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Best Practice Dust Management Benchmarking Study – Maules Creek Coal Mine

Prepared for:

NSW Environment Protection Authority

March 2017

Final

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Document Control

Deliverable #:	D15162-3
Title:	Best Practice Dust Management Benchmarking Study – Maules Creek Coal Mine
Version:	1.0 (Final)
Client:	NSW Environment Protection Authority
Document reference:	D15162-3 Best Practice Dust Management Benchmarking Study Maules Creek Coal Mine v1.0.docx
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Approved by:	Christine Killip 15 March 2017

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Acknowledgement

Katestone wishes to acknowledge the co-operation afforded during the preparation of this Dust Management Review by:

- Members of the community living in the area surrounding the Maules Creek Coal Mine
- Whitehaven Coal Limited and its employees and contractors
- The Environment Protection Authority and its employees
- The Department of Planning and Environment and its employees.

Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
µm	micrometres
km	kilometre
km/h	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
Nomenclature	**Definition**
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
TSP	total suspended particulate matter
Abbreviations	**Definition**
AEMR	Annual Environmental Management Report
ROM	Run-of-mine. Generally, refers to coal that has not passed through the processing plant.
CHPP	Coal handling and preparation plant
AQMP	Air quality management plan
EIS	Environmental Impact Statement

EXECUTIVE SUMMARY

Katestone was commissioned by the NSW EPA and the DPE to complete a Dust Benchmarking Study of dust controls applied at the Maules Creek Coal Mine (MCCM).

Since the commencement of mining operations, numerous complaints have been received by the EPA and DPE regarding dust and particulate emissions and alleged non-compliance with the mine's approval conditions. This Dust Benchmarking Study provides EPA and DPE with advice on current dust control measures (documented and actual) compared to best practice, and potential emissions reductions and expected costs associated with alignment to best practice approaches and any other additional controls that may be appropriate due to site-specific factors.

The MCCM is an open-cut operation that adopts standard truck and shovel techniques. MCCM is approved to extract up to 13 million tonnes (Mt) of coal per year and to rail 12.4 Mt of product coal from the site per year. Construction of the mine commenced in January 2014. Railing of coal commenced in December 2014. The mine has a 2016 production target of 7.1 – 7.3 Mt of ROM coal. Mining is conducted up to 24 hours per day, seven days per week. The mine production rates are planned to ramp up to approximately 9 Mtpa of ROM coal and approximately 55 million bank cubic metres (Mbcm) of overburden during 2016, and approximately 12 Mtpa of ROM coal and 81 Mbcm of overburden during 2017.

Wheel generated dust associated with haulage of materials is the most significant source of emissions of dust. Other key sources include wind erosion, truck loading and dumping, and dozer use. The top six sources of dust contribute 81% of total dust emissions.

The Overburden Emplacement Area is proposed to continue to develop in the existing location and to progress further to the north up to the final extent approved under the Project Approval. This will bring mining activities to within 2.8 km of nearest residences.

The Project Approval includes the requirement that the ‘air quality monitoring program [...] adequately supports the proactive and reactive air quality management system.’ The following conclusions were reached regarding this:

- TEOM 1 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 4 km north of the mine. Receptors 67, 68, 82, 134 and those further north are likely to be adequately covered by this monitor.
- TEOM 2 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 1-2 km west and northwest of the mine. Receptors 103, 104, 105 and 108 are likely to be adequately covered by this monitor, although levels at TEOM 2 will be higher than at the receptors.
- The two monitors may not be representative of conditions in the vicinity of receptors 42, 53, 106, 111, 116, 122 and 123, particularly, as the northern emplacement area progresses northwards. An additional monitor should be considered that is representative of dust levels to the northwest.
- Data capture for the period is relatively low, particularly at TEOM 2, and could be improved. Whilst 87.6% of 1-hour average measured at TEOM 2 met the criteria for valid data, Katestone’s detailed inspection of the data suggests that capture rate of valid data may be less than 87.6%. Data from the TEOMs should be subjected to regular review and quality assurance checks, erroneous data should be checked so that any problems with the equipment may identified early and rectified to avoid data loss.

Predominantly, winds occur from the south-eastern quadrant, which could at times contribute to the transport of dust from the mine towards some sensitive receptors to the north and northwest. The winds from this quadrant are generally light to moderate in strength and occur throughout the year. Winds from this quadrant occur frequently through the night, when their strength is generally light.

The following findings relate to application of best practice at the MCCM:

- Control and management of dust from blasting and drilling is generally consistent with best practice.

However, Whitehaven should incorporate consideration of blast size and dust impact potential into its decision to conduct or delay blasts.

- Control and management of dust from bulldozing is generally consistent with best practice.
- Control and management of dust associated with loading trucks with overburden and trucks dumping overburden includes some best practice measures. However, additional controls would seem to be feasible. These activities were estimated in the EIS to contribute 7% to total dust emissions from the MCCM. The adoption of additional control measures such as the application of water to minimise and control emissions from excavators and dumping trucks could reduce emissions from this activity theoretically by 70%. However, Whitehaven has identified a number of issues that make water application unfeasible.
- Control and management of dust associated with loading trucks with coal and trucks dumping coal includes some best practice measures. However, additional controls would seem to be feasible. These activities were estimated in the EIS to contribute 16% to total dust emissions from the MCCM. The adoption of additional control measures such as the application of water to minimise and control emissions from excavators and dumping trucks could reduce emissions theoretically by 70%. However, Whitehaven has identified a number of issues that make water application in the pit unfeasible. Water application at the ROM pad to reduce emissions from dumping trucks would appear to be a viable option and should be subject to detailed consideration by Whitehaven.
- Control and management of dust associated with haulage includes some best practice measures. However, additional controls would seem to be feasible. Dust emissions associated with vehicles hauling overburden, coal and rejects were estimated in the EIS to contribute 36% of total dust emissions. Consequently, minor additional improvements in dust emissions from this activity could contribute to an important overall reduction in dust emissions. Whitehaven currently applies dust suppressant to the ROM Ramp from December to March. The remainder of the coal and overburden haul routes are subjected to watering alone. Whitehaven should give consideration to extending the use of suppressant to all site haul routes to further minimise dust emissions. Whitehaven has indicated that it will trial further application of suppressant.
- Control and management of dust associated with stockpiles, cleared areas, conveyors, transfers, stacking, reclaiming and train loading is generally in accordance with best practice.
- Control of dust emissions from rail wagons is not consist with best practice. While improving this aspect of MCCM's operations will not provide a material benefit for the community living to the north of MCCM, some benefits would be achieved for residents along the rail network. It has been demonstrated that dust emissions from coal wagons can be effectively controlled by the application of water in some instances, or chemical suppressant in others.

More broadly, whilst the AQMP includes provision for amending activities when wind speed threshold triggers occur, some activities, such as bulldozing, produce dust regardless of the wind speed. Consequently, elevated dust levels may also occur as a result of poor dispersive conditions coinciding with dust production. The AQMP should be amended to broaden the consideration of meteorological conditions that may trigger a response due to elevated dust risk.

Katestone notes that Whitehaven is in the process of implementing a predictive and real time dispersion model as part of the BTM Air Quality Management Strategy (AQMS). Katestone has not evaluated the system. However, such a predictive system will likely provide a basis for broadening the meteorological conditions that may trigger a response to elevated dust risk.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by the NSW Environment Protection Authority (EPA) and the Department of Planning and Environment (DPE) to complete a Best Practice Benchmarking Study (Dust Benchmarking Study) of dust controls applied at the Maules Creek Coal Mine (MCCM).

1.1 Background

Katestone understands that since the commencement of mining operations, numerous complaints have been received by the EPA and DPE regarding dust and particulate emissions and alleged non-compliance with the mine's approval conditions. This Dust Benchmarking Study provides EPA and DPE with advice on current dust control measures (documented and actual) compared to best practice, and potential emissions reductions and expected costs associated with alignment to best practice approaches and any other additional controls that may be appropriate due to site-specific factors.

1.2 Scope of work

The following scope of works has been implemented:

- Identify and review the dust management strategies and practices in place at the MCCM.
- Determine if these strategies and practices represent best management practices to the maximum extent achievable as described within the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005 – see page 29) (Approved Methods for Modelling) and when benchmarked against the findings of the report '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*' dated June 2011.
- Estimate the likely reduction in particle emissions associated with implementing best practice measures to the maximum extent achievable at the MCCM, where existing strategies and practices do not meet this requirement already.
- Estimate the costs associated with implementing each achievable best practice dust mitigation measure at the MCCM, and assess whether site specific circumstances or conditions are likely to mean that these costs would vary significantly to those at other coal mines in NSW.
- Identify any site-specific factors that may be contributing to increased dust emissions relative to other coal mining operations in NSW and determine whether these issues are sufficient to cause impacts at nearby, offsite receptors that warrant additional particulate matter controls to be implemented above those that might be considered as best practice at other sites.

1.3 Limitations

Katestone has taken due care to consider all reasonably available information that was provided during the undertaking of this Dust Benchmarking Study. Katestone has taken this information to represent a fair and reasonable characterisation of the status of the site. However, Katestone also recognises that such studies are necessarily limited in scope and true site conditions may differ from those inferred from the available data.

This report has not considered blasting fume. Blasting fume is being addressed by others.

2. METHODOLOGY FOR REVIEW

2.1 Identify major sources and rank

The major sources of emissions of particulates (reported as TSP, PM_{10} and $PM_{2.5}$) have been identified. The major sources were identified based on a desktop review of all available information including: the *Air Quality Impact Assessment - Maules Creek Coal Project* (PAE Holmes, 2011) and the *Maules Creek Air Quality and Greenhouse Gas Management Plan* (Whitehaven, 2014). The adequacy of the emissions estimation methodology was evaluated.

The potential reduction in emissions due to implementation of best practice controls, if not already in place, has been estimated.

2.2 Site inspection and interviews

Katestone personnel inspected the mine site over two days in June 2016. During the inspection, the current operational practices and emission controls were identified and inspected, with particular attention given to the major sources of dust emissions and their associated management and control measures.

During the site inspection and subsequently, the mine's operational records were viewed and analysed to determine if dust mitigation practices are maintained at all times.

There are approximately six households that regularly make complaints about the mine. These complainants were interviewed over two days by Katestone personnel. The aim of the interviews was to obtain additional details about the timing, nature and location of dust impacts that have resulted in complaints. The interviews also investigated the complainants' impressions as to the consistency of application and effectiveness of the mine's management practices. Whilst the views of complainants are confidential, they have been considered in drafting this report.

The following issues of concern were raised by complainants:

- Overburden emplacement is moving closer to residents
- Visible dust emissions occur from mining activities
- Dust deposited on cars, roofs, in tank water and on outdoor furniture
- Control measures are not being diligently applied at all times e.g. water carts are parked at night
- Mine is not implementing best practices
- Concern about the health of people, particularly children, living in the area
- Some first noticed dust when construction started, others noticed dust more recently
- Dust most noticeable in morning
- Whitehaven provides notice of blasting 2-3 days before
- Potential for higher levels of dust overnight due to inversions
- EIS air quality assessment deficient in relation to meteorology and modelling approach
- Current monitoring insufficient in quality and extent and monitoring is not available to community
- Dust from coal trains not adequately managed.

2.3 Review of dust mitigation measures

A desktop review of relevant documentation along with the findings of the source identification, inspection and interviews has been used to identify any gaps between the mine's implementation of dust controls and what is reasonably considered to be best practice.

Dust mitigation measures that are implemented at the site have been reviewed and evaluated with respect to:

- Compliance with the requirements of the EPL and the Maules Creek Coal Project Approval conditions
- Consistency in application of management and control measures
- Comparison against best practice approaches.

The following specific documents were also considered:

- The original approval documentation including the Environmental Assessment, specialist appendices, project approval and/or any subsequent consent modifications.
- Relevant and current air quality management plans, and other relevant site management plans as approved by DPE.
- Maules Creek Coal Pty Ltd and/or Whitehaven responses to the Dust Stop pollution reduction programs.
- The SMEC Independent Audit Report conducted in 2015, including expert advice provided by Jacobs.
- Any other documents or data that is available, including the documents that are available on Whitehaven Coal's website, such as monitoring reports and AEMR.

Where possible, the mine's operational records and complaints information have been used to determine whether dust mitigation measures have been consistently applied, particularly at night, and at times when regulatory agencies or contractors who are monitoring environmental performance are not present.

The dust mitigation measures employed at the mine have been compared against best practice approaches. Any inconsistencies between actual measures, those contained in approval documents, and best practice approaches are highlighted in Section 5.

2.4 Site-specific factors

Site specific factors that influence dust generation, potential impacts on surrounding residences, the effectiveness and/or feasibility of controlling particulate matter and the range of achievable best management practice controls at the site have been identified, reviewed and discussed. This has included an evaluation of the significance of the following factors, and any additional factors identified during the completion of the above tasks:

- The operation of the limited clearing window, which means that vegetation clearing can occur up to 12 months ahead of mining, potentially resulting in exposed areas being in existence for extended periods.
- The size of the fleet and trucks used.
- Short term adverse weather conditions and early morning dust haze.
- The nature of the overburden materials being handled at the site, if sampling data is available to characterise the overburden (e.g. silt and moisture contents).
- Local meteorological patterns, and the topography within which the mine is situated, and the mine's position in the landscape relative to receptors.

To assist in this aspect of the review, Katestone has conducted a detailed review of the ambient air quality and meteorological monitoring data that has been collected by the mine.

2.5 Recommendations for monitoring network

The existing dust monitoring network has been reviewed to determine its adequacy for determining compliance with the requirements of the POEO Act, the EPL 20221 and Project Approval conditions. Recommendations for improvements to the monitoring network are provided.

2.6 Additional dust mitigation measures

Any best practice dust mitigation measures not currently employed are discussed, along with any additional measures considered to be appropriate for this specific site. The focus of the additional control measures is the minimisation of dust emissions to the maximum extent achievable.

The practicality and cost effectiveness (e.g. cost per tonne of dust avoided) of any additional dust mitigation measures is evaluated, where possible. The reasoning behind the findings of the evaluation will be clearly stated.

3. MAULES CREEK COAL MINE

3.1 Overview

The MCCM was granted approval by the Planning Assessment Commission (PAC) under delegation of the Minister for Planning on 23 October 2012 with modifications approved on 25 July 2013 and 10 March 2014. The mine is expected to have a life in excess of 30 years. The mine is located on the northwest slopes and plains of New South Wales, approximately 18km northeast of Boggabri and 45km southeast of Narrabri. The mine is located approximately 55km north of the town of Gunnedah (Figure 1).

MCCM is approved to extract up to 13 million tonnes (Mt) of coal per year and to rail 12.4 Mt of product coal from the site per year. Construction of the mine commenced in January 2014. Railing of coal commenced in December 2014. The mine has a 2016 production target of 7.1 – 7.3 Mt of ROM coal.

MCCM is owned by a joint venture between Whitehaven Coal Limited (75%), ITOCHU Coal Resources Australia Maules Creek Pty Ltd (ICRA MC Pty Ltd) (15%) and J-Power Australia Pty Limited (10%).

The mine is located in the northern part of the Leard State Forest and to the east of the Leard State Conservation Area. The project boundary is shown in Figure 2. Mining is conducted up to 24 hours per day, seven days per week.

