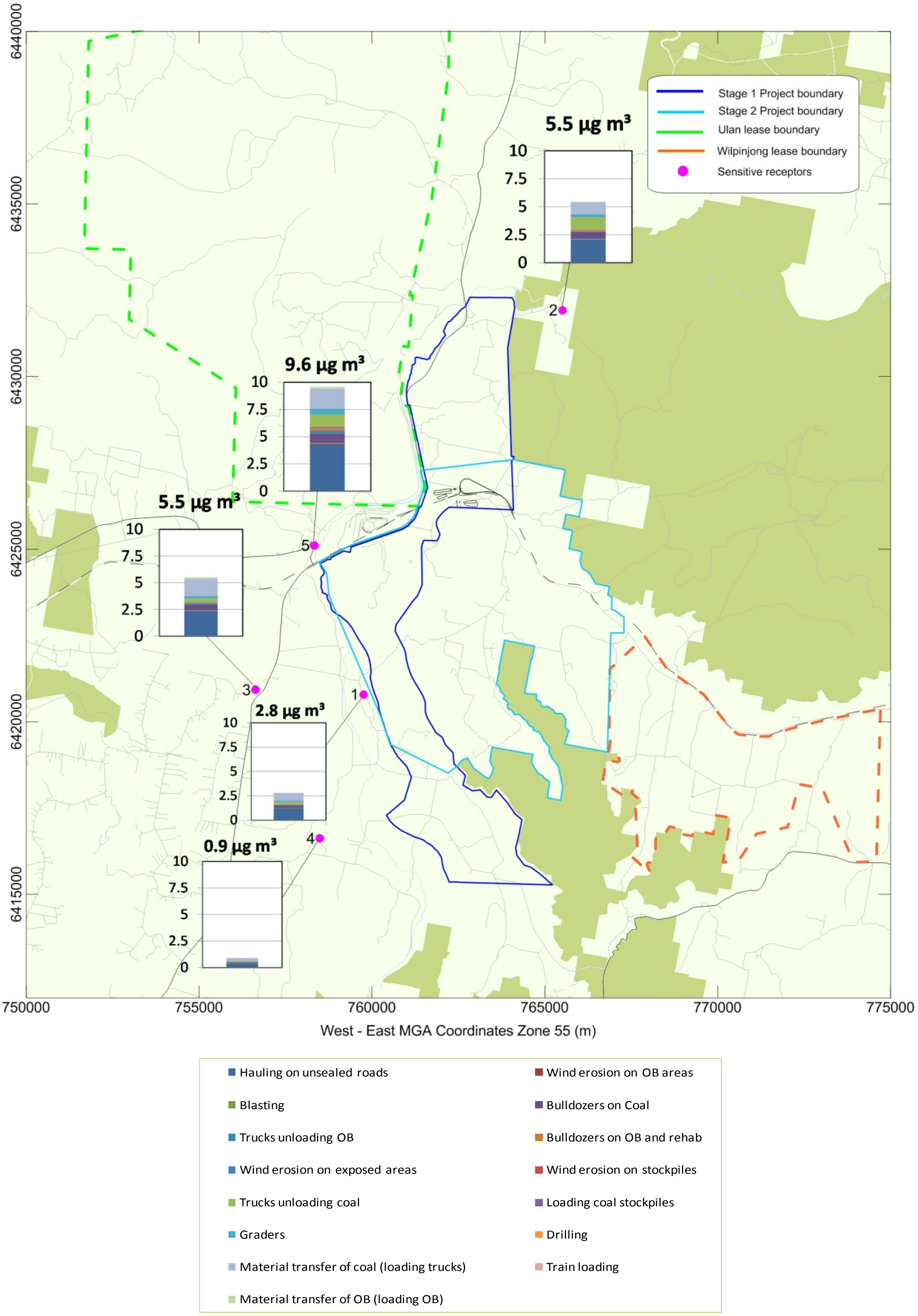


Figure 2.4: Annual contribution of each mining activity at each receptor – (controlled) – TSP (µg m³)

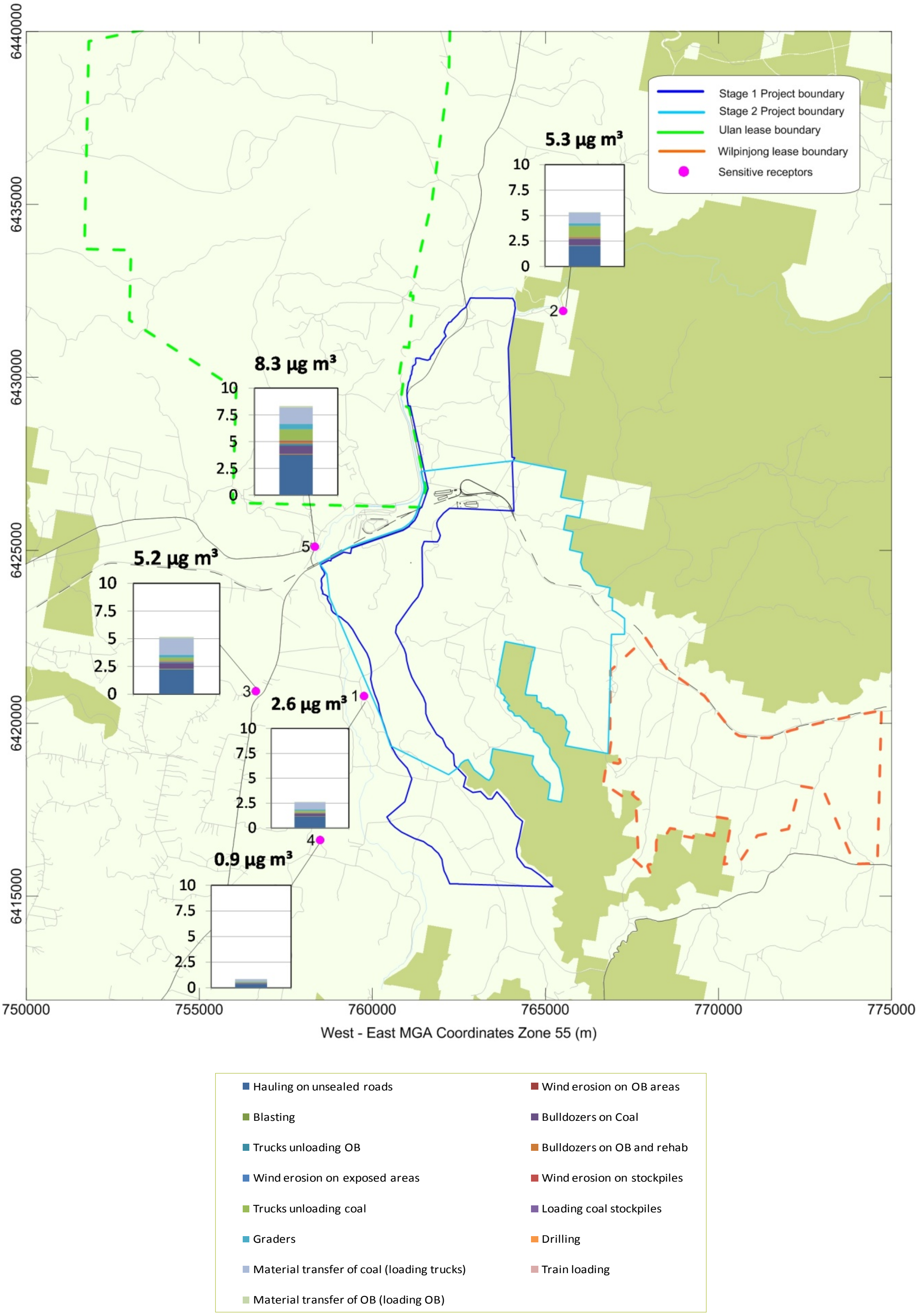


Figure 2.5: Annual contribution of each mining activity at each receptor – (controlled)– PM10 (µg m³)