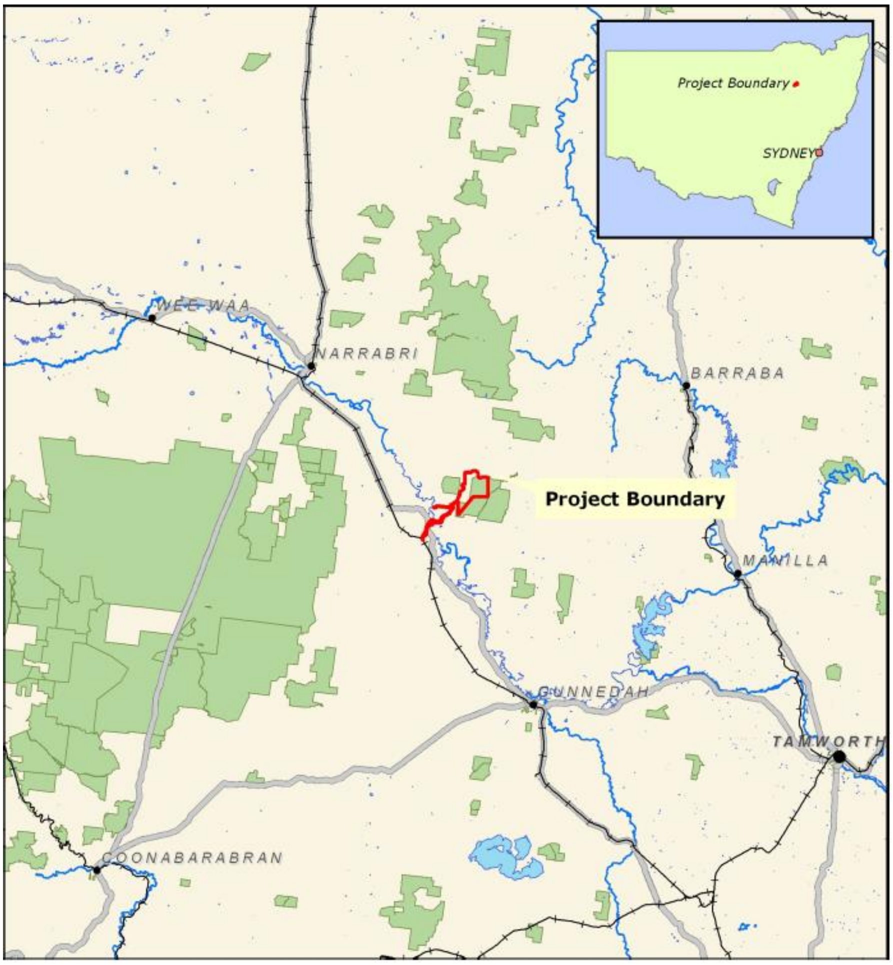

Figure 1 MCCM Regional Setting (source: PAE Holmes, 2011)

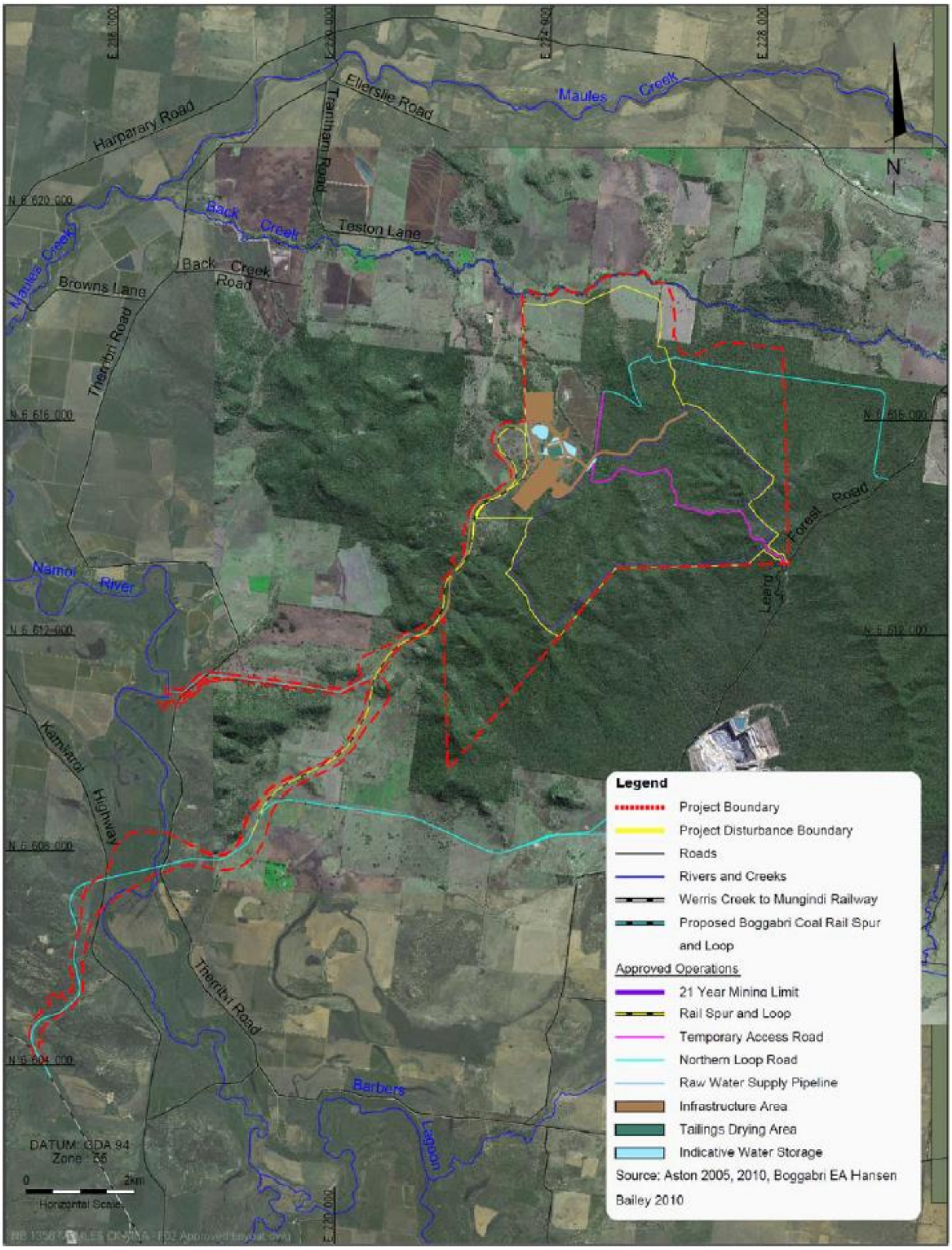

Figure 2 **MCCM Local Setting (source: Project Approval 10_0138, Modification 2, 10 March 2014)**

3.2 Mining methods

The MCCM is an open-cut operation that adopts standard truck and shovel techniques. Prior to mining, vegetation is mulched, mixed with topsoil and stripped for use in rehabilitation areas or stockpiled for later use. Vegetation clearing activities in mining areas are restricted to an annual ten week clearing campaign from 15 February to 30 April each year, except under exceptional circumstances and with the approval of the Secretary of DPE.

Overburden is blasted prior to removal by excavator and trucks. Blasting of overburden is conducted once per day at around 1:00pm. The frequency of blasts is strictly limited under the conditions of approval as follows:

> *The Proponent may carry out a maximum of:*
>
> > *a) 1 blast a day; unless an additional blast is required following a blast misfire; and*
> >
> > *b) 4 blasts a week, averaged over a calendar year;*
>
> *for the project.*
>
> *This condition does not apply to blasts that generate ground vibration of 0.5 mm/s or less at any residence on privately-owned land, or to blasts required to ensure the safety of the mine or its workers.*

Overburden is either placed in mined-out pits (where available) or is hauled to an overburden emplacement area to the north of the mine.

Coal mined from the open-cut is delivered to the ROM (run-of-mine) pad area, where it is either fed directly into the ROM coal hopper from the rear dump trucks or stockpiled. Coal stockpiled on the ROM pad is fed to the ROM coal hopper via front end loader and/or rear dump trucks. From the hopper the ROM coal is fed through various sizing stations and either bypassed to the product coal stockpiles (30-40% of total) or fed via a surge bin to the CHPP for washing.

Coal is loaded into the product stockpiles by luffing stacker. Product coal is extracted from the stockpiles by portal reclaimer. Product coal is fed by conveyors to the Train Loading Facility. Once loaded, trains travel from the mine via the Maules Creek Rail Spur, Shared Rail Spur and the Werris Creek to Mungindi Railway Line to the Port of Newcastle for export.

3.3 Conditions relating to air quality

3.3.1 Project Approval 10_0138

The Project Approval 10_0138 conditions 26 to 35 relate to air quality and greenhouse gas. These conditions are reproduced in Appendix A. Conditions include provision for:

- Additional air quality mitigation upon request (Condition 28)
- Air quality criteria (Condition 29)
- Mine specific air quality criteria (Condition 30)
- Mine owned-land related air quality condition (Condition 31)
- Air quality acquisition criteria (Condition 32)
- Operating conditions (Condition 33)
- Air quality and greenhouse gas management plan (Condition 34)
- Meteorological monitoring (Condition 35).

The Air Quality and Greenhouse Gas Management Plan (AQMP) includes the following:

- Statutory requirements
- Sources of emissions
- Air quality management actions such as:
  - Watering haul roads using water carts
  - Vehicle speed limitations
  - Minimise pre-strip
  - Rehabilitation
  - Water sprays on product stockpiles
  - Avoiding operations during adverse conditions
- Predictive real time air quality management
- Additional air quality mitigation upon request
- Air quality and meteorological monitoring
- Roles and responsibilities
- Complaints handling
- Reporting.

3.3.2 EPL 20221

The MCCM operates under an Environment Protection Licence (EPL) number 20221. The licence includes the EPA's conditions relating to air quality that were specified as part of the Project Approval. Conditions include provision for:

- Monitoring of PM_{10} using a TEOM at one location (P1.1 and M2.2, See Figure 3)
- Monitoring of PM_{10} using a high volume air sampler at one location (P1.1 and M2.2, See Figure 3)
- Monitoring of dust deposition rates at four locations (P1.1 and M2.2, See Figure 3)
- Monitoring of meteorological conditions at one location (P1.4 and M4, See Figure 3)
- A condition requiring all activities to be carried out in a manner that minimises the emission of dust (Condition O2)
- A condition requiring recording of pollution complaints (M5 and M6)
- Conditions related to reporting information to the EPA (R1, R2, R3 and R4)
- Special condition requiring the licensee to achieve and maintain dust control efficiency of 85% or more on active haul roads (E1)
- Special condition requiring the licensee to alter or cease the use of equipment on overburden and the loading and dumping of overburden during adverse weather conditions to minimise generation of dust.

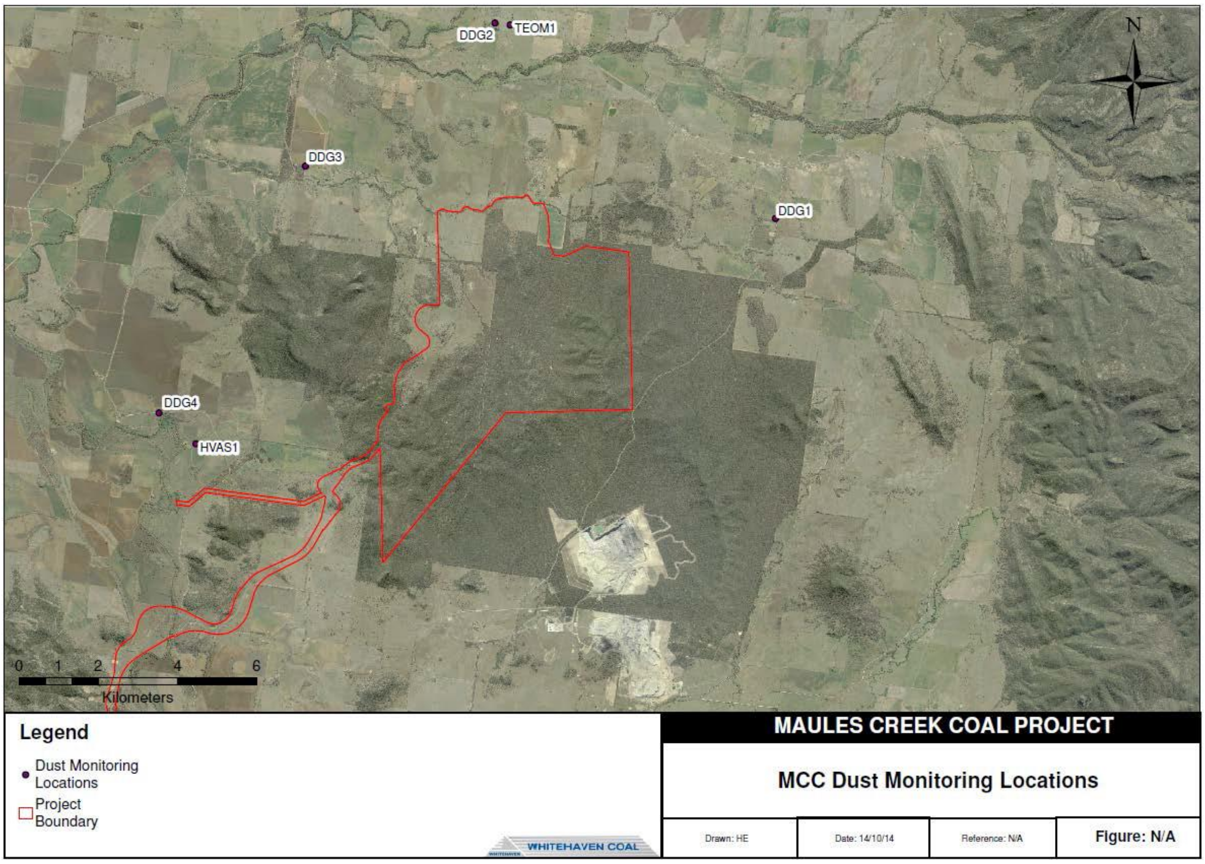

Figure 3 MCCM EPL Dust Monitoring Locations (source: Whitehaven Coal, 2016)

3.4 Dust emission sources and characterisation

Dust emissions from the mine during Year 5, 10, 15 and 21 were estimated as part of the Air Quality Impact Assessment (PAE Holmes, 2011) that was conducted for the EIS. Year 5 is most representative of current operations of the mine. Year 5 emissions of TSP are shown in Table 1 and

Figure 4, grouped by activity.

Wheel generated dust associated with haulage of materials is the most significant source of emissions of dust. Other key sources include wind erosion, truck loading and dumping, and dozer use. The top six sources of dust contribute 85% of total dust emissions. Table 1 ranks the estimated emissions by activity and material type. This identifies overburden haulage as the most significant contributor to overall emission from the mine. Wind erosion of exposed areas (overburden dumps and exposed pit areas), and truck dumping operations are the other highest contributors to emissions.

Katestone has reviewed the Air Quality Impact Assessment and the methodologies that were used to calculate emissions of particulate matter. The approach is consistent with the requirements of the Approved Methods for Modelling. Emission rates of dust that were estimated in the Air Quality Impact Assessment are generally consistent with estimates for other similar activities. Katestone has checked the calculations and they appear to be correct.

It is important to note that emissions depend on a range of mine specific factors that mean that emissions are not able to be simply inferred from one factor alone (e.g. ROM coal tonnage). Factors include:

- Tonnage of ROM and overburden extracted – a mine that targets a shallower resource will need to extract and dispose of lower quantities of overburden than a mine with a deeper resource.

- Length of travel on haul routes from pit to ROM pad and overburden dumps.
- Truck size – a mine that adopts larger trucks for haulage of coal and overburden will generate fewer trips and, hence, will produce lower emissions.
- Dust emission controls.

Table 1 Estimated TSP emission rates from MCCM for each activity (by material type) in Year 5

Activity and type of material	TSP emission (kg/yr)	TSP emission (%)
Haulage - OB	2,376,988	36.1
Wind erosion - exposed areas	1,405,279	21.3
Truck loading - Coal	514,942	7.8
Truck dumping - Coal	514,942	7.8
Dozers - OB	354,789	5.4
Truck loading - OB	237,546	3.6
Truck dumping - OB	237,546	3.6
Dozers - Coal	220,958	3.4
Haulage - Coal	195,790	3.0
OB - Blasting	131,788	2.0
Sizer	124,000	1.9
Grading	104,383	1.6
Dozers - product stockpiles	49,624	0.8
Topsoil Removal	35,424	0.5
OB - Drilling	28,044	0.4
Wind erosion - stockpiles	26,280	0.4
Haulage - rejects	12,082	0.2
Dozers - rehab	8,368	0.1
Transfers at processing - Coal	3,818	0.06
Train loading	1,489	0.02
Transfers - rejects	162	0.00
Total	**6,584,242**	**100**

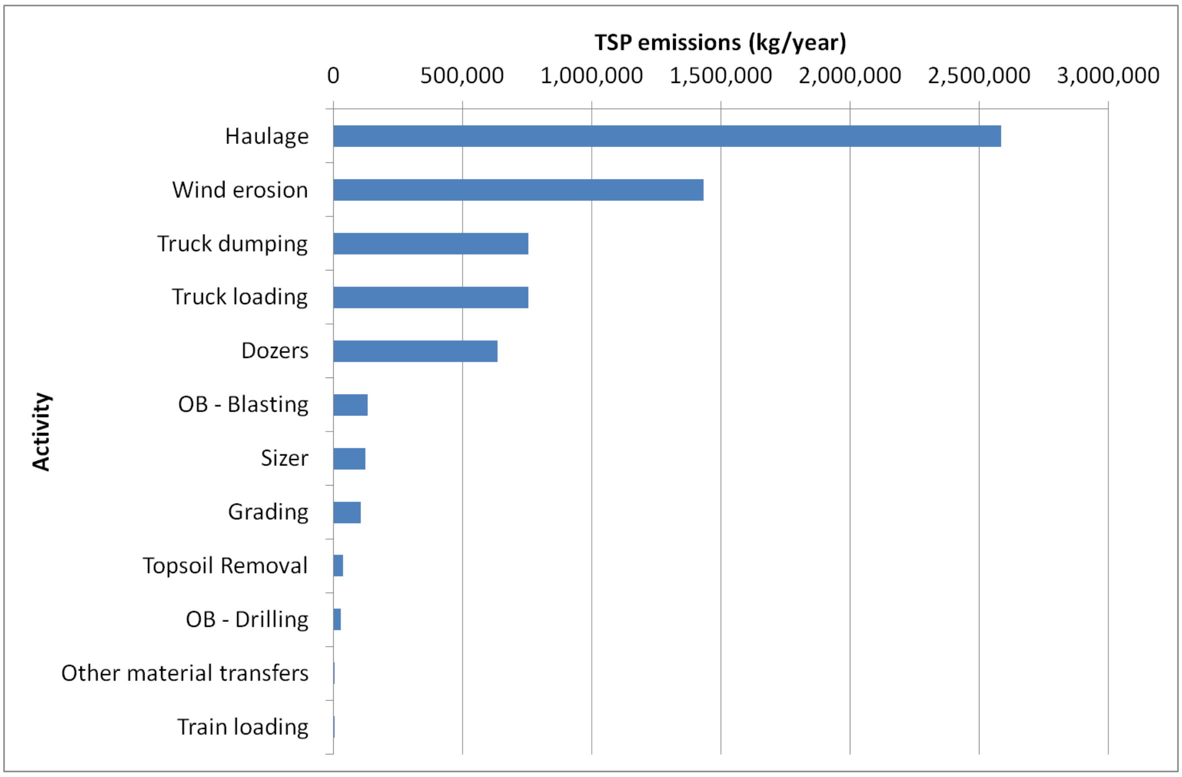

Figure 4 **Estimated TSP emission rate from MCCM for grouped activities in Year 5**

Table 2 compares the emission rate of TSP for various coal mines operating elsewhere in NSW with the estimates for MCCM Year 5 that were contained in the Air Quality Impact Assessment. For mines other than MCCM, the data presented in Table 2 comes from the 2008 NSW GMR Air Emissions Inventory as reported in the Coal Mine Benchmarking Study (Katestone, 2011). The data indicates that the emission rates that were adopted in the Air Quality Impact Assessment are at the lower end of the spectrum compared with the other mines in NSW. In part, this is explained by the fact that the Air Quality Impact Assessment applied a haul road control factor of 85%, whereas, emissions from the other mines were estimated using control factors of 50% or 75%.

The adoption of the higher control factor for haul roads is consistent with more recent research funded by ACARP and has been subsequently shown to be achievable by measurements at MCCM.

Table 2 Estimated TSP emission rates from various NSW Coal Mines as detailed in the NSW 2008 Air Emissions Inventory compared with MCCM Year 5

Coal Mine	EPL	Type	ROM Coal Throughput (Mtpa)	TSP emission (tonnes/yr)
Hunter Valley Operations	640	OC	17.2	27,928 [1]
Mt Arthur North Coal Mine	11457	OC	14.0	17,710 [1]
Saxonvale Colliery Holding	563	COMB	10.8	13,755 [2]
Warkworth Coal Mine	1376	OC	12.8	10,575 [1]
Mt Owen Coal Mine	4460	OC	10.9	8,275 [2]
MCCM	20221	OC	12.4[2]	6,584 [3] 8,169 [1] 12,130 [2]

Table note:
[1] Assumes that watering of haul roads achieves 75% emissions control
[2] Assumes that watering of haul roads achieves 50% emissions control
[3] EIS assumed that watering of haul roads achieves 85% emissions control

3.5 Future mining activities

The Mining Operations Plan (MOP, Whitehaven, 2015) specifies the activities that will occur over the MOP term, which ends on 1 January 2018. The mine production rates are planned to ramp up to approximately 9 Mtpa of ROM coal and approximately 55 million bank cubic metres (Mbcm) of overburden during 2016, and approximately 12 Mtpa of ROM coal and 81 Mbcm of overburden during 2017. Plant and equipment proposed to be implemented in 2016 and 2017 are summarised in Table 3.

The Overburden Emplacement Area (OEA) is proposed to continue to develop in the existing location and further to the north up to the final extent approved under the Project Approval (Figure 5). Consequently, in the near term, mining activities will progress closer to the nearest receptors to the north, northeast and northwest. At the same time, coal and overburden extraction rates will also increase.

Table 3 Plant and Equipment Proposed for Implementation at the end of 2016 and 2017 (Whitehaven MOP, 2015)

Equipment	2016	2017
800 t Excavator	4	4
600 t Excavator	0	1
350 t Excavator	4	4
350 t Truck	32	42
180 t Truck	21	22
Bulldozer	13	14
Front End Loader	2	2
Grader	5	6
Water Carts	7 [1]	8
Drill Rig	7	7

Note:
[1] During Katestone's site inspection Whitehaven advised that its water cart fleet consisted of nine vehicles as follows:

- Three CAT 777 with 75,000L tanks
- Four CAT 773 with 50,000L tanks
- Two Volvo A40E with 30,000L tanks

The EIS estimated rates of ROM coal extraction and overburden removal by year of operation, which indicate relatively consistent production levels from about Year 3 of operations. These rates are reproduced in Table 4.

Table 4 ROM coal and overburden extraction by year of operation of MCCM

Year of operations	ROM coal extraction (Mtpa)	Overburden removed (Mbcm)
Year 1	3.8	22.2
Year 2	6.3	53.6
Year 3	11.7	73.6
Year 4	11.7	74.3
Year 5	12.4	74.3
Year 6	11.3	74.3
Year 7	11.3	74.3
Year 8	13.0	74.3
Year 9	13.0	74.2
Year 10	12.7	74.3
Year 11	12.3	74.3
Year 12	12.0	74.3
Year 13	12.4	74.3
Year 14	13.0	74.3
Year 15	11.2	74.3
Year 16	11.5	74.3
Year 17	12.6	74.3
Year 18	13.0	85.4
Year 19	12.2	85.7
Year 20	12.0	85.2
Year 21	13.0	85.4

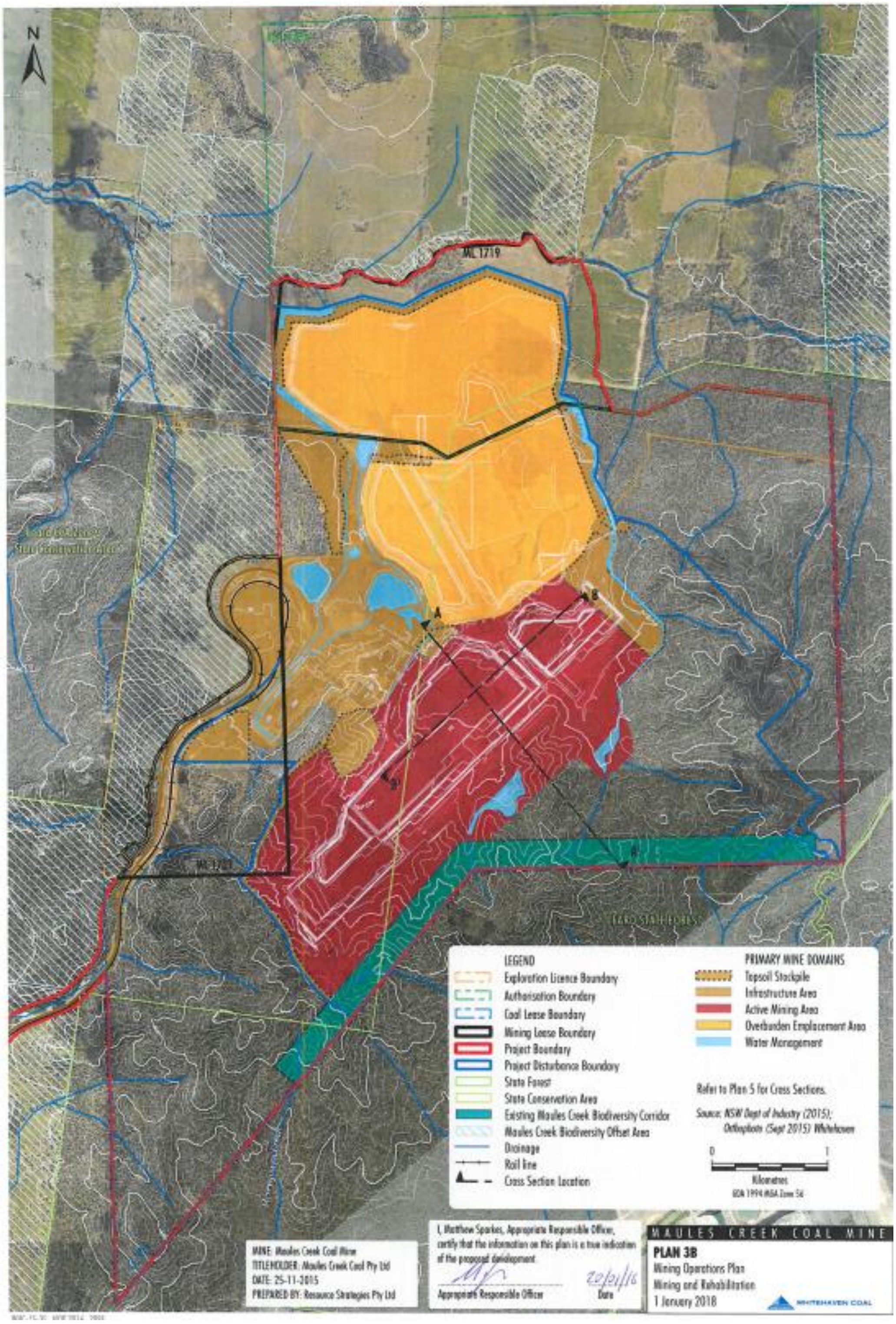

Figure 5 **Mining Operations Plan, MOP Plan 3B (Whitehaven, 2015)**

3.6 Water carts

3.6.1 Water fill points

Water for dust suppression is drawn from various water fill points in the mine water system. These include:

- The MIA Fill Point: 33 L/sec i.e. 15-minute fill time
- The OOP Fill Point: 100 L/sec i.e. 5-minute fill time
- MWD Fill Point
    - Red: 270 L/sec
    - Yellow: 320 to 400 L/sec i.e. 3.5-minute fill time
- Tanks have the capability to hold 470,000L.

Whitehaven has advised that the water fill point system has significantly reduced fill times (from approximately 20 to 25 minutes) and therefore has increased system efficiency. The fill point system should allow for quicker turn-around times for the water carts, which would reduce the overall number of water carts that would be required at any one time.

A detailed analysis of water cart GPS data has been conducted to understand water cart usage. This is presented in the following sections.

3.6.2 Water Cart GPS Data

Whitehaven provided GPS (Global Positioning System) data for its mining fleet water carts covering the period between 31 October 2015 and 5 June 2016. This data has been analysed to provide information on water cart usage at MCCM.

Each GPS data record included the following information:

- Timestamp (Date and time, including seconds)
- Equipment code, identifying the water cart
- Shift date and number, identifying the water cart shift
- Northing, easting and elevation of the water cart at the given timestamp
- Speed of the water cart
- Various GPS signal quality indicators.

The GPS records were not evenly spaced in time or space, but typically more records were made while the trucks were in motion. Records were as frequent as 1 second apart, but typically several records were recorded per minute.

Whitehaven has advised that, between 2 and 6 water carts in addition to the mining fleet water carts, are in use at MCCM. These additional water carts are supplied on an as needed basis by contractors conducting activities such as:

- Topsoil stripping
- Drilling and blasting
- Vegetation clearing.

These additional water carts are not tracked by the mine's GPS system.

3.6.3 Water Cart GPS Data Analysis methodology

For each shift (identified as unique combination of Equipment Code, Shift Date and Shift Number) the following information was determined:

- Start time: earliest timestamp.
- Finishing time: latest timestamp.
- Total distance travelled: sum of all straight-line distances between consecutive points. Whilst it was recognised that this method could introduce errors as the time between consecutive GPS points increases, inspection of the data found that any errors were likely to be minor.
- Proportion of water cart travel distance occurring during the day (6am to 6pm) and night (6pm to 6am).

Water cart operating capacity for the mine fleet was determined from the Equipment Code of the water cart that was operating during a period. Vehicles with Equipment Codes: WAT801, WAT802, WAT803 and WAT814 were in operation during the entire dataset (31 October 2015 to 5 June 2016). WAT821 commenced operation on 16 December 2015 and WAT501 commenced operation on 7 January 2016. Therefore, the number of water carts that were identified by GPS data ranged between four and six during the period.

3.6.4 Analysis outcomes and observations

A time series showing the total distance travelled throughout the day as well as the number of truck operator hours per day is presented in Figure 6. The distance travelled, represented as columns, is split into day and night operations. The following observations can be made from this figure:

- The distance covered by water carts on a daily basis varies significantly
- Water carts operate more during the day than at night
- On most days, water carts travel a total distance between 600 and 1,000 km.

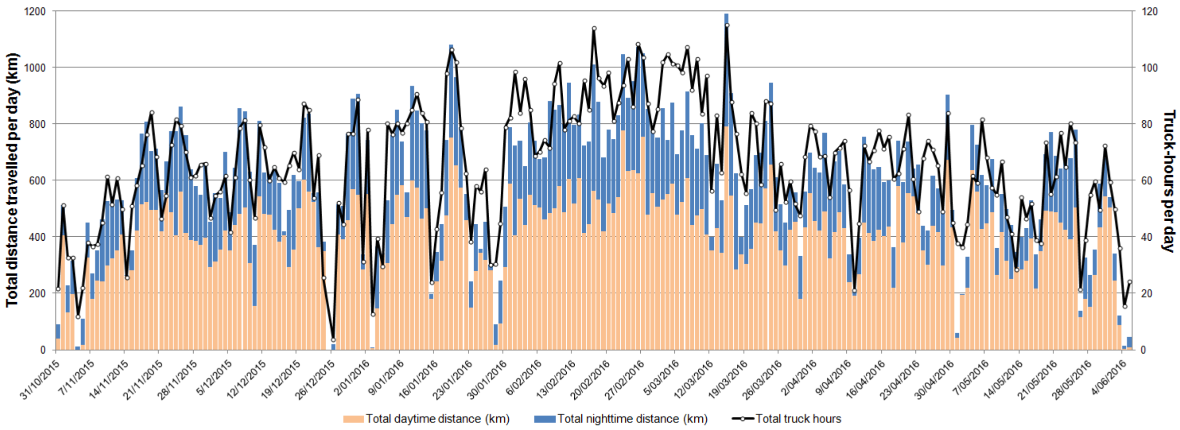

Figure 6 **Total distance travelled by water carts and number of shifts operating daily between 31 October 2015 and 5 June 2016**

The distance travelled by water carts during each day is compared to daily rainfall totals in Figure 7. The following observations can be made from this figure:

- Some, although not all, periods of lower water cart activity coincide with rainfall onsite
- The benefit of rainfall (i.e. allowing a period of lower water cart activity) does not appear to last for more than a day or two.

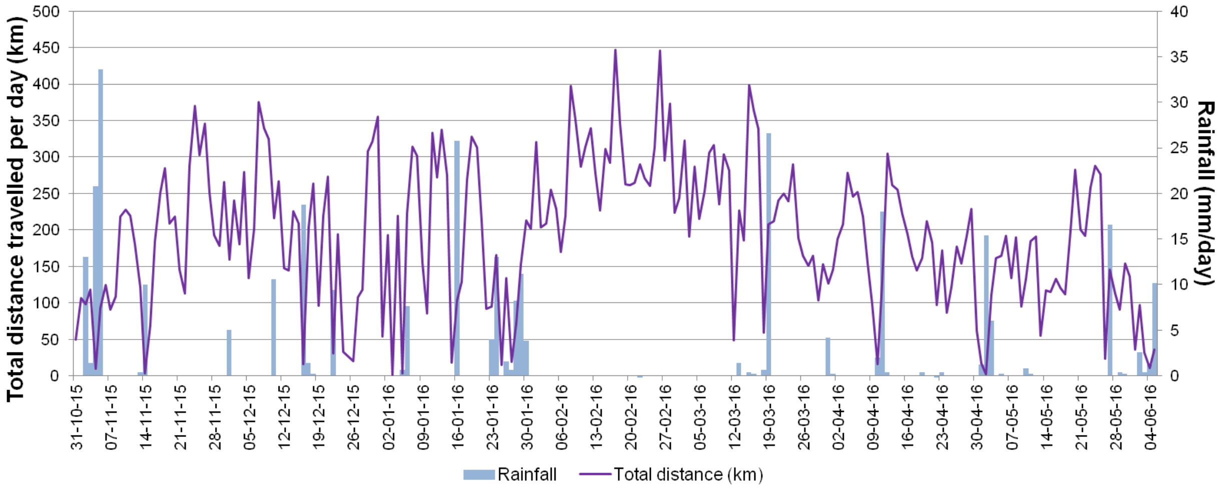

Figure 7 **Total distance travelled daily by water carts and daily rainfall between 31 October 2015 and 5 June 2016**

The utilisation rate, or number of water carts operating as a percentage of the available vehicles (capacity), was determined for each hour of each day. A vehicle was counted as in operation during an hour if any part of its shift occurred in that hour. The distribution of the utilisation rate is shown as a box and whisker plot in Figure 8. The following observations can be made from the figure:

- The average number of water carts is highest during the day (8 am to 5 pm), slightly lower overnight and lowest during the early morning, 4 am to 8 am.
- The lowest number of water carts operating on average occurs at between 7 am and 8 am, which may be related to the change of shifts.
- There is capacity for greater water cart usage during the night and day, although this would be subject to safety considerations.

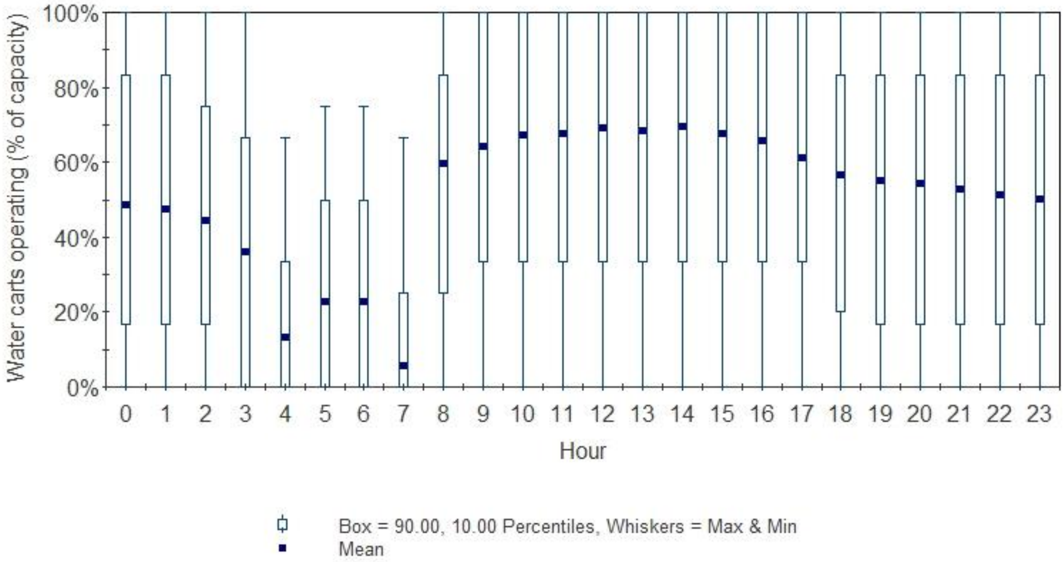

Figure 8 **Box and whisker plot showing the number of trucks operating according to hour of the day**

Figure 9 summarises GPS water cart usage by day over the period from October 2015 to June 2016. The figure shows the number of available water carts evident in the data set. The data set contains water carts indicated by four unique identifiers (WAT801, WAT802, WAT803 and WAT814) up to 16 December 2015 when an additional GPS water cart (WAT821) commenced operation. On 7 January 2016, a sixth GPS water cart commenced operation (WAT501).