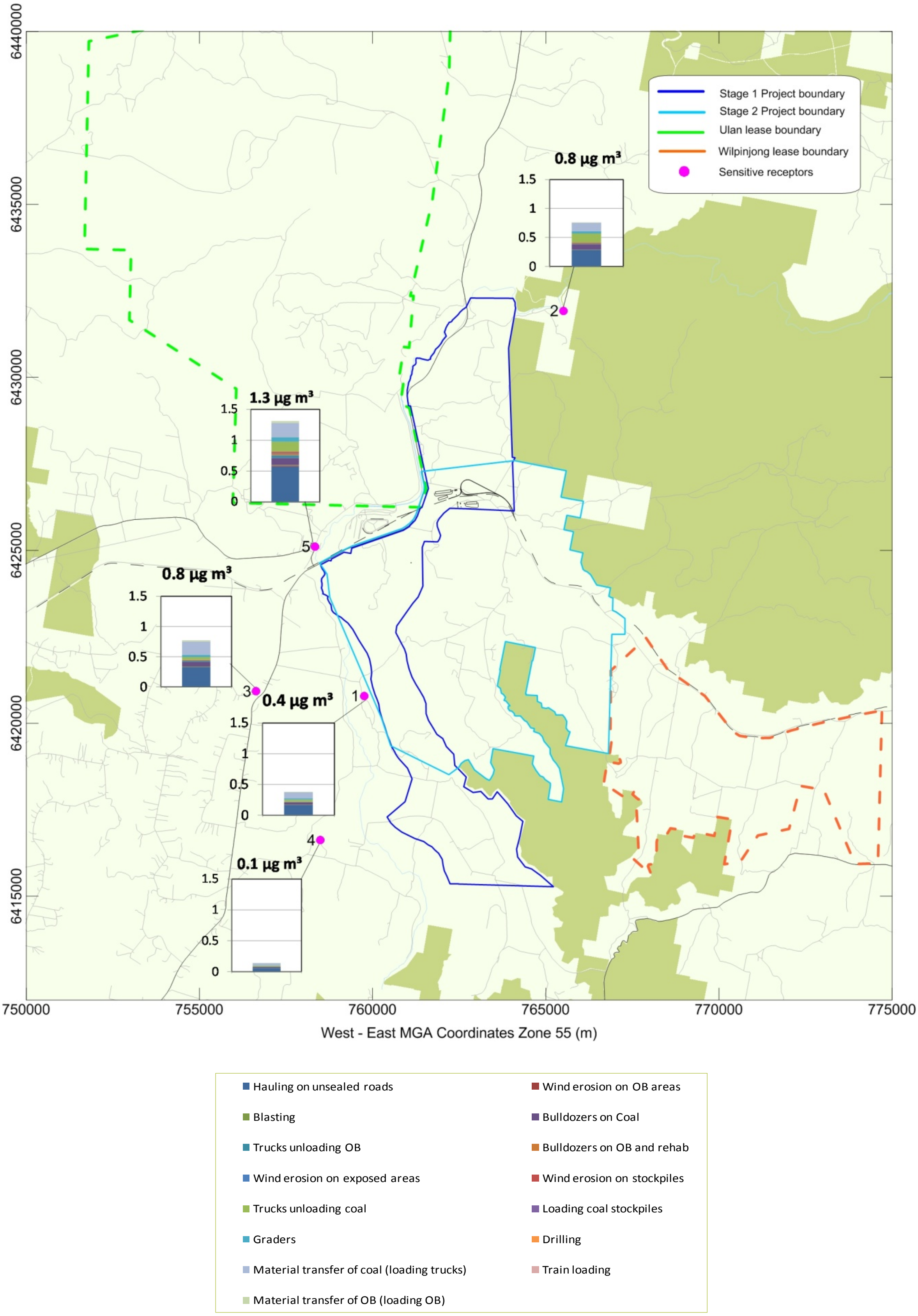


Figure 2.6: Annual contribution of each mining activity at each receptor – (controlled)– PM2.5 (µg m³)

Inspection of **Figure 2.4**, **Figure 2.5** and **Figure 2.6** indicates that the one of the main activities contributing to impacts at nearby receptors across all particle size fractions is haulage on unsealed roads.

This is not unexpected as it is the highest ranking mass emission source as documented in **Table 2.4**.

2.3 Top Four Highest Particulate Generating Activities

The top four ranked activities according to mass particulate emissions are listed in **Table 2.6** for TSP, PM_{10} and $PM_{2.5}$.

Table 2.6: Top four activities for each particle size fraction (annual mass emission)

Rank	Mining Activity
	TSP
1	Hauling on unsealed roads
2	Material transfer of coal
3	Trucks unloading coal
4	Bulldozers on coal
	PM_{10}
1	Hauling on unsealed roads
2	Material transfer of coal
3	Wind erosion of stockpiles
4	Bulldozers on coal
	$PM_{2.5}$
1	Hauling on unsealed roads
2	Material transfer of coal
3	Wind erosion of stockpiles
4	Trucks unloading overburden

Table 2.7 provides a summary of which activities are the top four ranked activities according to impact at the five receptors (four closest residences and Ulan Public School) for TSP, PM_{10} and $PM_{2.5}$.

Table 2.7: Top four activities for each particle size fraction (impact)

Mining Activity	R1	R2	R3	R4	R5
			TSP		
Hauling on unsealed roads	1	1	1	1	1
Material transfer of coal	2	3	2	2	2
Bulldozers on coal	3	4	3	3	4
Trucks unloading coal	4	2	4	4	3
			PM_{10}		
Hauling on unsealed roads	1	1	1	1	1
Material transfer of coal	2	3	2	2	2
Bulldozers on coal	3	4	3	3	4
Trucks unloading coal	4	2	4	4	3
			$PM_{2.5}$		
Hauling on unsealed roads	1	1	1	1	1
Material transfer of coal	2	3	2	2	2
Bulldozers on coal	3	4	3	3	4
Trucks unloading coal	4	2	4	4	3

Whilst hauling on unsealed roads is the number one source of emissions and impact for all size fractions, activities such as wind erosion on stockpiles is ranked in the top four in terms of mass emissions but not impacts, for all size fractions.

Emissions are quantified by known relationships between specific site data and environmental conditions. Impacts are quantified by determining the specific influence of emissions from the site at sensitive receptors close to the site. For this particular mine site, the ranking of emissions and ranking of impacts correlate reasonably well.

The following activities have therefore been taken forward for evaluation of Best Practice measures in **Section 3**:

- Hauling on unsealed roads;
- Material transfer of coal;
- Trucks unloading coal / overburden;
- Bulldozers on coal; and
- Wind erosion of stockpiles.

These are considered to be the highest ranking activities when both magnitude of emission and off-site impact are considered.

3 BEST PRACTICE MEASURES

A summary of the best practice measures available, as well as the associated effectiveness, as documented within the Best Practice Report (**Donnelly *et al*., 2011**) is provided in **Table 3.1**.

An estimation of the emissions through application of these measures is then provided in **Section 3.2**.

3.1 Best Practice Measures for Highest Ranking Activities

3.1.1 Hauling on unsealed roads

Table 3.1: Best practice control measures to reduce particulate matter emissions from haul roads

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%
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 1 (2l/m^2/hr)	50%
	Watering level 2 (>2l/m^2/hr)	75%
	Watering grader routes	75%
	Watering twice a day for industrial unpaved roads	55%
	Suppressants	84%
	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%

Note

[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: Donnelly *et al*, 2011

3.1.2 Material transfer of coal / trucks unloading coal

Table 3.2: Best practice control measures to reduce particulate matter emissions from loading and dumping ROM coal

Control Measure		Effectiveness
Avoidance	Bypass ROM stockpiles	50% reduction in dumping emissions for coal bypassing ROM stockpile Emissions associated with forming coal into stockpile (e.g. by dozer push) would be reduced by 100% for bypassing coal
Truck or loader dumping coal	Minimise drop height	Reduce from 10 m to 5 m: 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% by combing control factors from above.
	Enclosure with control device	90 – 98%

Note

a reduction achieved because one dump required rather than two

b Reductions due to reduced drop heights have been inferred from the emission estimation equation for dropping material from a dragline.