Figure 9 also identifies the number of unique GPS water carts used on each day. The number of unique water carts is less than or equal to the number of water carts that is available to be used. For example, on 31 October 2015 (the first day of the data set), four unique water carts were in use for some part of the day. On the following day, three unique water carts were used whilst four were available.

Figure 9 also shows the effective number of water carts in use on each day. The effective number of water carts is a measure of the utilisation of the water carts. It has been calculated by summing the water cart operating hours in each day and dividing the total by 24. For example, if three water carts each operated for 20 hours each in a day, the total number of operating hours would be 60 and the effective number of water carts would be (60/24) 2.5. The average number of water carts utilised across the period of available data is 2.7.

Highest average water cart utilisation occurred during February and March with 3.7 and 3.5 water carts per day, respectively. The lowest months were November and May with average usage of 2.3 water carts per day. There was insufficient data to produce reliable averages for October (1 day) and June (5 days).

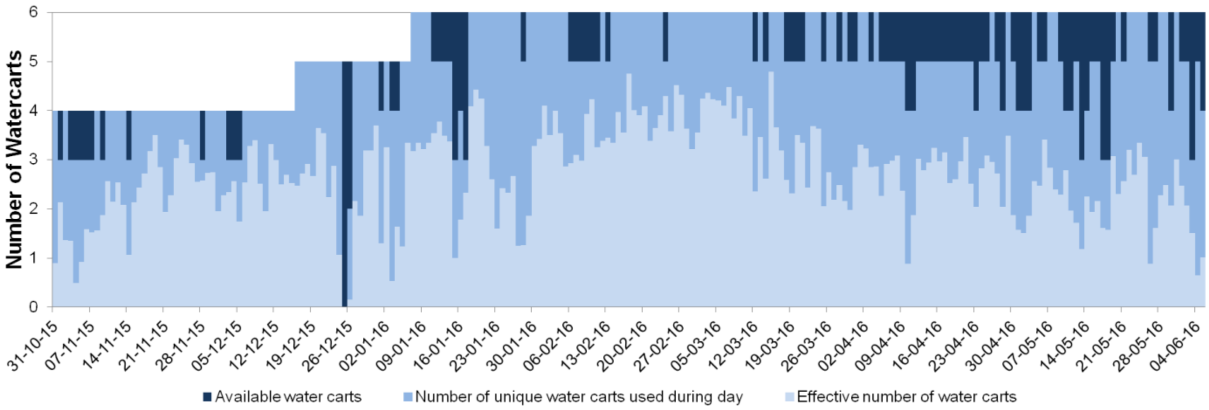

Figure 9 **Water carts in use per day, including: number available, unique water carts used, effective number of water carts used**

3.7 Continuous dust monitoring

3.7.1 Monitoring data

Whitehaven conducts continuous monitoring for PM_{10} and $PM_{2.5}$ at two locations. The monitoring locations are shown in Figure 10:

- TEOM1 – Compliance site, data is publically available
- TEOM2 – Not a compliance site, data is used for dust management and control, data not publically available
- MCCM automatic weather station (AWS).

Data was provided by Whitehaven in the following format:

- TEOM1 from 1 November 2011 to 30 June 2015 as hourly records of PM_{10} and $PM_{2.5}$
- TEOM1 from 1 July 2015 to 26 June 2016 downloaded from NSW EPA Namoi Monitoring Network website (http://www.epa.nsw.gov.au/air/namoi/station2.htm) as 1-hour averages of PM_{10} and $PM_{2.5}$
- TEOM2 data access provided through a third party as 1-hour averages – data unvalidated
- Meteorological data from 14 May 2014 to 20 June 2016 at five-minute intervals for temperature (2m and 10m), wind speed, wind direction and its standard deviation, and rainfall.

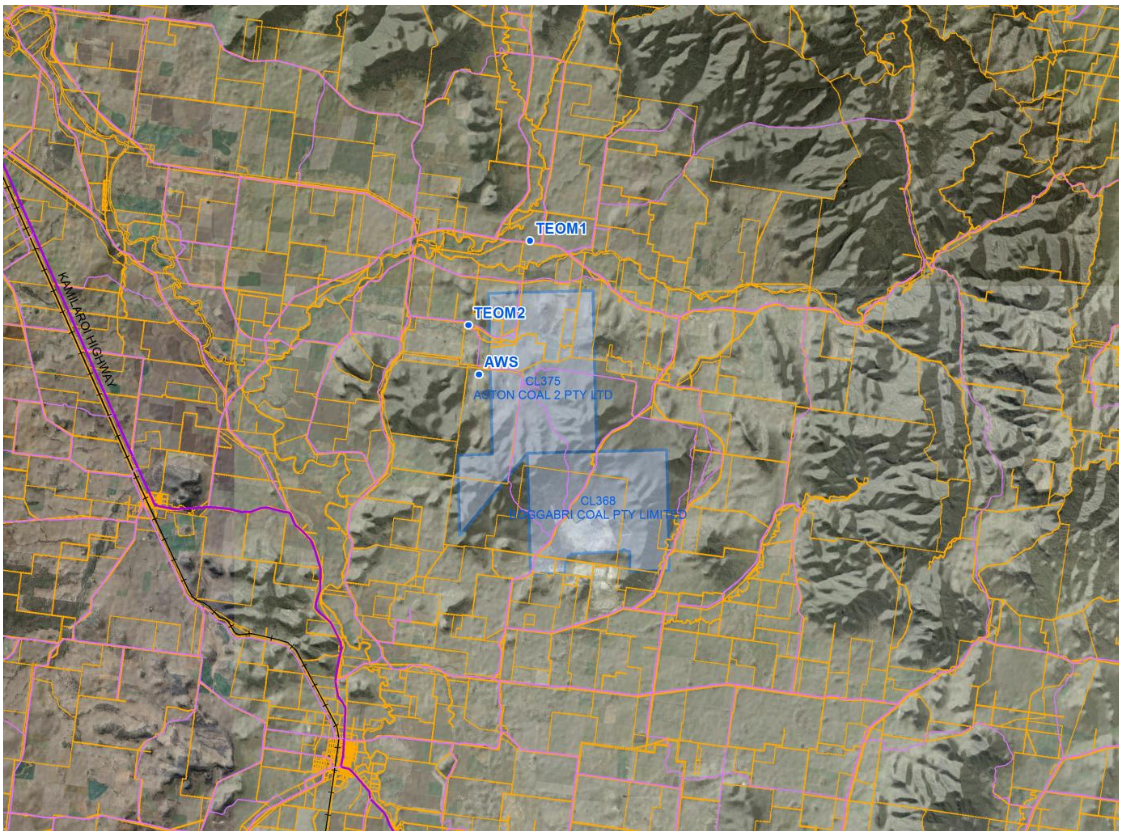

Figure 10 MCCM and surrounds showing locations of TEOM1, TEOM2 and the site weather station

Katestone applied the following quality assurance checks and validation:

- 1-hour average values were deemed to be valid if they were within the following ranges (inclusive):
  - PM_{10}: -5 to 2,000 µg/m³
  - $PM_{2.5}$: -5 to 1,000 µg/m³
- 24-hour average values were calculated from 1-hour averages if a capture rate of 75% was achieved for the calendar day. If 75% capture was not achieved, the data point was set as missing.

Key statistics regarding the monitoring program are provided in Table 5 for PM_{10} and Table 6 for $PM_{2.5}$. In terms of data capture, the following is recommended under the *National Environment Protection (Ambient Air Quality Measure)*:

> "*...It is essential that data loss is kept to an absolute minimum. For representative monitoring data and for credible compliance assessment it is desirable to have data capture rates higher than 95%. 75% data availability is specified as an absolute minimum requirement for data completeness.*"[1]

Hence, 95% has been applied in this report as a suitable and achievable goal for data capture.

Table 5 TEOM PM_{10} data quality statistics

Parameter	Units	TEOM 1	TEOM 2
Data set commences		1 November 2011	31 March 2013
Data set finishes		26 June 2016	30 June 2016
Total possible 1-hour measurements		40,800	28,512
Total reported 1-hour measurements		38,263 [a]	26,176
Total data capture	%	93.8% [a]	91.8%
Total valid 1-hour measurements		37,208	25,251
Valid data capture [b]	%	91.2%	88.6%

Table note:
[a] From July 1 2015 only validated data was reported, so total data capture will be underestimated in this period.
[b] Desirable for data capture rate to exceed 95% (NEPC Peer Review Committee, 2001)

Table 6 TEOM $PM_{2.5}$ data quality statistics

Parameter	Units	TEOM 1	TEOM 2
Data set commences		1 November 2011	31 March 2013
Data set finishes		26 June 2016	30 June 2016
Total possible 1-hour measurements		40,800	28,512
Total reported 1-hour measurements		38,144 [a]	26,179
Total valid 1-hour measurements		37,093	24,979
Valid data capture [b]	%	90.9%	87.6%

Table note:
[a] From July 1 2015 only validated data was reported, so total data capture will be underestimated in this period.
[b] Desirable for data capture rate to exceed 95% (NEPC Peer Review Committee, 2001)

The Project Approval includes the requirement that the 'air quality monitoring program [...] adequately supports the proactive and reactive air quality management system.' The following conclusions can be reached regarding this:

- TEOM 1 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 4 km north of the mine. Receptors 67, 68, 82, 134 and those further north are likely to be adequately covered by this monitor.

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[1] NEPC Peer Review Committee, 2001, National Environment Protection (Ambient Air Quality) Measure, Technical Paper No. 5, Data Collection and Handling, Prepared by the Peer Review Committee, May 2001

http://nepc.gov.au/system/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaqprctp05datacollection200105final.pdf

- TEOM 2 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 1-2 km west and northwest of the mine. Receptors 103, 104, 105 and 108 are likely to be adequately covered by this monitor, although levels at TEOM 2 will be higher than at the receptors. Consequently, it would also be prudent to conduct monitoring in closer proximity to these receptors.
- The two monitors may not be representative of conditions in the vicinity of receptors 42, 53, 106, 111, 116, 122 and 123, particularly, as the northern emplacement area progresses northwards. Receptors 116, 122 and 123 are owned by Whitehaven and Receptor 111 has voluntary acquisition rights under the Project Approval (PA10_0138).
- Data capture for the period is relatively low, particularly at TEOM 2, and could be improved. Whilst 87.6% of 1-hour average measured at TEOM 2 met the criteria specified above for valid data, Katestone's detailed inspection of the data suggests that capture rate of valid data may be less than 87.6%. The following additional quality issues were noted:
    - Of the 31 days when the 24-hour average concentration of PM_{10} was above 50 µg/m³ at TEOM 2, inspection of data on each day indicates that at least eight of these days have poor data quality.
    - For example, on 12 January 2015, TEOM 2 recorded 23 out of 24 readings that met the validation criteria specified above. However, on closer inspection, four consecutive readings of 0 were recorded during the day followed by a large negative value (-477 µg/m³) and then by three very large positive values (729 µg/m³, 829 µg/m³ and 894 µg/m³). The existence of five invalid data points prior to the significant increase in concentration gives no confidence in the subsequent readings.
    - Twenty exceedance days occurred prior to or during the project construction phase in 2013 and 2014. Operations began at the end of 2014.
    - The TEOM 2 data that was provided to Katestone was unvalidated data. It is not clear whether the TEOM 2 data is subject to routine quality assurance, checking and validation by Whitehaven. A detailed validation of the TEOM 2 data was not possible because the data was made available only for inspection.

3.7.2 Monitoring results

The results of monitoring for PM_{10} at TEOM 1 and TEOM 2 are presented in Table 7. The monitoring results show the following:

- Average concentrations of PM_{10} are higher at TEOM 2 than at TEOM 1.
- Maximum 24-hour average concentrations of PM_{10} are generally higher at TEOM 2 than TEOM 1.
- There were two days when the concentration measured at TEOM 1 exceeded 50 µg/m³: 15 November 2014 and 31 January 2016. An analysis of these two days is presented below.

Table 7 Summary of MCCM monitoring results

Parameter	Units	Year	TEOM 1	TEOM 2
Maximum 24-hour average PM_{10}	µg/m³	2011	27.9	-
		2012	31.9	-
		2013	38.1	65.1
		2014	78.9	316.7
		2015	46.2	115.9
		2016	62.8	61.0

Parameter	Units	Year	TEOM 1	TEOM 2
		2011 - 2016	78.9	316.7
Mean 24-hour average PM_{10}	µg/m³	2011	7.7	-
		2012	6.8	-
		2013	7.2	18.1
		2014	8.6	26.8
		2015	9.9	13.9
		2016	11.0	18.1
		2011 - 2016	8.5	19.3
Number of 24-hour periods that average PM_{10} is greater than 50 µg/m³		2011	0	-
		2012	0	-
		2013	0	3
		2014	1	17
		2015	0	6
		2016	1	5
		2011 - 2016	2	31

3.7.3 Exceedance days at TEOM 1

3.7.3.1 15 November 2014

A timeseries of PM_{10} measurements made at TEOM 1 and TEOM 2 during 15 November 2014 is shown in Figure 11. The figure shows that during most of the day, including the time concentrations increased at both monitors, winds were from the west, not the direction of the mine. Hourly average wind speeds were low (less than 2 m/s) between midnight and 7am. Wind speeds were higher during the day, ranging from 5 to 7 m/s between the hours of 9am and 6pm, before slowing to 1 – 3 m/s during the late evening.

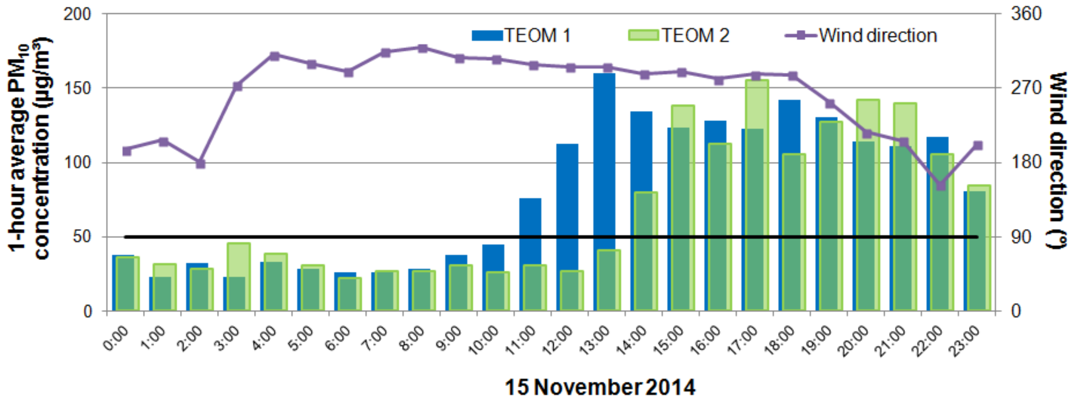

Figure 11 Measurements made at TEOM 1 and TEOM 2 during 15 November 2014

3.7.3.2 31 January 2016

The 24-hour average concentration of PM_{10} on 31 January 2016 at TEOM 1 was 62.8 µg/m³. A timeseries of measurements made at TEOM 1 on 31 January 2016 is shown in Figure 12. The figure shows that the 24-hour average concentration of PM_{10} exceeded 50 µg/m³ due, primarily, to a period of elevated measurements from 5am to 1pm and two significantly higher measurements in the evening between 7pm and 9pm. Winds during these hours were from various directions including from the west and from the south to southeast. It is possible that dust emissions from the mine, as well as other activities in the region contributed to measurements of PM_{10} on this day.

Twenty-four-hour average measurements of PM_{10} on the same day at Breeza, Werris Creek and Wil-gai were lower: 29.2 µg/m³, 41.3 µg/m³ and 39.1 µg/m³, respectively. The data from Breeza, Werris Creek and Wil-gai show a similar trend throughout the day except that TEOM 1 shows elevated levels at 7pm and 8pm.

Hourly average wind speeds were consistently light throughout the day, with no recorded hourly average above 2.6 m/s and a daily average of 1.6 m/s.

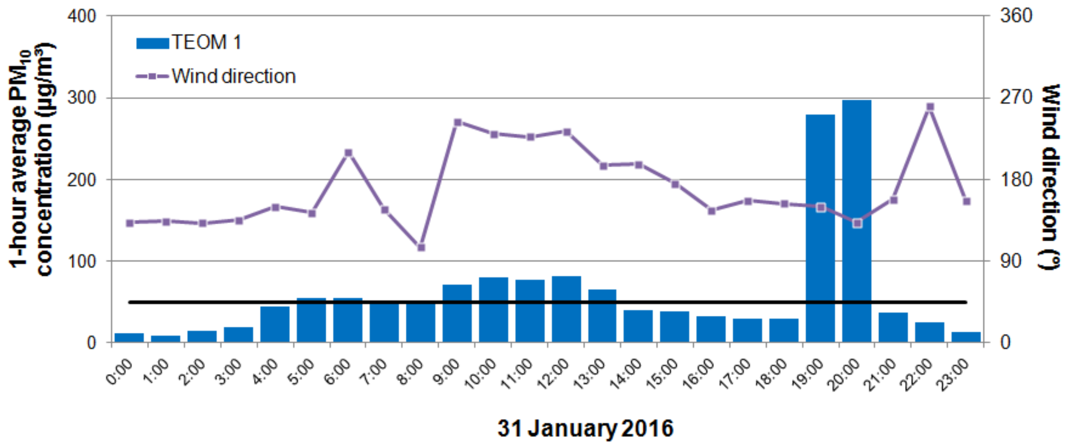

Figure 12 Measurements made at TEOM 1 during 31 January 2016

3.7.4 Trends in dust levels

Dust roses are presented in Figure 13 and Figure 14. The dust roses are generated from the 1-hour average data and present the measured PM_{10} concentration as a function of wind speed and direction, and indicate the direction from which PM_{10} levels occur. The following observations can be made from these figures:

- Strong winds generally from the west lead to higher concentrations, on average, at both monitoring sites.
- At TEOM 2, highest concentrations are associated with 2-5 m/s winds from the northwest. The cause of this is unclear but is unlikely to be coal mining activities.
- The influence of the mine is indicated to a much lesser extent at TEOM 2 (Figure 14) with somewhat higher average concentrations observed from the southeast, particularly during wind speeds between 2 and 4 m/s.
- There is no obvious influence of the mine on average concentrations at TEOM 1.