Source: Donnelly *et al*, 2011

3.1.3 Bulldozers on coal

Table 3.3: Best practice control measures to reduce particulate matter emissions from bulldozers

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

Source: Donnelly *et al*, 2011

3.1.4 Wind erosion of stockpiles

Table 3.4: Best practice control measures to reduce particulate matter emissions from coal stockpiles

Control Measure		Effectiveness
Avoidance	Bypass stockpiles	100% reduction in wind erosion for coal bypassing stockpile
Surface stabilisation	Water spray	50%
	Chemical wetting agents	80-99%
	Surface crusting agent	95%
	Carry over wetting from load in	80%
Enclosure	Silo with bag house	95-100%
	Cover storage pile with a tarp during high winds	99%[a]
Wind speed reduction	Vegetative wind breaks	30%
	Reduce pile height	30%
	Wind screens/wind fences	75-80%
	Erect 3-sided enclosure around storage piles	75%
Note [a] Estimated based on the effectiveness of chemical surface treatments		

Source: Donnelly *et al*, 2011

3.2 Estimated resultant emissions

For each of the top activities identified in **Section 2.3**, the emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity after applying the measures identified in **Section 3.1** have been estimated.

Table 3.5 presents the annual mass emissions anticipated through application of Best Practice for current operations, as well as a summary of the percentage reduction achievable.

Table 3.5: Mass Emissions through Application of Best Practice (tonnes/year)

	Best Practice Control	Percentage reduction	TSP	PM_{10}	$PM_{2.5}$
Hauling on unsealed roads	Vehicle restrictions	None - Best practice already in place	1,534	309	31
	Surface Improvements	90% (75% current [(a)])	534	123	12
	Surface Treatments	84% (75% current [(a)])	801	185	19
Material transfer of coal	Avoidance	50% (bypassing coal stockpile)	472	55	9
Trucks unloading coal / overburden	Truck or loader dumping coal	None - Best practice already in place (water sprays on ROM pad)	871	102	17
	Truck or loader dumping to ROM bin	95% (enclosure control device)	51	9	1
Bulldozers on coal	Keep travel routes and materials moist	None - Best practice already in place	383	91	8
Wind erosion of stockpiles.	Bypass stockpiles	100%	0	0	0
	Water spray	None - Best practice already	189	94	14

	Best Practice Control	Percentage reduction	TSP	PM_{10}	$PM_{2.5}$
		in use			
	Chemical wetting agents	89.50%	40	20	3
	Surface crusting agent	95%	19	9	19
	Carry over wetting from load in	80%	75	38	6
	Silo with bag house	97.50%	9	5	1
	Cover storage pile with a tarp during high winds	99%	4	2	0
	Vegetative wind breaks	30% (less than current control)	264	132	20
	Reduce pile height	30% (less than current control)	264	132	20
	Wind screens/wind fences	77.50%	85	42	6
	Erect 3-sided enclosure around storage piles	75%	94	47	7

Notes:

(a) Value consistent with Donnelly et al., 2011. Further discussion and refinement of this value is provided within Section 4.3.

4 PRACTICABILITY OF IMPLEMENTATION OF BEST PRACTICE MANAGEMENT

4.1 Justification of existing controls

In determining the value of additional best practice controls, it is also important to contextualise existing controls in terms of their ability to limit adverse air quality impacts within the local air shed.

Current ambient air monitoring at Moolarben Coal shows that the air shed is relatively clean and this has bearing on the practicability of increasing controls at the site.

Currently the air quality monitoring network consists of nine dust deposition gauges, two High Volume Air Samplers (HVAS) fitted with size-selective inlets to measure PM_{10} concentrations at six day intervals and three Tapered Element Oscillating Microbalances (TEOMs) that measure PM_{10} concentrations in real-time.

The monitors measure dust deposition rates and PM_{10} concentration levels in the air due to emissions from all sources that contribute to dust in the area. These sources include emissions from existing mining at Moolarben Coal, emissions from neighbouring mines (Wilpinjong, Ulan), agricultural activities and other emissions in the area.

4.1.1 Dust Deposition

The annual average dust deposition rates are summarised in **Table 4.1** below (**PAEHolmes, 2011**). Any data that was deemed to be contaminated from insects, bird droppings and plant matter has been excluded.

Table 4.1: Monitored dust (insoluble solids) deposition levels (g/m²/month)

Gauge	2005	2006	2007	2008	2009	2010	2011
D1	1.4	0.9	1	1.2	0.9	1.1	0.2
D2	1.7	1	2	-	2.5	1.8	1.0
D3	1.8	1.9	2.1	-	1.8	0.6	0.6
D4	1.9	1.1	1.7	1.6	2	1.9	0.7
D5	1.5	1.3	1.5	1.9	2	2	0.7
D6	1	0.8	0.9	1.3	1.5	0.7	0.2
D7	1.2	1.3	1.3	1.7	1.7	1.5	0.3
D8	1.1	0.9	1.5	1.2	1.5	0.8	0.5
D9				0.9*	1	0.4	0.2
Average	**1.5**	**1.1**	**1.5**	**1.5**	**1.7**	**1.3**	**0.5**

*Results available from October 2008. These results have not been included when calculating the annual average

All gauges recorded an annual average dust deposition rate considerably less than the criterion of 4 g/m²/month. The data shows that the level of dust deposition in the existing environment is low and in all areas an acceptable increase in annual average dust deposition would be 2 g/m²/month, as defined by OEH criteria.

4.1.2 Particulate Matter Concentrations (PM_{10})

The average concentration of the PM_{10} data (**PAEHolmes, 2011**) at monitor 1 (HV01) has been 15.0 µg/m³ and the maximum 24-hour concentration has been 53.9 µg/m³ in December 2009. The average concentration over all data collected at the second monitor (HV02) has been 10.3 µg/m³ and the maximum 24-hour concentrations has been 44.3 µg/m³ also in December, 2009.

There was only found to one occasion in the data when the OEH 24-hour goal of 50 µg/m³ was exceeded at HV01. This was attributable due to a dust storm that was reported for most of NSW (**Bureau of Meteorology, 2011**).

The current contributors to PM_{10} are likely to be mining operations at Moolarben Coal, Ulan and to a lesser extent those at Wilpinjong and also natural and agricultural activities in the area (**Table 4.2**).

Table 4.2: HVAS annual average PM_{10} (µg/m³)

HVAS	2005	2006	2007	2008	2009	2010	2011
HV01*	12	19	18	14	15	10	12
HV02**	-	-	-	-	11	9	9
Annual Average	**12**	**19**	**18**	**14**	**13**	**10**	**11**
						Average over all sites and years	**14**

* Data available from October 2005

** Data available from May 2009

4.1.3 Tapered Element Oscillating Microbalances (TEOM)

Additional real-time PM_{10} monitoring using TEOMs is also conducted as part of the internal monitoring scheme for Moolarben Coal Mine (**Table 4.3**). Some elevated 24-hour PM_{10} concentrations throughout the monitoring set were noted of greater than 200 µg/m³ (**PAEHolmes, 2011**).

Table 4.3: TEOM Annual Average PM_{10} (µg/m³)

TEOM	2008*	2009	2010	2011
TEOM01	11	12	13	9
TEOM02	15	14	16	10
TEOM03	9	8	10	11
Average	**12**	**11**	**13**	**10**
			Average over all sites and years	**12**

* Data available from October 2008

These monitoring data are important to consider because future controls should take the current environment into account. The data indicate that the current mining area does not have a significant effect on air quality in Ulan Village or for residents located on Ridge Road. The practicability of further controls will rely on the current conditions which are consistently below the current OEH guidelines for annual average, with short term exceedances attributable to regional events (**PAEHolmes, 2011**). Environmental Impacts at residences

In addition to the other factors influencing the practicability of introducing best practice measures, consideration also needs to be given as to how the impact at residences would change by implementing each of the best practice measures identified in **Section 2.3**.

Each of the measures for reducing emissions from the top ranked emissions (see **Section 3.1**) were incorporated into the dispersion modelling and the change in contribution to impact at the receptors assessed.

Table 4.4 presents the change in annual mass concentration (µg/m³) at the sensitive receptors documented in **Section 2.2.2** associated with the introduction of the above best practice activities.

Table 4.4: Mass contribution (mg m^3) to impact at residences R1 to R5 due to implementation of best practice

Activity	Control Option	% Reduction (emissions)	Contribution to annual impact (mg m^3) TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
			R1			R2			R3			R4			R5		
Haulage	Current (>2L/m^2/hour watering)	75	1.2	1.2	0.2	2.1	2.0	0.3	2.4	2.2	0.3	0.4	0.4	0.1	4.3	3.7	0.6
	Chemical suppressant	85	0.7	0.7	0.1	1.2	1.2	0.2	1.4	1.3	0.2	0.2	0.2	0.0	2.6	2.2	0.3
	Surface Improvements	90	0.5	0.5	0.1	0.8	0.8	0.1	0.9	0.9	0.1	0.2	0.1	0.0	1.7	1.5	0.2
Material transfer of coal	Current	0	0.8	0.7	0.1	1.1	1.0	0.1	1.6	1.5	0.2	0.2	0.2	0.0	1.8	1.5	0.2
	Avoidance	50	0.4	0.4	0.1	0.5	0.5	0.1	0.8	0.7	0.1	0.1	0.1	0.0	0.9	0.8	0.1
Trucks unloading coal/overburden	Current	50	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3	0.2	0.0
	Truck or loader dumping to ROM bin (enclosure control device)	95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulldozers on coal	Current (keep travel routes and materials moist)	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Wind erosion on coal stockpiles	Bypass stockpiles	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Current (water sprays)	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
	Chemical wetting agents	89.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Surface crusting agent	95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Carry over wetting from load in	80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Silo with bag house	97.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cover storage pile with a tarp during high winds	99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Vegetative wind breaks	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
	Reduce pile height	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
	Wind screens/wind fences	77.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Erect 3-sided enclosure around storage piles	75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Notes:

(a) Value consistent with **Donnelly et al., 2011**. Further discussion and refinement of this value is provided within **Section 4.3**.

Table 4.4 indicates that when annual impacts at receptors are considered, there is only any potential value in introducing additional best practice control measures to the following activities:

- Haulage; and
- Material transfer of coal.

Application of additional best practice measures to remaining top five particulate generating activities yield no additional (measurable) benefit in terms of reductions in annual particulate impacts at sensitive receptors.

4.2 Identification of Best Management Practices to be Implemented

Evaluation of the information contained in **Table 4.4** indicates that, when both current and best practice impacts at nearby receptors are used as a metric of practicability, a more limited set of activities / best management practices are generated.

As noted in **Section 2.2.2**, modelling predicts that there are only potential tangible additional reductions in annual particulate impacts at receptors associated with control activities applied to haulage and material transfer of coal.

For each of the best practice measures identified in **Section 3**, an evaluation of the practicability of the implementation of activity has been undertaken by taking into consideration:

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

A matrix evaluating the top five ranking activities, additional best practice control options, and the consideration of the above aspects, as developed by Moolarben Coal, is presented in **Table 4.5**.