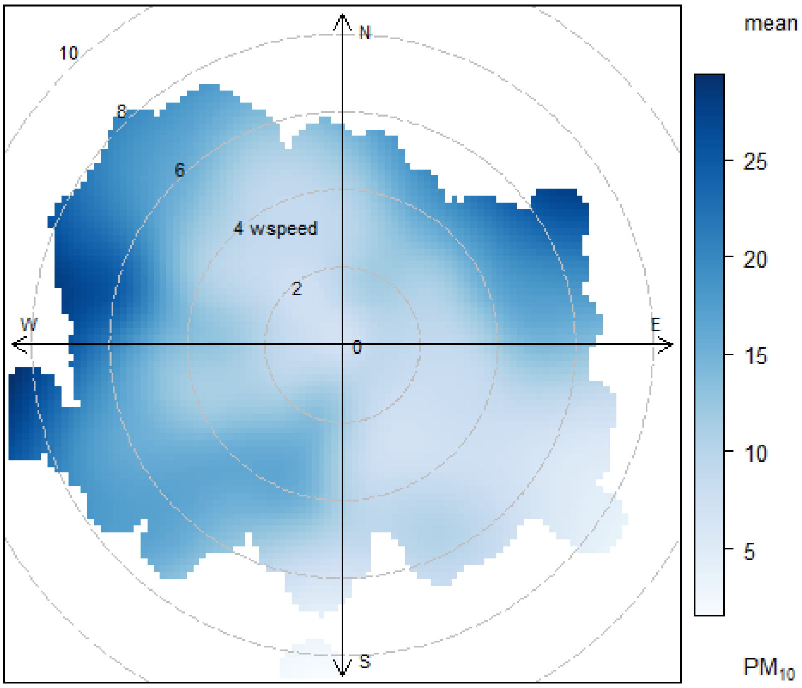

Figure 13 **Dust rose showing the relationship between average PM_{10} concentration levels at TEOM 1 and wind speed and wind direction**

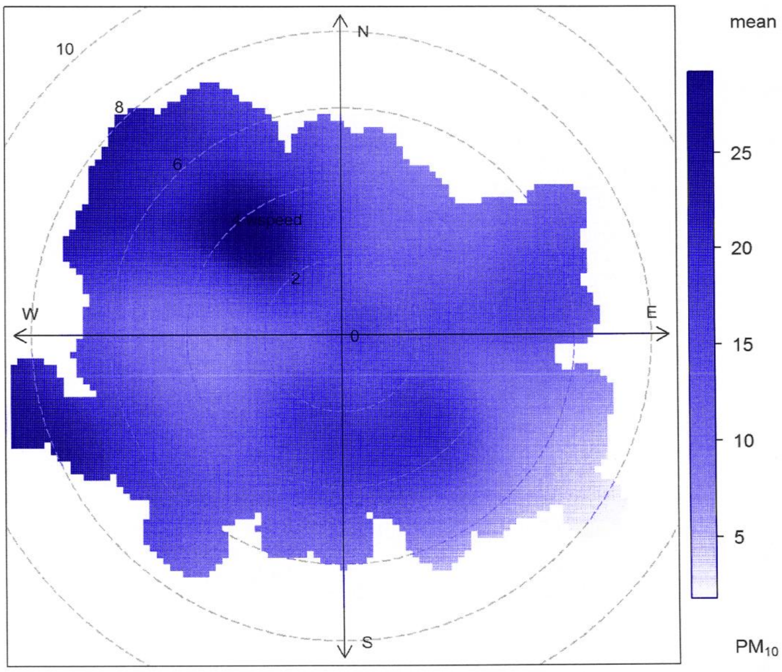

Figure 14 **Dust rose showing the relationship between average PM_{10} concentration levels at TEOM 2 and wind speed and wind direction**

3.8 Location and nearest sensitive receptors

Fairfax Public School and a number of isolated rural residences are located in the vicinity of the MCCM (Figure 15). The school is shown as receptor 68 and is 4.3km north of the Project Boundary. The nearest private residences to the mine (two receptors at 108) are approximately 2.8km west of the nearest point of the Project Boundary. A third private residence (receptor 123) is approximately 2.9km north of the nearest point of the Project Boundary. All other residences are greater than 3km from the Project Boundary and are generally situated along Maules Creek and Back Creek (including receptors 104, 106 and 111).

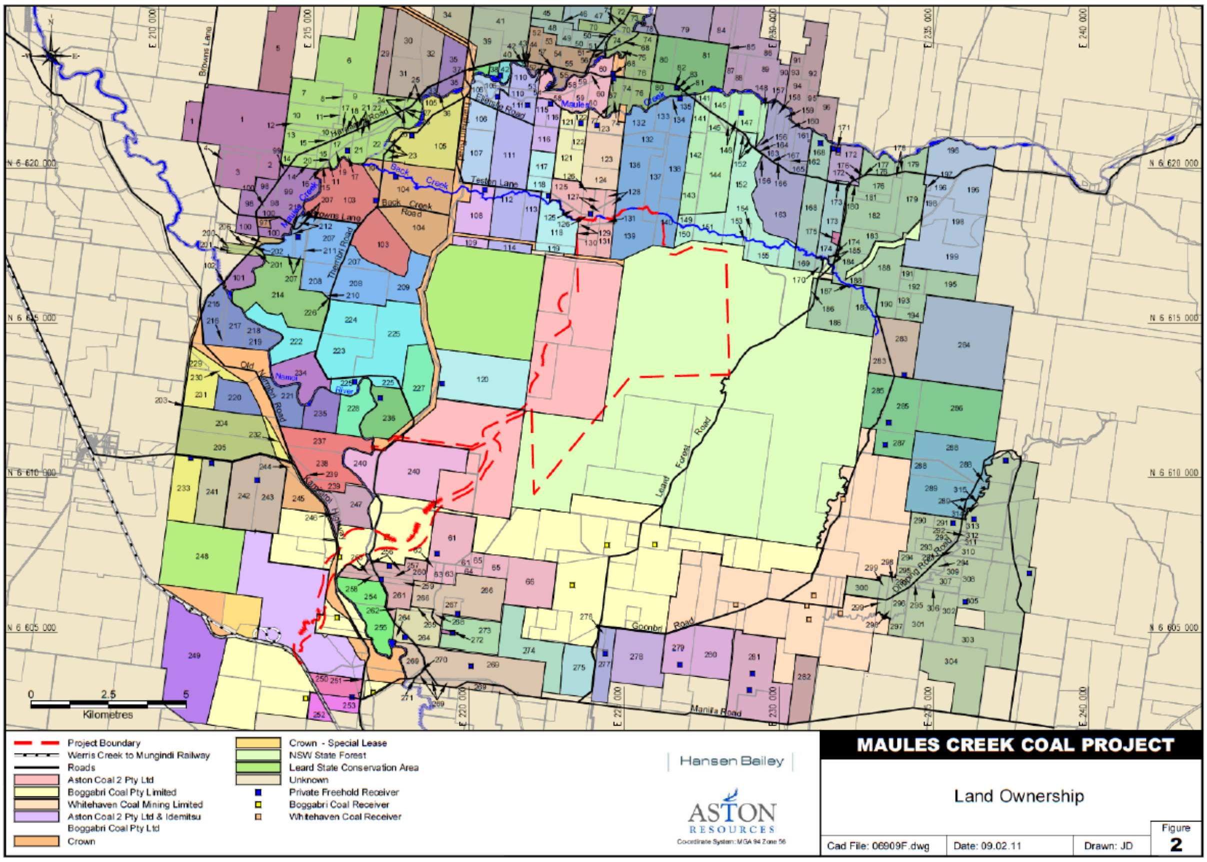

Figure 15 Land Ownership Plan (source: Project Approval 10_0138)

Figure 16 shows the land ownership contained in the MOP. This figure shows land owned or part-owned by Whitehaven as distinct from private land.

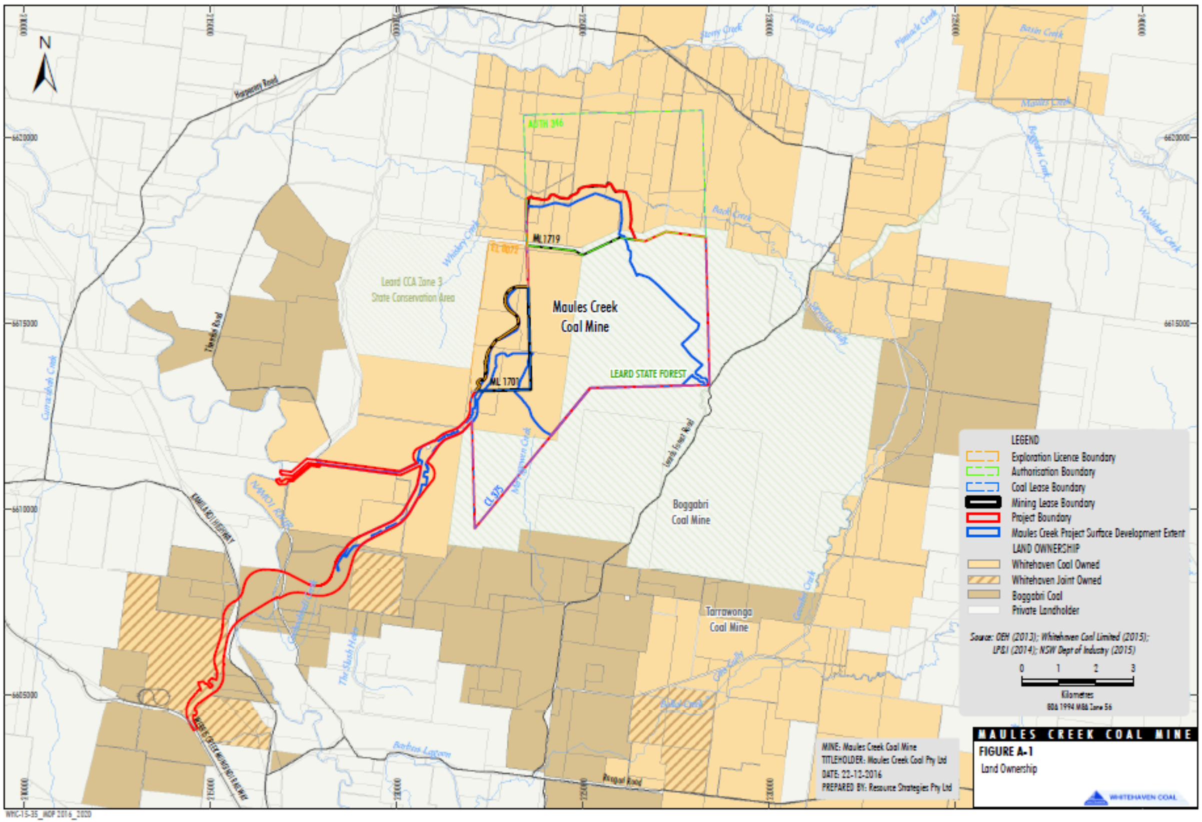

Figure 16 **Land Ownership Plan**

3.9 Local meteorology

The annual, seasonal and diurnal wind distributions measured by the on-site monitor at MCCM are presented in Figure 17, Figure 18 and Figure 19.

Predominantly, winds occur from the south-eastern quadrant, which could at times contribute to the transport of dust from the mine towards some sensitive receptors to the north and northwest. The winds from this quadrant are generally light to moderate in strength and occur throughout the year. Winds from this quadrant occur frequently through the night, when their strength is generally light. If dust is generated at times of these light winds, dispersion is likely to be relatively poor resulting in relatively higher dust levels to the northwest.

These winds are strongest during summer and lightest during winter. Winds from this quadrant occur somewhat less frequently during the day, but are stronger.

Stronger winds are most likely to occur from the north-western quadrant. These stronger winds can occur throughout the year and tend to occur during the day.

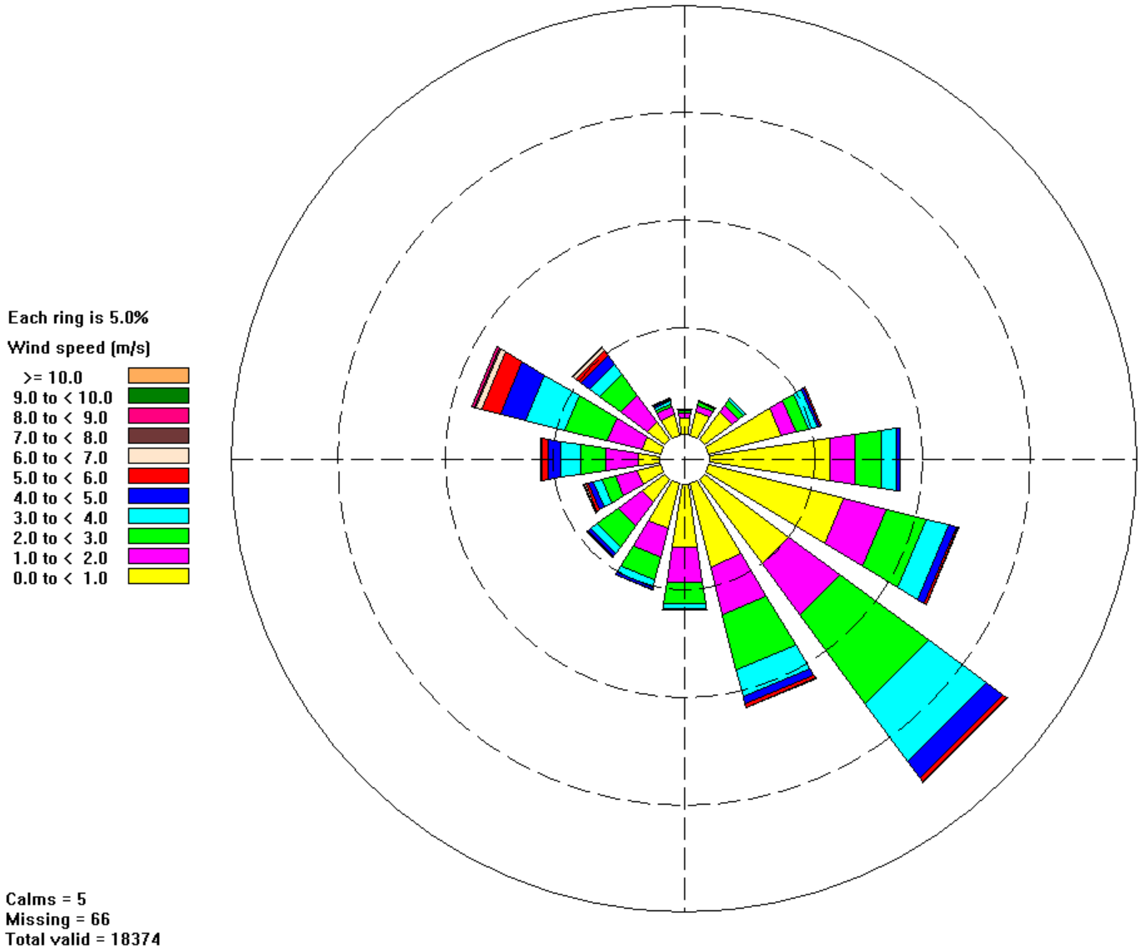

Figure 17 **Wind distribution measured by the MCCM on-site weather station (14 May 2014 to 20 June 2016)**