Table 4.5: Mass Emissions through Application of Best Practice (tonnes/year)

Activity	Recommended Best Practice Control Measure	Implementation Costs	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with Current Processes and Future Developments
Haulage	Increase water application rate	No significant capital costs. Manning and other costs (e.g. fuel) estimated to be $40,000/year.	Current water licences are adequate.	No additional noise impacts as existing equipment will be utilised. No water usage above what has already been licensed.	No additional impacts. Continue working in accordance with the road watering SWP.	Once mining operations are expanded this option needs to be reconsidered. This option will need to be reconsidered if water supplies become low.
	Use of chemical dust suppressants	If water supplies become low this option will be considered, however, a full detailed trial will need to be undertaken to determine the feasibility of this option				
Material Transfer	Bypass ROM stockpile	ROM stockpile is bypassed where possible. Total bypass is not a feasible option due to mining and processing practices – need to be able to stockpile during periods of shutdown.				
	Enclosure and control device fitted to ROM hopper	Already enclosed as much as possible. Self-activated sprays are already installed at the ROM hood.				
Trucks Unloading Coal/Overburden	No feasible option	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Bulldozers on Coal	No feasible option	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Wind erosion on stockpiles	No feasible option	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Source: Moolarben Coal, 2012

Independent of the discussions above, as shown in **Table 4.5**, Moolarben Coal have concluded that there are no feasible control options available to them other than for haulage and material transfer of coal.

Given the conclusions to date surrounding the lack of benefit associated with additional control to other activities, this outcome is considered reasonable.

Further, **Table 4.5** indicates that, as far as is practicable, best practice controls are already being applied to material transfer of coal.

This therefore only leaves haulage as a potential area where additional best practice controls may be of benefit.

With the application of alternative surface treatments / improvements to haul roads, a further reduction in both emissions and impacts can theoretically be achieved when the values within **Donnelly et al., 2011** are referenced.

However, Moolarben Coal is a mine with a current surplus of water, a move towards reducing the use of water at the site (e.g. through the use of chemical dust suppressants) should be viewed in this context.

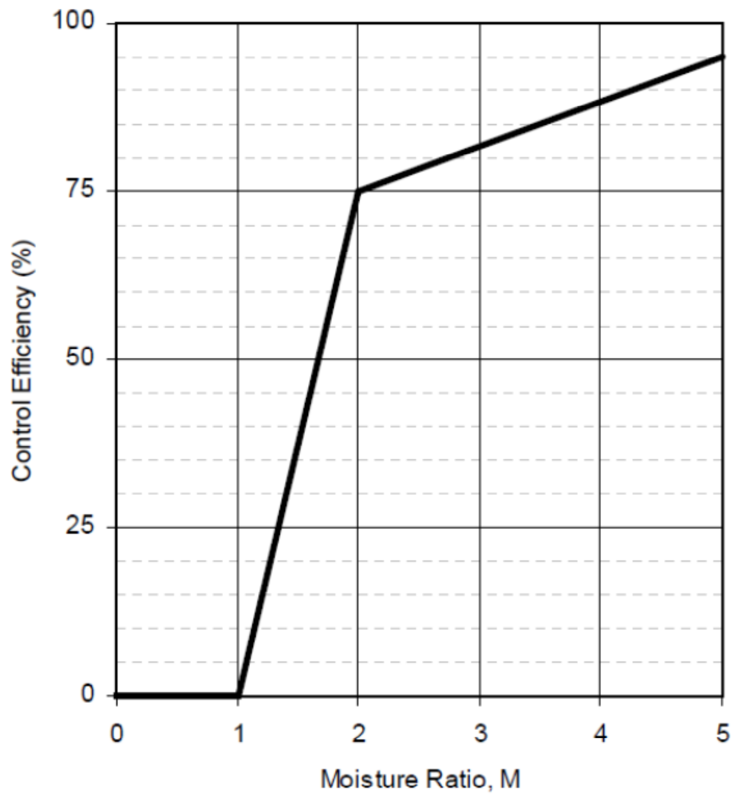
Additionally, given the high level of haul road watering conducted at the site (conducted for the dual purpose of dust suppression and water redistribution), the control efficiency awarded to this activity is revisited in **Section 4.3**.

4.3 Site Specific Evaluation of Haul Road Watering Effectiveness

Table 3.1 (after **Donnelly et al., 2011**) states that the maximum achievable control from watering haul roads at or above 2L/m²/hr is 75%. This value is often referenced within coal mine air quality assessments, and is derived from a value presented within the *National Pollutant Inventory Emission Estimation Technique Manual for Mining* (**DSEWPC, 2011**).

This maximum control level is disputed by **SKM (2005)** who derived an equation that shows control benefits for increased watering up to 95%. This finding is confirmed by **Buonicore and Davis (1992)** who state that a level of control of 90% is expected to be achieved by increasing the application rate of water and/or through the use of dust suppressants. The study states that 90% control can only be maintained provided the moisture content of the surface material is approximately 8%.

The above observations are further reinforced within **USEPA, 2006**. **Figure 4.1** (after **USEPA, 2006**) presents the relationship between the instantaneous control efficiency due to watering and the resulting increase in surface moisture. The moisture ratio "M" (shown on the x-axis) is calculated by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road.



Source: US EPA, 2006

Figure 4.1: Watering Control Effectiveness for Unpaved Travel Surfaces

USEPA, 2006 states that as the watered surface dries, both the ratio M, and the predicted instantaneous control efficiency (shown on the y-axis), decrease. The figure shows that between the uncontrolled surface moisture content and a value twice as large, a small increase in moisture content results in a large increase in control efficiency. Beyond that, control efficiency grows slowly with increased moisture content. For example, if the uncontrolled surface moisture content was 2%, and the addition of water increased this to 4%, a 75% reduction in emissions could be expected. However, increasing the surface moisture content to 6% would only result in an additional 5% control.

Notwithstanding the above, it is clear from **Figure 4.1**, that, while returns diminish beyond 75% control, theoretical control efficiencies from the application of water alone may reach up to 95%.

The Air & Waste Management Association Air Pollution Engineering Manual (**Buonicore & Davis, 1992**) provides the following empirical equation to calculate average control efficiencies from watering:

$$C = 100 - \frac{0.8pdt}{i}$$

Where:

C = average control efficiency (%)

p	= potential average hourly daytime evaporation rate, mm/h;
d	= average hourly daytime traffic (h-1)
i	= application intensity (L/m^2)
t	= time between applications

Using this equation for Moolarben Coal's stated watering regime (2L/m^2 application intensity, 3 applications per hour) in conservative conditions (high evaporative conditions of 2mm/hr); the control regime shows the maximum theoretical control benefit achievable of greater than 95% control.

Whether indeed such a control efficiency is achievable operationally, it is clear from the above discussions that, in instances where a mine is operating under a water surplus (as with Moolarben Coal), the use of water suppression on haul roads may be considered to be both competitive with the use of other dust suppressants, and in itself the optimal Best Practice option for this activity.

Moolarben Coal have indicated that it is practicable to increase their watering by approximately 5%. As stated above, the mine appears to be operating close to the theoretical maximum control efficiency for water suppression on roads. It is thus queried whether such a measure is cost effective (i.e. yields significant additional benefit relative to its associated costs). To evaluate this, an implementation costing exercise, consistent with the requirements of Appendix A of the Site Specific Determination Guideline, is presented in **APPENDIX C.**

Costings indicate that the net cost per tonne of PM_{10} abated as a result of such a measure would be of the order of $2,700/tonne-$PM_{10}$.

On face value, this is not considered to be a cost-effective control measure, and for this reason the proposed increase of 5% increase in application frequency is not recommended at this stage.

5 CLOSING/CONCLUSIONS

This study has been produced to address the requirements of the Coal Mine Particulate Matter Control Best Practice PRP as attached to the Moolarben Coal Environmental Protection Licences (EPL 12932) as varied in August 2011.

The study identified that the following activities represent the highest ranking activities in terms of particulate generation, when both emissions and impacts are evaluated:

- Hauling on unsealed roads;
- Material transfer of coal;
- Trucks unloading coal / overburden;
- Bulldozers on coal; and
- Wind erosion of stockpiles.

Potential Best Practice control measures for the above activities were identified, and their practicability evaluated.

When annual impacts at receptors are considered, there is only any potential value in introducing additional best practice control measures to the following activities:

- Haulage; and
- Material transfer of coal.

Application of additional best practice measures to remaining top five particulate generating activities yield no additional (measurable) benefit in terms of reductions in annual particulate impacts at sensitive receptors.

As far as is practicable, Moolarben Coal indicates that best practice controls are already being applied to material transfer of coal.

Best Practice is by definition site-specific. In view of the water surplus at Moolarben Coal, greater than average rates of water suppression is currently applied to haul roads. Investigations to date indicate that the level of water suppression (~6L/m^2/hour) applied to roads may be considered to be both competitive with the use of other dust suppressants, and in itself the optimal Best Practice option for this activity.

Given that no additional best practice measures have been explicitly identified through this exercise, no timeframes for implementation are provided.

6 REFERENCES

Bureau of Meteorology. (2011). Monthly Weather Review, Bureau of Meteorology website http://www.bom.gov.au/climate/mwr/

Buonicore, A.J., and W.T. Davis. (1992). Air Pollution Engineering Manual, Van Nostrand Reinhold, New York, pp. 31–52, 58–70.

Donnelly, S.-J., Balch, A., Wiebe, A., Shaw, N., Welchman, S., Schloss, A., Castillo, E., Henville, K., Vernon, A., Planner, J. (2011). "NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and / or Minimise Emissions of Particulate Matter from Coal Mining" Prepared by Katestone Environmental Pty Ltd for Office of Environment and Heritage June 2011.

DSEWPC, 2011, Emission Estimation Technique Manual for Mining Version 3.0, Department of Sustainability, Environment, Water, Population and Communities, GPO Box 787, Canberra, ACT 2601, Australia.

<http://www.npi.gov.au/publications/emission-estimation-technique/pubs/mining.pdf>

PAEHolmes. (2011). "Air Quality Assessment Moolarben Stage 2 Preferred Project" PAEHolmes Job 5576, prepared for Hansen Bailey on behalf of Moolarben Coal Mines Pty Limited, 22 November 2011.

SKM. (2006). Improvement of NPI fugitive particulate matter emission estimation techniques. Sinclair Knight Merz report, Perth.

USEPA, 2006. AP-42 Emission Factors Section 13.2.2 Unpaved Roads. US.

APPENDIX A

Copy of PRP as contained in Moolarben Coal EPL Licence

8 Pollution Studies and Reduction Programs

U1 Coal Mine Particulate Matter Control Best Practice

U1.1 The Licensee must conduct a site specific Best Management Practice (BMP) determination to identify the most practicable means to reduce particle emissions.