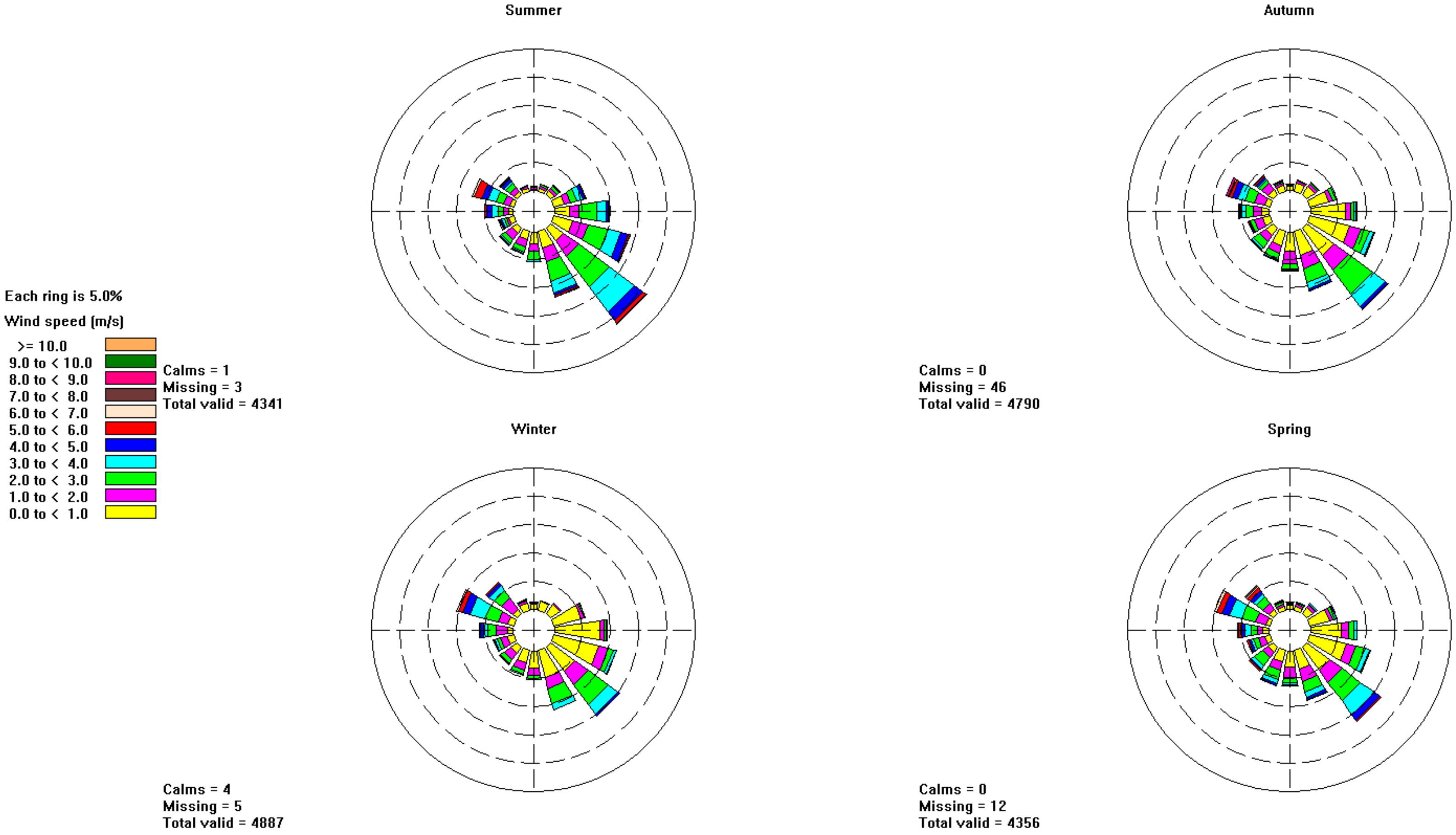

Figure 18 Seasonal wind distribution measured by the MCCM on-site weather station (14 May 2014 to 20 June 2016)

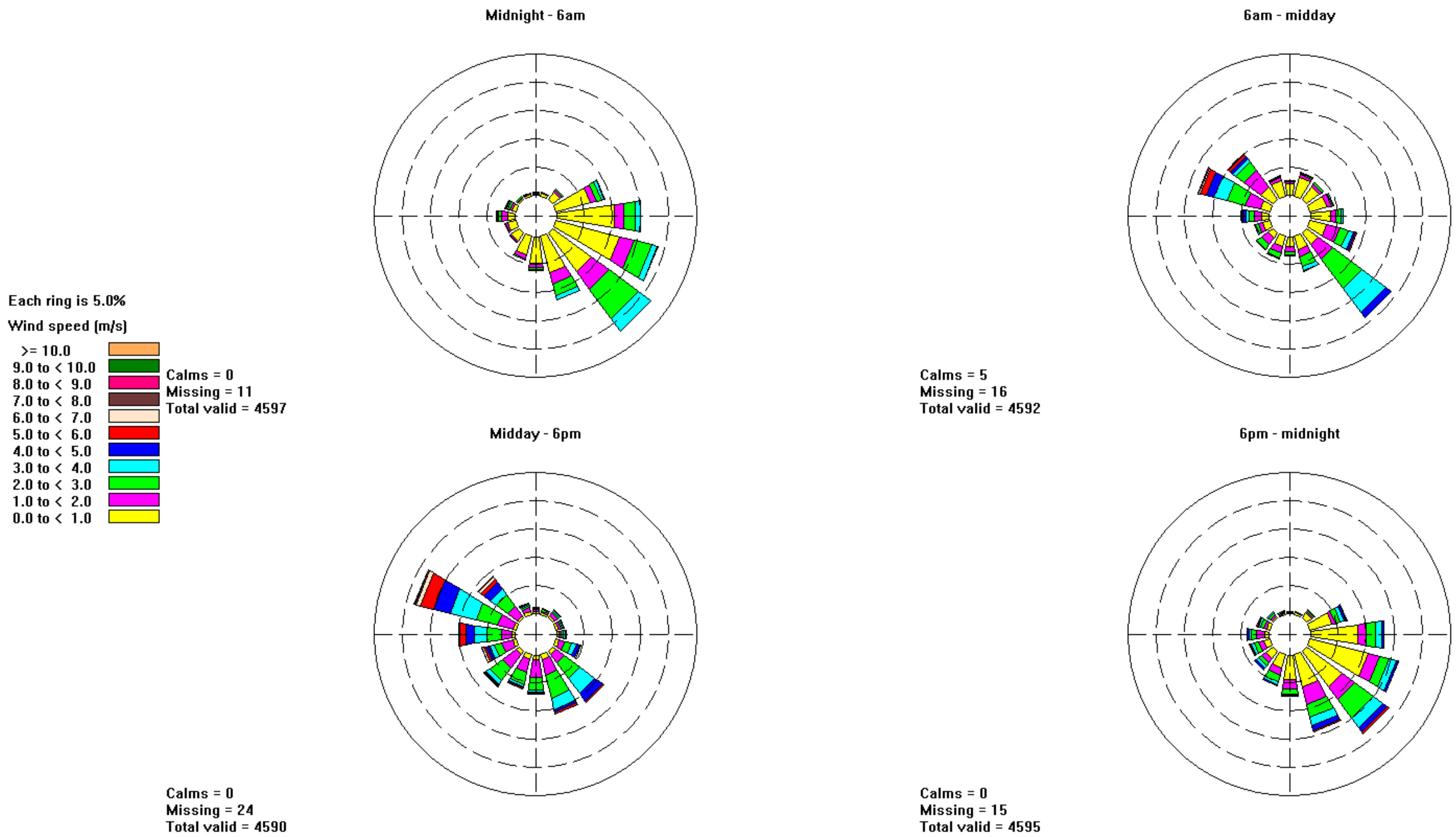

Figure 19 Diurnal wind distribution measured by the MCCM on-site weather station (14 May 2014 to 20 June 2016)

4. BEST PRACTICE

4.1 Overview

In June 2011, the Office of Environment and Heritage commissioned Katestone to prepare the report: *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011) (Benchmarking Study). The Benchmarking Study provided a comprehensive statement of techniques used internationally for the management of particulate matter emissions from coal mining activities. The Benchmarking Study considered the EPA Victoria and EU definitions of best practice, namely:

> *"...The best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity." State Environment Protection Policy (Air Quality Management)* (Victoria)
>
> *"...'best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:*
>
> *a) 'techniques' shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;*
>
> *(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;*
>
> *(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole.* (*Directive 2008/1/EC*)

The Approved Methods, at Page 29, states:

> "...*Principal toxic air pollutants must be minimised to the maximum extent achievable through the application of best-practice process design and/or emission controls. Decisions with respect to achievability will have regard to technical, logistical and financial considerations. Technical and logistical considerations include a wide range of issues that will influence the feasibility of an option: for example, whether a particular technology is compatible with an enterprise's production processes.*
>
> *Financial considerations relate to the financial viability of an option. It is not expected that reductions in emissions should be pursued 'at any cost'. Nor does it mean that the preferred option will always be the lowest cost option. However, it is important that the preferred option is cost-effective. The costs need to be affordable in the context of the relevant industry sector within which the enterprise operates. This will need to be considered on a case-by-case basis through discussions with the EPA.*"

Consequently, the literature review has focused on identifying techniques that are used in the coal mining industry that have been demonstrated to achieve a reduction in emissions of particulate matter. To achieve best practice does not require a mine to implement all possible control measures simultaneously. Best practice does not require that reductions be pursued at any cost and feasibility needs to account for technical and logistical considerations.

4.2 Documents considered

The following documents have been produced since the Benchmarking Study and are relevant to the consideration of the MCCM:

- Development of Australia-specific PM_{10} Emission Factors for Coal Mines (Pacific Environment Operations, 2015), ACARP Project C22027.
- Coal Mine Pollution Reduction Program Condition U3 Assessment, NSW Minerals Council/ACARP Project C22027 (Pacific Environment Limited, 2014) (part of the Development of Australia-Specific PM_{10} Emission Factors for Coal Mines, ACARP Project C22027).
- Generation, Measurement, and Control of Dust Emissions from Unsealed Haul Roads, Final Report - Stage One (PAEHolmes, 2012), ACARP Project C20023.
- Jay F., Colinet; James P., Rider; Jeffrey M., Listak; John A., Organiscak; Anita L., W. (2010). Best Practices for Dust Control in Coal Mining. IC 9517 Information Circular: Best Practices for Dust Control in Coal Mining (Vol. 01).
- Maules Creek Coal Mine PRP E1: Monitoring Results - Wheel Generated Dust (PEL, 2016)

Best practice dust control measures that are relevant to the activities conducted at MCCM are summarised in the following sections.

4.3 Blasting

Best practice control measures to reduce particulate matter emissions due to blasting are summarised in Table 8.

Table 8 Best practice control measures to reduce particulate matter emissions from blasting (Katestone, 2011)

Control Measure		Effectiveness
Blasting	Design: Delay shot to avoid unfavourable weather conditions	Not quantified
	Design: Minimise area blasted	Not quantified

4.4 Drilling

Best practice control measures to reduce particulate matter emissions due to drilling are summarised in Table 9.

Table 9 **Best practice control measures to reduce particulate matter emissions from drilling (Katestone, 2011)**

Control Measure		Effectiveness
Dry collection	Fabric filter Cyclone	99% 80-90%
Wet	Water injection depending on water flow rate: 0.76 L/min to 4.5 L/min	9 – 96%[2], 70%[3]

4.5 Bulldozing

Best practice control measures to reduce particulate matter emissions due to bulldozing are summarised in Table 10.

Table 10 **Best practice control measures to reduce particulate matter emissions from bulldozers (Katestone, 2011)**

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

4.6 Loading and dumping overburden

Best practice control measures to reduce particulate matter emissions due to loading and dumping overburden are summarised in Table 11.

Table 11 **Best practice control measures to reduce particulate matter emissions from loading and dumping overburden (Katestone, 2011)**

Control measure		Effectiveness
Excavator	Minimise drop height	Reduce from 3 m to 1.5 m: 30%
	Irrigating work bench with water cart mounted cannon	70% [4]
Truck dumping	Minimise drop height	Reduce from 3 m to 1.5 m: 30%
	Water application	50%
	Modify activities in windy conditions	Unquantified
Truck loading	Fogger cannon on loading plume	Unquantified 4

[2] Jay F., Colinet; James P., Rider; Jeffrey M., Listak; John A., Organiscak; Anita L., W. (2010). Best Practices for Dust Control in Coal Mining. IC 9517 Information Circular: Best Practices for Dust Control in Coal Mining (Vol. 01).

[3] Environment Australia (2001), Emission Estimation Technique Manual for Mining Version 2.3, Environment Australia, GPO Box 787, Canberra, Act 2601, Australia,

[4] Coal Mine Pollution Reduction Program Condition U3 Assessment, NSW Minerals Council/ACARP Project C22027 (Pacific Environment Limited, 2014) (part of the Development of Australia-Specific PM_{10} Emission Factors for Coal Mines, ACARP Project C22027).

Control measure		Effectiveness
and dumping	Pre-soaking blasted overburden with an agricultural sprinkler	40% 4
	Irrigating work bench with water cart mounted cannon	70% 4
	Modify activities in windy conditions	Unquantified 4

4.7 Loading and dumping ROM coal

Best practice control measures to reduce particulate matter emissions due to loading and dumping ROM coal are summarised in Table 12.

Table 12 Best practice control measures to reduce particulate matter emissions from loading and dumping ROM coal (Katestone, 2011)

Control Measure		Effectiveness
Avoidance	Bypass ROM stockpiles	50% reduction in dumping emissions for coal bypassing ROM stockpile Emissions associated with forming coal into stockpiles (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 combining control factors from
	Enclosure with control device	90-98%

4.8 Haulage

Best practice control measures to minimise dust emissions due to haulage and road maintenance (i.e. grading) are presented in Table 13.

Table 13 Best practice control measures to reduce particulate matter emissions from haul roads (Katestone, 2011)

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 (2 l/m²/hr)	50%
	Watering Level 2 (>2 l/m²/hr)	75%
	Watering (and suppressant on ROM haul)	92% [5]
	Watering grader routes	50%
	Watering twice a day for industrial unpaved road	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% 140t to 220t: 20% 140t to 360t: 45%
	Use conveyors in place of haul roads	>95%

4.9 Conveying

Best practice control measures to reduce particulate matter emissions due to conveyors are summarised in Table 14.

[5] Maules Creek Coal Mine PRP E1: Monitoring Results - Wheel Generated Dust (PEL, 2016)

Table 14 **Best practice control measures to reduce particulate matter emissions from conveyors and transfers (Katestone, 2011)**

Control Measure		Effectiveness
Conveyors	Application of water at transfers	50%
	Wind shielding - roof or side wall	40%
	Wind shielding - roof and side wall	70%
	Belt cleaning and spillage minimisation	Not quantified
Transfers	Enclosure	70%

4.10 Product coal handling

Best practice control measures to reduce particulate matter emissions due to product coal handling are summarised in Table 15.

Table 15 **Best practice control measures to reduce particulate matter emissions from stacking and reclaiming product coal (Katestone, 2011)**

Control Measure		Effectiveness
Avoidance	Buy-pass coal stockpiles	100% reduction in stacking emissions for coal bypassing stacker
Loading coal stockpiles	Variable height stack	25%
	Boom tip water sprays	50%
	Telescopic chute with water sprays	75%
Unloading coal stockpiles	Bucket-wheel, portal or bridge reclaimer with water application	50%

4.11 Train loading and rail transport

Best practice control measures to reduce particulate matter emissions due to train loading and rail transport are summarised in Table 16.

Table 16 **Best practice control measures to reduce particulate matter emissions from rail corridors (Katestone, 2011)**

Control Measure	Effectiveness
Profile load to manage overloading/underloading wagons	Not quantified
Maintain a consistent profile	Not quantified
Maintain 100mm freeboard around edge of wagon	Not quantified
Apply suppressant to surface of coal profile	Depends on individual suppressant
Remove parasitic coal from surface of coal wagons before leaving mine site	Not quantified
Cover load (e.g. tarpaulins or lid)	Not quantified

4.12 Wind erosion

4.12.1 Wind erosion of exposed areas and overburden emplacements

Best practice control measures to reduce particulate matter emissions due to wind erosion of exposed areas and overburden emplacements are summarised in Table 17.

Table 17 Best practice control measures to reduce particulate matter emissions from exposed areas and overburden emplacements (Katestone, 2011)

Control Measure		Effectiveness
Avoidance	Minimise pre-strip. EMP should specify a benchmark for optimal performance and report annually against benchmark.	100% per m^2 of pre-strip avoided
Surface stabilisation	Watering	50%
	Chemical suppressants	70% 84%
	Paving and cleaning	>95%
	Apply gravel to stabilise disturbed open areas	84%
	Inactive [6] crusted overburden (soaked or natural control)	65-85%[7]
	Aerial seeded overburden	80-90%[7]
	Rehabilitation	85-95%[7]
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	99%
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	30% 70-80%
	Vegetative ground cover	70%

4.12.2 Wind erosion of coal stockpiles

Best practice measures to control particulate matter emissions due to wind erosion of coal stockpiles are presented in Table 18. In addition, stockpile watering on a continuous cycle with modification depending on prevailing weather conditions is considered best practice (Katestone, 2011).

[6] Exposed areas have a finite availability to be eroded by the wind. Active areas are subject to continual replenishment of the erodible surface. For example, loading into a storage pile will expose fresh material that will be potentially eroded by the wind. If the erodible surface is not disturbed for a period of time, a natural crust can form that binds erodible material and reduces wind erosion.

[7] Development of Australia-specific PM_{10} Emission Factors for Coal Mines, NSW Minerals Council/ACARP Project C22027 (Pacific Environment Limited, 2015)

Table 18 **Best practice control measures to reduce particulate matter emissions from coal stockpiles**

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

4.13 Air Quality Management Tools

Best practice air quality management tools that assist in minimising dust emissions due to mining are summarised as follows:

Air Quality Management Plan

- Environmental criteria
- Mission Statement
- Particulate matter management strategy
    - Objectives and targets
    - Particulate matter risk assessment
    - Particulate matter suppression improvement plan
- Monitoring requirements, including assignment of responsibility
- Communication strategy
- System and performance review for continuous improvement

Other air quality management tools

- Meteorological monitoring
- Dust deposition gauges
- TEOMs

- HVAS
- Directional dust gauges
- Continuous, non-standard particulate measurement method
- GPS in trucks to aid dust controls
- SMS alarm system during high winds
- Ceasing or modifying activities on dry windy days considering monitoring information
- Forecasting system to assist in anticipating adverse meteorological conditions that may give rise to emissions of particulate matter and implementation of operational changes and improved mitigation to avoid adverse impacts.

5. BENCHMARKING MCCM BY ACTIVITY

5.1 Overview

This section compares the dust management activities that are adopted at MCCM with best practice as detailed above. In the assessment of compliance with best practice, the status of each element is described as:

- Implemented routine (✓)
- Implemented reactive (R)
- Partially implemented or ad hoc (P)
- Not implemented (×)
- Not determined (N)
- Not Applicable or Not Triggered (NA) – considers whether covered by other controls.