U1.2 The Licensee must prepare a report which includes, but is not necessarily limited to, the following:
- identification, quantification and justification of existing measures that are being used to minimise particle emissions;
- identification, quantification and justification of best practice measures that could be used to minimise particle emissions;
- evaluation of the practicability of implementing these best practice measures; and
- a proposed timeframe for implementing all practicable best practice measures.

In preparing the report, the Licensee must utilise the document entitled *Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline – August 2011*.

U1.3 All cost related information is to be included as Appendix 1 of the Report required by condition U1.2 above.

U1.4 The report required by condition U1.2 must be submitted by the Licensee to the Office of Environment and Heritage's Regional Manager Bathurst, at PO Box 1388 BATHURST NSW 2795 by 6 February 2012.

U1.5 The report required by condition U1.2 above, except for cost related information contained in Appendix 1 of the Report, must be made publicly available by the Licensee on the Licensee's website by **13 February 2012**.

Source: **EPL Licence 12932 8-Aug-2011**

APPENDIX B

Copy of Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline August 2011

COAL MINE PARTICULATE MATTER CONTROL BEST PRACTICE – SITE SPECIFIC DETERMINATION GUIDELINE
AUGUST 2011

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*".

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 (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).

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 the 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*, Katestone Environmental Pty Ltd, Terrace 5, 249 Coronation Drive, PO Box 2217, Milton 4064, Queensland, Australia;
- 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 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 and included as an attachment to the report;
- 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
- Loading and dumping 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

Appendix A: Presentation of Information on Cost of Implementation

The report should provide spreadsheets including estimates of the annual capital, labour and materials costs for each year over a ten year period for implementing each best practice measure identified in Step 2.

A template is given below for one best practice measure.

Mining Activity:	**Example: Wheel-generated particulates on unpaved roads**										
Specific Best practice measure:	**Example: Truck replacement – larger vehicles**										
Year	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10	**Total**
Cost of specific capital items (e.g. new vehicle)*											
Total capital costs											
Labour costs including directly related on-costs											
Cost of specific materials and other items (e.g. fuel)*											
Total material and other costs											
Estimated additional cost per tonne of particulate matter suppressed for TSP, PM_{10} and $PM_{2.5}$*											
Cost savings from implementing each best practice measure*											
Estimated net cost per tonne of particulate matter suppressed for TSP, PM_{10} and $PM_{2.5}$*											

* each item must be specified – one item per row in spreadsheet.

APPENDIX C

Emission Factors

PRP activity	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source
Wheel generated particulates on unpaved roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1203}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1203}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1203}{3}\right)^{0.45}$	AP-42 13.2.2
Wind erosion of overburden[a]	kg/ha/h	0.1	0.5 * TSP (0.5 from AP-42 13.2.5)	0.075 * TSP (0.075 from AP-42 13.2.5)	AP-42 11.9 Table 11.9-4
Blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 * TSP	0.03 * TSP	AP-42 11.9 Table 11.9-2
Bulldozing coal	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.3}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9 Table 11.9-2
Trucks unloading overburden	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4
Bulldozing overburden & front-end loaders on overburden	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 * TSP	AP-42 11.9 Table 11.9-2
Wind erosion of exposed areas[a]	kg/ha/h	0.1	0.5 * TSP (0.5 from AP-42 13.2.5)	0.075 * TSP (0.075 from AP-42 13.2.5)	AP-42 11.9 Table 11.9-4
Wind erosion of coal stockpiles	kg/ha/h	1.8 * u	0.5 * TSP (0.5 from AP-42 13.2.5)	0.075 * TSP (0.075 from AP-42 13.2.5)	AP-42 11.9 Table 11.9-2
Unloading from coal stockpiles	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Dragline	kg/bcm	$0.0046 \times \frac{d^{1.1}}{M^{0.3}}$	$0.002175 \times \frac{d^{0.7}}{M^{0.3}}$	0.017 * TSP	AP-42 11.9 Table 11.9-2
Trucks unloading coal	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Loading coal stockpiles	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4 (Note: AP-42 11.9-7 Table 11.9-4 has Train loading emission factor but footnote direct user to Chapter 13 for more accurate emissions factors.)
Graders	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP-42 11.9 Table 11.9-2

PRP activity	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source
Drilling	kg/hole	0.59	0.52 * TSP (PM_{10} ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	0.03 * TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	AP-42 11.9 Table 11.9-4
Drilling	kg/hole	0.1	0.52 * TSP	0.03 * TSP	AP-42 11.9 Table 11.9-4
Coal crushing	kg/t	0.0027	0.0012	No data	AP-42 11.19.2 Table 11.19.2-2
Material transfer of coal (use for Loading coal to trucks)	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Scrapers on overburden	kg/t	0.029 [(b)]	No data	No data	AP-42 11.9 Table 11.9-4
Train loading	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4 (Note: AP-42 11.9-7 Table 11.9-4 has default train loading emission factor but footnote directs user to Chapter 13 for more accurate emissions factors.)
Screening	kg/t	0.025	0.0087	No data	AP-42 11.19.2 Table 11.19.2-2
Material transfer of overburden (use for Loading OB to trucks)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4

Where:

A	=	horizontal area (m^2)
M	=	material moisture content (%)
s	=	material silt content (or surface silt content in unpaved roads) (%)
u	=	wind speed (m/s)
d	=	drop height (m)
W	=	mean vehicle weight (tonnes)
S	=	mean vehicle speed (km/h)

Notes:

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

(b) The equation referenced relates to topsoil removal by scraper. No data is provided within the AP-42 relating to scraper activity on overburden. Nor is this activity identified within the activities conducted at the subject mine.