The following information has been considered:

- Maules Creek Coal Mine Report on overburden handling in adverse conditions: Actions and Results (Pacific Environment Limited, 2015)
- Maules Creek Coal Mine PRP E1: Monitoring Results - Wheel Generated Dust (Pacific Environment Limited, 2016)
- Air Quality & Greenhouse Gas Management Plan (PAEHolmes, 2014)
- Maules Creek Coal Mine Traffic Management Plan (Maules Creek Coal Pty Ltd, 2014)
- 2015 Independent Environmental Audit, Maules Creek Coal Pty Limited, The SMEC Group, 22 September 2015 (SMEC Report).
- Site inspection and conducted by Katestone from 1 June 2016 and 2 June 2016.
- Inspection of sensitive receptors conducted by Katestone on 30 and 31 May 2016 and 3 June 2016.
- Maules Creek Coal Mine response to Pollution Reduction Programs 1, 2 and 3, required by the NSW Dust Stop Program:
    - Maules Creek Coal Mine PRP E1: Monitoring Results - Wheel Generated Dust (PEL, 2016)
    - Maules Creek Coal Mine Report on Overburden Handling in Adverse Conditions: Actions and Results (PEL, 2015).

The Coal Mining Benchmarking Study[8] estimated the costs associated with the implementation of a range of best practice measures to control emissions of particulate matter from coal mines in NSW. Costs ranged from a saving of $17,240 per tonne of PM_{10} reduced for haul road dust by replacing smaller trucks with larger trucks to $309,165 per tonne of PM_{10} reduced by applying water to control emissions from grading. Where relevant, the cost per tonne of PM_{10} reduced as estimated in the Coal Mine Benchmarking Study has been used in the following sections to provide an estimate of the cost effectiveness of specific control measures. The Coal Mine

[8] Katestone, 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, June 2011.

Benchmarking Study suggested that a mitigation cost of less than $40,000 per tonne of PM_{10} reduced was reasonable.

5.2 Blasting

The application of best practice control measures to reduce particulate matter emissions from blasting at MCCM are summarised in Table 19. Management of noise and blast fume would require consideration of inversion conditions and light winds, this review has not considered the adequacy of current management measures for fume and noise management.

Table 19 Summary of application of best practice control measures to reduce particulate matter emissions from blasting at MCCM

Control measure	Application at MCCM	Comments
No blasting during adverse weather conditions	P	Blast Management Plan implemented - blasting not allowed if wind speed exceeds 8m/s.SMEC Report page 176 - observed during audit. The Blast Management Plan does not contemplate the possibility that larger blast sizes could cause elevated dust levels for winds less than 8m/s if the wind direction is towards sensitive receptors.
Blast design – minimise blast area	×	Not implemented for dust management.
Blast during day only	✓	Project Approval 10_0138 Condition 19. Blasting occurs at around 1pm, a time when dispersion is most likely to be conducive to good dispersion.
Advise local residents of blasting times	✓	Procedures include 24-hour notification via text to stakeholders / residents. Website contains details of time of next blast: https://www.whitehavencoal.com.au/community/blastnotification/maulescreek.cfm. Residents that were interviewed indicated that blast notifications were received regularly. Noted in SMEC report, condition 33.
Gravel stemming blast holes	N[1]	Blast Management Plan does not mention use of gravel stemming, but states "*…To ensure compliance with regulatory limits, and to minimise the likelihood of blast impact, all blast designs will consider:…The adequacy of stemming and suitability of material used*".
Blast protocol	✓	Blast Management Plan implemented. SMEC Report page 69. Available on MCCM Website.
Coordination with surrounding mines	✓	Project Approval 10_0138 Condition 23. Implemented as part of Blast Management Plan. Noted as compliant in SMEC Report.

Note:
[1] Whitehaven has advised that gravel stemming of blast holes is conducted.

The Blast Management Plan makes the following statements in relation to managing blasting in adverse weather conditions:

- *Meteorological conditions will be reviewed (wind speed, direction and inversion strength) to ensure the forecast model is accurate and meteorological conditions are suitable before approval to blast. Records of each pre-blast assessment will be retained.*

- *During the pre-blast assessment if a very low wind speed, less than 1.5m/s is detected, further consideration will be given to other factors, such as wind direction, inversions (cold air), unstable conditions e.g. storms and chance of fume production. If it is likely that a level 3 Fume event will be produced and could potentially leave site, in the direction of a possible receiver than blasting will be avoided…*
- *During a high wind event, 8m/s or above over successive 5 minute periods, MCC will not initiate a blast to minimise potential dust from leaving site.*

The Blast Management Plan considers dust from blasting by not allowing a blast to be initiated when winds exceed 8 m/s. The Blast Management Plan does not appear to consider the possibility that adverse dust impacts could occur for larger blast sizes if lighter winds occur in the direction of sensitive receptors. Whilst the Blast Management Plan includes modelling of each blast for vibration, overpressure and fume potential, it does not include modelling of each blast for dust potential. The Blast Management Plan does not include minimisation of blast area as a means of controlling dust emissions. It is possible that by considering a combination of dust related factors such as: blast size, blast location, wind speed, wind direction and atmospheric stability, offsite dust levels associated with blasting could be reduced.

Katestone notes that Whitehaven is in the process of implementing a predictive and real time dispersion model as part of the BTM Air Quality Management Strategy (AQMS). Katestone has not evaluated the system. However, such a predictive system may have the capability to address this issue.

Dust was observed due to one blasting event which took place during Katestone's site inspection (Figure 20). Meteorological conditions at the time of the blast were such that the dust plume travelled very slowly as it dispersed vertically. The plume travelled slowly away from the sensitive receptors that are north of the mine.

Figure 20 **Dust associated with blasting on 2 June 2016 at 1:06pm**

5.3 Drilling

The application of best practice control measures to reduce particulate matter emissions from drilling at MCCM are summarised in Table 20.

Table 20 **Summary of application of best practice control measures to reduce particulate matter emissions from drilling at MCCM**

Control measure	Application at MCCM	Comments
Drill rigs have dust curtains	✓	Implemented as part of Air Quality Management Plan (AQMP). The SMEC Report notes water injection and curtains are used, and equipment is shut down if not operating correctly.
Water sprays on the drill	✓	
Fabric filters on the drill	×	Not implemented.
No drilling in adverse weather	×	Not implemented.
Drill area moistened	R	Under the AQMP, operators can request water truck if drill bench is dusty.

Whilst the drills do not use fabric filters and drilling is not amended due to weather conditions, implementation of these controls are not likely to reduce emissions significantly, for the following reasons:

- Residual emissions associated with drilling represent less than 0.5% of emissions from MCCM.
- Existing controls provide a reasonable and appropriate minimisation of dust emissions.
- The Benchmarking Study found the cost to reduce emissions by application of fabric filter and enclosure to be relatively low at $935 per tonne of PM_{10} accounting for a relatively low level of adoption of best

practice controls in NSW at the time. The cost per tonne for MCCM is likely to be higher because MCCM currently uses water sprays and curtains to control emissions, which are reported to achieve up to 96% control. Depending on the effectiveness of MCCM's current controls, the cost to achieve a greater level of reduction would be from $3,000 to $8,000 per tonne of PM_{10} reduced.

- Overall, the marginal benefit for further reductions in dust emissions from this activity would be negligible. However, as existing drilling equipment is replaced, it would be prudent to implement new drilling equipment that use fabric filters to control emissions.

5.4 Bulldozing

The application of best practice control measures to reduce particulate matter emissions from bulldozer activity at MCCM are summarised in Table 21.

Table 21 Summary of application of best practice control measures to reduce particulate matter emissions from bulldozer activities at MCCM

Control measure	Application at MCCM	Comments
Minimise travel speed and distance	✓	Implemented in AQMP. SMEC Report page 176 - observed during audit.
Keep travel routes and materials moist	✓	Implemented in AQMP.
Avoid operations on exposed overburden areas during high dust periods	R	Implemented in AQMP - Level 3 - relocate dozers from elevated/high risk areas, cease all dozer activity on overburden. SMEC Report, page 39 - dozers moved from top dumps depending on weather conditions. The TARP includes triggers based on increasing wind speed thresholds i.e. >5m/s, >6m/s and >8m/s. However, elevated dust levels may also occur as a result of poor dispersive conditions, such as: light winds and stable atmospheric conditions.

Whilst the AQMP includes provision for amending activities when wind speed threshold triggers occur, some activities, such as bulldozing, produce dust regardless of the wind speed. Consequently, elevated dust levels may also occur as a result of poor dispersive conditions coinciding with dust production. The AQMP should be amended to broaden the consideration of meteorological conditions that may trigger a response due to elevated dust risk.

Katestone notes that Whitehaven is in the process of implementing a predictive and real time dispersion model as part of the BTM Air Quality Management Strategy (AQMS). Whitehaven has also implemented additional mobile dust monitoring equipment and will use 1-hour average measurements to trigger additional dust controls. Katestone has not evaluated the system. However, such a predictive system may address this issue.

5.5 Truck Loading/Dumping Overburden

The application of best practice control measures to reduce particulate matter emissions from truck loading and dumping of overburden at MCCM are summarised in Table 22.

Table 22 Summary of application of best practice control measures to reduce particulate matter emissions from truck loading/dumping overburden at MCCM

Control measure		Application at MCCM	Comments
Excavator	Minimise drop height	✓	Implemented in AQMP SMEC Report, page 37 (when excess dust is observed).
	Irrigating work bench with water cart mounted cannon	×	Has been used at times, but not routinely implemented. Photograph supplied by Whitehaven and as advised by Whitehaven personnel. Whitehaven has provided a detailed explanation as to why this measure is not feasible.
Truck dumping	Minimise drop height	✓	AQMP Page 41, (operator responsibility) SMEC Report, page 37 (when excess dust is observed).
	Water application	×	Not implemented. Whitehaven has provided a detailed explanation as to why this measure is not feasible.
	Modify activities in windy conditions	R	AQMP: Page 41, (manager mining responsibility) AQMP Level 3: water spraying, limit to in-pit loading and dumping AQMP page 45 - Level 3 - cease topsoil stripping, cease all activity on exposed areas TARP (May 2015) - Level 2: Plan for relocating excavation and dumping to less exposed areas. Level 3: Consider reducing/ceasing loading/dumping. Example of Dispatch log notes that EXC261 was down for a period due to dust (doesn't specify whether this was wind related or not). Example of "Daily risk response report" includes forecast weather conditions and alert level. Does not specify the actions to be taken. Also did not include actions taken over previous day, even though there was a space to record this. The SMEC Report page 38 notes that options are in place for dumping high or low, depending on the conditions. Audit condition 33 - in addition to minimising drop heights, reducing swing rates and slowing production, dumping to another bench noted when excess dust is observed.
Truck loading	Pre-soaking blasted overburden with an agricultural sprinkler	×	Not implemented. Whitehaven has provided a detailed explanation as to why this measure is not feasible.
	Irrigating work bench with water cart mounted cannon	×	Has been used at times, but not routinely implemented. Photograph supplied by Whitehaven and as advised by Whitehaven personnel. Whitehaven has provided a detailed explanation as to why this measure is not feasible.

Control measure		Application at MCCM	Comments
	Modify activities in windy conditions	R	Altering or ceasing use of equipment on overburden, and loading/dumping of overburden during adverse weather conditions. SMEC Report notes that shutdown logs were inspected that included reference to weather conditions. See above for truck dumping overburden.

Loading trucks with overburden and trucks dumping overburden was estimated in the EIS to contribute 7% to total dust emissions from the MCCM. Over the next few years, truck dumping on the OEA will move closer to residences. The adoption of additional control measures such as the application of water to minimise and control emissions from excavators and dumping trucks could theoretically reduce these emissions by 70%.

Whitehaven has provided information to support its conclusion that the various means of water application to truck loading and dumping overburden are not feasible at MCCM. The following points are cited by Whitehaven:

- *Safety considerations regarding installation of irrigation and sprinkler systems.*
- *Equipment operator visibility is compromised due to wet, dirty windows.*
- *Personnel and heavy vehicle interactions will increase the risk of safety incidents when personnel are required to move sprinklers, pipes etc.*
- *Geotechnical stability may be compromised due to the volume and locations of soaked material.*
- *Hauling wet material increases the likelihood of truck rollover as the material 'hangs up' in the body of the truck when tipping.*
- *Increased risk of vehicle collision on slippery surfaces caused by input of additional water in the working area.*

In terms of costs, the Coal Mine Benchmarking Study did not estimate costs for controlling dust emissions from truck loading and dumping. Whitehaven provided capital and operating cost estimates for its Tarrawonga Mine (operating at 3 Mtpa) of $10 – 20 million and $13 – 17 million, respectively. Applying the operating cost alone to MCCM and assuming that watering achieves a reduction in emissions from excavating overburden of 70%, the Whitehaven's estimated operating cost alone would be $165,000 to $220,000 per tonne of PM_{10} reduced.

Figure 21 illustrates a truck dumping overburden to the emplacement area that was observed during Katestone's visit to the coal mine on 1 June 2016.

Figure 21 **Truck dumping overburden on northern overburden emplacement of MCCM**

5.6 Truck loading/dumping ROM coal

The application of best practice control measures to reduce particulate matter emissions associated with ROM coal loading of trucks and dumping from trucks at MCCM are summarised in Table 23.

Table 23 Summary of application of best practice control measures to reduce particulate matter emissions from truck loading/dumping ROM coal at MCCM

Control Measure		Application at MCCM	Comments
Avoidance	Bypass ROM stockpiles	✓	AQMP page 41, page 45, Level 1 control. Whitehaven personnel suggested 30-40% bypasses. SMEC Report page 176 - observed during audit.
Truck or loader dumping coal	Minimise drop height	✓	AQMP page 41. SMEC Report page 176 - observed during audit.
	Water sprays on ROM pad	×	Not implemented.
Truck or loader dumping to ROM bin	Water sprays on ROM bin	✓	Katestone site inspection observed dumping to ROM bin. Sprays were not evident at the time. AQMP page 41. Page 71 – water sprays not used. SMEC Report page 37 - dust curtains and sprays inside hopper. Whitehaven has provided photos that show water sprays in operation.
	Three sided and roofed enclosure of ROM bin	✓	Observed during site inspection. AQMP page 71. Noted in SMEC Report at page 37.
	Three sided and roofed enclosure of ROM bin plus water sprays	✓	See above.
	Enclosure with control device	×	Not implemented.
Truck loading	Modify activities in windy conditions	R	Altering or ceasing use of equipment on overburden, and loading/dumping of overburden during adverse weather conditions. SMEC Report notes that shutdown logs were inspected that included reference to weather conditions. See above for truck dumping overburden.

Loading trucks with coal and trucks dumping coal was estimated in the EIS to contribute 16% to total dust emissions from the MCCM. In relation to truck loading, the adoption of additional control measures such as the application of water to minimise and control emissions from excavators could theoretically reduce emissions by 70%. However, as detailed above in relation to loading trucks with overburden, Whitehaven has provided information to support its conclusion that the various means of water application to truck loading using excavators are not feasible at MCCM.

In terms of costs, the Coal Mine Benchmarking Study did not estimate costs for controlling dust emissions from truck loading with coal. As detailed above, Whitehaven provided capital and operating cost estimates for its Tarrawonga Mine (3 Mtpa) of \$10 – 20 million and \$13 – 17 million, respectively. Applying the operating cost alone to MCCM and assuming that watering achieves a reduction in emissions from excavating coal of 70%, the cost would be \$240,000 to \$320,000 per tonne of PM_{10} reduced.

In its emission estimates, the EIS did not account for the controls that have been adopted at the ROM hopper. Whitehaven staff estimated that 30-40% of ROM coal bypasses the ROM pad, the remainder is dumped on the ROM pad. If the ROM hopper controls and ROM pad bypass are accounted for, emissions from this source would be 20% lower. The majority of these emissions occur as a result of trucks dumping coal on the ROM pad.

It is likely that application of water to trucks dumping coal on the ROM pad would reduce emissions by 70%. Assuming a capital cost of $1M and operating cost of 10% of the capital cost per annum, the cost of this measure was estimated to be $5,700 per tonne of PM_{10} reduced.

The MCCM ROM bin is shown in Figure 22

Figure 22 ROM bin at MCCM

Figure 23 ROM bin at MCCM with water sprays in operation

5.7 Haulage

The application of best practice control measures to reduce particulate matter emissions during haulage at MCCM are summarised in Table 24.

Table 24 Summary of application of best practice control measures to reduce particulate matter emissions from haulage at MCCM

Control Measure		Application at MCCM	Comments
Vehicle restrictions	Speed reduction from 75 km/h to 50 km/h	✓	AQMP (Page 71) - says designated routes and speed limits outlined in the Traffic Management Plan (TMP). TMP does not specify speed restrictions. It says further controls, ... such as speed restrictions... will be implemented, subject to receiving the appropriate approvals from the relevant authority. AQMP page 45 - Level 3 - truck speeds reduced, scale back or cease hauling.
	Reduction from 65 km/hr to 30 km/hr	×	Not implemented.
	Grader speed reduction from 16 km/h to 8 km/h	✓	AQMP (Page 40). SMEC Report page 176 - observed during audit.
Surface Improvements	Pave the surface	×	Not implemented.
	Low silt aggregate	×	Not implemented.
	Oil and double chip surface	×	Not implemented.
Surface treatments	Watering	✓	AQMP page 40, page 45 - Level 3 - water application rates increased. 2015 Annual Review states 712ML water was used for dust suppression. Example of dispatch log includes number of water carts manned per shift (does not specify task). GPS data recorded to monitor water truck movements. SMEC Report page 37 - operators are encouraged to radio directly to water carts, fill points appropriately positioned around haul routes. Fill point shown in Figure 24. During site inspection, Katestone was shown water storage capacity in tanks of 470,000L. System can fill a water cart in less than 4 minutes. Whitehaven has determined the control efficiency of watering to be 92% based on on-site measurements.
	Suppressants – ROM Ramp Dec to Mar	✓	SMEC Report page 37 - Dust-a-Side used from December to March on ROM Coal Ramp.

Control Measure		Application at MCCM	Comments
	Suppressants – other than ROM Ramp Dec to Mar	×	Not implemented.
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips	✓	Katestone observed large overburden and coal haul trucks during site inspection. AQMP (Page 40, 42, 71). SMEC Report page 176 - observed during audit. Whitehaven MOP, 2015.
	Use conveyors in place of haul roads	×	Not implemented.

Dust emissions associated with vehicles hauling overburden, coal and rejects were estimated in the EIS to contribute 36% of total dust emissions. Consequently, minor additional improvements in dust emissions from this activity could contribute to an important overall reduction in dust emissions. Whitehaven currently applies dust suppressant to the ROM Ramp from December to March. The remainder of the coal and overburden haul routes are subjected to suppressant using watering alone.

The Coal Mine Benchmarking Study estimated the cost of Level 2 watering to be $4,145 per tonne of PM_{10} reduced, whilst the cost of Level 2 watering plus dust suppressant to be $4,710 per tonne of PM_{10} reduced. Whitehaven has advised that in 2016, it spent $280,780 on dust suppressant for haul roads. If this amount were doubled and assuming that, as a result, the control efficiency for haul roads was increased by 10%, the cost of additional suppressant would be $425 per tonne of PM_{10} reduced.

Whitehaven proposes to conduct a trial to consider expansion of its use of dust suppressant on haul roads.

Figure 24 Water cart fill point at MCCM

5.8 Conveyors and transfers

The application of best practice control measures to reduce particulate matter emissions due to conveyors at MCCM are summarised in Table 25.

Conveyors running from the ROM hopper to the CHPP, product stockpiles and rail loading silo do not have wind shielding. However, water is applied at conveyor transfers, which will minimise dust emissions from conveyors. The EIS for MCCM did not quantify emissions from conveyors most likely because their emissions are likely to be very low compared to other sources at the mine site.

The potential additional reduction in dust emissions that could be achieved by wind shielding is likely to be negligible.

Table 25 Summary of application of best practice control measures to reduce particulate matter emissions from conveyors at MCCM

Control Measure		Application at MCCM	Comments
Conveyors	Application of water at transfers	✓	Advised during Katestone site inspection. AQMP page 41, page 45 - Level 3 additional watering rates. Page 72 - not planned. SMEC Report page 176 - observed during audit.
	Wind shielding - roof or side wall	×	Not implemented.
	Wind shielding - roof and side wall	×	Not implemented.
	Belt cleaning and spillage minimisation	✓	Observed during Katestone site inspection. AQMP page 41. SMEC Report page 176 - observed during audit.
Transfers	Enclosure	✓	Observed during Katestone site inspection. AQMP page 72.

Figure 25 **View along conveyor to ROM bin at MCCM**

5.9 Product coal handling

The application of best practice control measures to reduce particulate matter emissions due to product coal handling at MCCM are summarised in Table 26.

Table 26 **Summary of application of best practice control measures to reduce particulate matter emissions from product coal handling at MCCM**

Control Measure		Application at MCCM	Comments
Avoidance	Bypass ROM stockpiles	✓	AQMP page 41, page 45, Level 1 control. Whitehaven personnel suggested 30-40% bypasses. SMEC Report page 176 - observed during audit. Cease stockpile loading if wind speed > 8m/s.
Loading coal stockpiles	Variable height stack	✓	Observed during Katestone site inspection. AQMP page 41. SMEC Report page 176 - observed during audit.
	Boom tip water sprays	×	Not implemented.[1]
	Telescopic chute with water sprays	×	Not required with variable height stacker
Unloading coal stockpiles	Bucket-wheel, portal or bridge reclaimer with water application	✓	Portal reclaimer observed during Katestone site inspection (Figure 26).

Note:

[1] AQMP page 72 states that boom tip water sprays are not used. Whitehaven has advised that sprays are operational and used.

Dust emissions associated with stacking of coal to the product stockpiles was estimated in the EIS to contribute less than 0.1% of total dust emissions. It is likely that application of water by boom tip water sprays to product coal transferred to stockpiles would reduce emissions by less than 50%. Assuming a capital cost of $1M and operating cost of 10% of the capital cost per annum, the cost of this measure was estimated to be $380,000 per tonne of PM_{10} reduced. The product coal reclaimer is shown in Figure 26.

Figure 26 **Portal reclaimer on product stockpile at MCCM**

5.10 Wind erosion

5.10.1 Wind erosion of exposed areas

The application of best practice control measures to reduce particulate matter emissions due to wind erosion of exposed areas at MCCM are summarised in Table 27.

Table 27 Summary of application of best practice control measures to reduce particulate matter emissions from wind erosion of exposed areas at MCCM

Control Measure		Application at MCCM	Comments
Avoidance	Minimise pre-strip. EMP should specify a benchmark for optimal performance and report annually against benchmark	✓	AQMP page40. SMEC Report page 39 - Pre-strip area is minimised. SMEC Report notes that vegetation is cleared for twelve months of mining due to limited clearing window. Page 175 of the SMEC Report notes clearing has been done only to the extent necessary.
Surface stabilisation	Watering	✓	AQMP page 43, page 45 - Level 3 action - watering of active exposed area and overburden emplacements. Occurs if wind speed > 8 m/s. SMEC Report page 176 - observed during audit - watering is increased when excessive dust generation observed from material stockpiles or exposed areas. In addition to mining fleet watercarts, Whitehaven advised that additional watercarts are deployed to specific work areas, including: • 1 for mine infrastructure area • 1-2 for drill and blast crew • 2-3 for topsoil crews • 1 for vegetation clearing. Some of these watercarts were observed during the site inspection.
	Chemical suppressants	✓	SMEC Report page 39 - inactive stockpiles along road corridor have been sealed.
	Paving and cleaning	×	Not implemented.
	Apply gravel to stabilise disturbed open areas	×	Not implemented.
	Inactive crusted overburden (soaked or natural control)	×	Not implemented.
	Aerial seeded overburden	×	Not implemented.
	Rehabilitation	✓	AQMP page 45 - temporarily rehabilitate exposed material that is not being utilised for extended periods of time. SMEC Report page 176 - permanent rehabilitation in line with targets observed during audit.

	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	✓	AQMP page 45.
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	×	Not implemented.
	Vegetative ground cover	✓	AQMP page 40 - on overburden dumps, and also on topsoil stockpiles in place for longer than 3 months. SMEC Report page 176 - observed during audit

Whilst some best practice measures have not been implemented, their potential application to MCCM is limited or is otherwise addressed by some other equivalent measure. In particular, rehabilitation of finished areas and temporary rehabilitation, where appropriate, are important means of controlling dust from exposed areas. Where these cannot be applied, the routine use of water and chemical suppressants are an effective alternative.

It is noted that vegetation clearing can only occur during a specified window of the year. Whilst this could potentially result in higher dust emissions, Whitehaven mulches vegetation and spreads it over clear areas to reduce wind erosion. Dust emissions from areas cleared of vegetation and pre-stripped can also be readily controlled by the application of water or dust suppressant.

5.10.2 Wind erosion of coal stockpiles

The application of best practice control measures to reduce particulate matter emissions due to wind erosion of coal stockpiles at MCCM are summarised in Table 28.

Table 28 Summary of application of best practice control measures to reduce particulate matter emissions from wind erosion of coal stockpiles at MCCM

Control Measure		Application at MCCM	Comments
Avoidance	Bypassing stockpiles	×	Not implemented.
Surface stabilisation	Watering	P	AQMP page 40 - water sprays on product stockpiles. SMEC Report page 176 - observed during audit. Not implemented on ROM stockpiles.
	Chemical wetting agents	×	Not implemented.
	Surface crusting agent	×	Not implemented.
	Carry over wetting from load in	×	Not implemented.
Enclosure	Silo with bag house	×	Not implemented.
	Cover storage pile with a tarp during high winds	×	Not implemented.
Wind speed reduction	Vegetative wind breaks	×	Not implemented.
	Reduced pile height	×	Not implemented.
	Wind screens/wind fences	×	Not implemented.
	Pile shaping/orientation	×	Not implemented.
	Erect 3-sided enclosure around storage piles	×	Not implemented.

Wind erosion of ROM and coal stockpiles was estimated in the EIS to contribute 0.4% of total dust emissions. Consequently, significant overall reductions in emissions is unlikely to be achieved by the application of water to the ROM coal stockpiles.

Figure 27 is a photograph of the ROM pad. Figure 28 is a photograph of the product stockpiles.

Figure 27 ROM pad at MCCM

Figure 28 Product stockpiles at MCCM

5.11 Train loading and rail transport

The application of best practice control measures to reduce particulate matter emissions due to train loading and rail transport at MCCM are summarised in Table 29.

Table 29 Summary of application of best practice control measures to reduce particulate matter emissions from rail activities at MCCM

Control Measure		Application at MCCM	Comments
Train loading	Volumetric loading from overhead silo	✓	Advised by Whitehaven personnel during site inspection.
	Telescopic chute	✓	Advised by Whitehaven personnel during site inspection.
	Loading enclosed within building	✓	Observed by Katestone during site inspection.
Wagon	Profiling to manage overloading/ underloading wagons	✓	Observed by Katestone during site inspection. AQMP page 46. SMEC Report page 176 - observed during audit (limit load size to ensure coal is below sidewalls)
	Maintaining a consistent profile	✓	Observed by Katestone during site inspection. AQMP page 46. SMEC Report page 176 - observed during audit (limit load size to ensure coal is below sidewalls)
	Maintaining 100mm freeboard around edge of wagon	×	Not implemented.
	Application of suppressant to surface of coal profile	×	Not implemented.
	Remove parasitic coal from surface of coal wagons before leaving mine site	×	Not implemented.
	Covering load (e.g. tarpaulins or lid)	×	Not implemented.
	Wagon wheel wash	×	Not implemented.

Control of dust emissions from wagons will not provide a material benefit for the community living to the north of MCCM. Any benefit would be achieved for residents along the rail network. It has been demonstrated that dust emissions from coal wagons can be effectively controlled by the application of water in some instances, or chemical suppressant in others.

Katestone (2013) estimated the total cost to apply water or suppressant to coal wagons to be $0.37 per wagon and $1.44-$3.11 per wagon, respectively. MCCM trains generally consist of 82 wagons. The total cost per train would therefore be $30 for water or $255 for suppressant. At full production of 12.4 Mt of product coal, the total cost of water would be $50,000 and dust suppressant would be $422,000 per year.

5.12 Air Quality Management Tools

The application of best practice air quality management tools to assist in reducing particulate matter emissions due to mining at MCCM are summarised in Table 30. The AQMP is generally in accordance with best practice, subject to other comments made in relation to dust management at MCCM.

Katestone notes that Whitehaven is in the process of implementing a predictive and real time dispersion model as part of the BTM Air Quality Management Strategy (AQMS). Katestone has not evaluated the system because it is still being trialed and developed.

Table 30 Summary of application of best practice air quality management tools to assist in reducing particulate matter emissions from mining at MCCM

<table>
<tr><th colspan="2">Control Measure</th><th>Application at Maules Creek</th><th>Comments</th></tr>
<tr><td colspan="2">Air quality management plan</td><td></td><td></td></tr>
<tr><td colspan="2">Environmental criteria</td><td>✓</td><td>AQMP (page 32), Project Approval.
2015 Annual Review.</td></tr>
<tr><td colspan="2">Mission Statement</td><td>✓</td><td>Environmental Management Strategy (EMS) includes objectives.</td></tr>
<tr><td rowspan="3">Particulate matter management strategy</td><td>Objectives and targets</td><td>✓</td><td>AQMP (page 34).
2015 Annual Review.</td></tr>
<tr><td>Particulate matter risk assessment</td><td>✓</td><td>AQMP page 43.
TARP, revision data 11/05/2015</td></tr>
<tr><td>Particulate matter suppression improvement plan</td><td>✓</td><td>Continual improvement in dust management is included as an objective in the AQMP (page 34).</td></tr>
<tr><td colspan="2">Monitoring requirements, including assignment of responsibility</td><td>✓</td><td>AQMP (page 60).
SMEC Report - (PDF page 145) - signed calibration records for HiVols, Weather station, pumping flow meter and TEOMs.
SMEC Report - a dedicated inspector is located above the high wall to continuously monitor site operations and notify relevant staff when dust issues are identified.</td></tr>
<tr><td colspan="2">Communication strategy</td><td>✓</td><td>EMS page 18 -21 details the communication strategy including:
Internal Communication
Internal Environmental Incident Reporting
External Consultation
Community Consultative Committee
Complaints Handling and Response
Annual Environmental Management Report and SMEC Report, environmental awareness training material for inductions was sighted (and records of induction and competency are kept). Environment staff present on environmental issues regularly at pre-start meetings and at targeted environmental training for certain high environmental risk mine areas (tool box talks).</td></tr>
<tr><td colspan="2">System and performance review for continuous improvement</td><td>✓</td><td>Continual improvement in dust management is included as an objective in the AQMP (page 34).</td></tr>
</table>

Figure 29 **View from mine lookout across main pit**

6. FINDINGS

Katestone was commissioned by the NSW EPA and the DPE to complete a Dust Benchmarking Study of dust controls applied at the Maules Creek Coal Mine (MCCM). The study has the following findings:

- Wheel generated dust associated with haulage of materials is the most significant source of emissions of dust. Other key sources include wind erosion, truck loading and dumping, and dozer use. The top six sources of dust contribute 81% of total dust emissions.
- The Overburden Emplacement Area is proposed to continue to develop in the existing location and to progress further to the north up to the final extent approved under the Project Approval. This will bring mining activities to within 2.8 km of nearest residences.
- The Project Approval includes the requirement that the 'air quality monitoring program [...] adequately supports the proactive and reactive air quality management system.' The following conclusions were reached regarding this:
    - TEOM 1 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 4 km north of the mine. Receptors 67, 68, 82, 134 and those further north are likely to be adequately covered by this monitor.
    - TEOM 2 is likely to be generally representative of PM_{10} and $PM_{2.5}$ concentrations approximately 1-2 km west and northwest of the mine. Receptors 103, 104, 105 and 108 are likely to be adequately covered by this monitor, although levels at TEOM 2 will be higher than at the receptors.
    - The two monitors may not be representative of conditions in the vicinity of receptors 42, 53, 106, 111, 116, 122 and 123, particularly, as the northern emplacement area progresses northwards. An additional monitor should be considered that is representative of dust levels to the northwest.
    - Data capture for the period is relatively low, particularly at TEOM 2, and could be improved. Whilst 87.6% of 1-hour average measured at TEOM 2 met the criteria for valid data, Katestone's detailed inspection of the data suggests that capture rate of valid data may be less than 87.6%. Data from the TEOMs should be subjected to regular review and quality assurance checks, erroneous data should be checked so that any problems with the equipment may identified early and rectified to avoid data loss.
- Predominantly, winds occur from the south-eastern quadrant, which could at times contribute to the transport of dust from the mine towards some sensitive receptors to the north and northwest. The winds from this quadrant are generally light to moderate in strength and occur throughout the year. Winds from this quadrant occur frequently through the night, when their strength is generally light.
- The following findings relate to application of best practice at the MCCM:
    - Control and management of dust from blasting and drilling is generally consistent with best practice. However, Whitehaven should incorporate consideration of blast size and dust impact potential into its decision to conduct or delay blasts.
    - Control and management of dust from bulldozing is generally consistent with best practice.
    - Control and management of dust associated with loading trucks with overburden and trucks dumping overburden includes some best practice measures. However, additional controls would seem to be feasible. These activities were estimated in the EIS to contribute 7% to total dust emissions from the MCCM. The adoption of additional control measures such as the application of water to minimise and control emissions from excavators and dumping trucks could reduce emissions from this activity theoretically by 70%. However, Whitehaven has identified a number of issues that make water application unfeasible.

- Control and management of dust associated with loading trucks with coal and trucks dumping coal includes some best practice measures. However, additional controls would seem to be feasible. These activities were estimated in the EIS to contribute 16% to total dust emissions from the MCCM. The adoption of additional control measures such as the application of water to minimise and control emissions from excavators and dumping trucks could reduce emissions theoretically by 70%. However, Whitehaven has identified a number of issues that make water application in the pit unfeasible. Water application at the ROM pad to reduce emissions from dumping trucks would appear to be a viable option and should be subject to detailed consideration by Whitehaven.
  - Control and management of dust associated with haulage includes some best practice measures. However, additional controls would seem to be feasible. Dust emissions associated with vehicles hauling overburden, coal and rejects were estimated in the EIS to contribute 36% of total dust emissions. Consequently, minor additional improvements in dust emissions from this activity could contribute to an important overall reduction in dust emissions. Whitehaven currently applies dust suppressant to the ROM Ramp from December to March. The remainder of the coal and overburden haul routes are subjected to watering alone. Whitehaven should give consideration to extending the use of suppressant to all site haul routes to further minimise dust emissions. Whitehaven has indicated that it will trial further application of suppressant.
  - Control and management of dust associated with stockpiles, cleared areas, conveyors, transfers, stacking, reclaiming and train loading is generally in accordance with best practice.
  - Control of dust emissions from rail wagons is not consist with best practice. While improving this aspect of MCCM’s operations will not provide a material benefit for the community living to the north of MCCM, some benefits would be achieved for residents along the rail network. It has been demonstrated that dust emissions from coal wagons can be effectively controlled by the application of water in some instances, or chemical suppressant in others.
- More broadly, whilst the AQMP includes provision for amending activities when wind speed threshold triggers occur, some activities, such as bulldozing, produce dust regardless of the wind speed. Consequently, elevated dust levels may also occur as a result of poor dispersive conditions coinciding with dust production. The AQMP should be amended to broaden the consideration of meteorological conditions that may trigger a response due to elevated dust risk.
- Katestone notes that Whitehaven is in the process of implementing a predictive and real time dispersion model as part of the BTM Air Quality Management Strategy (AQMS). Katestone has not evaluated the system. However, such a predictive system will likely provide a basis for broadening the meteorological conditions that may trigger a response to elevated dust risk.

7. REFERENCES

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