Werris Creek Coal Mine

Coal Mine Particulate Matter Best Practice

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EXECUTIVE SUMMARY

The Werris Creek Coal No.2 Coal Mine is operated by Werris Creek Coal Pty Limited (WCC) and is located within the North West Slopes and Plains of New South Wales approximately 4 km south of the town of Werris Creek and 11 km north-northwest of Quirindi.

A Pollution Reduction Program (PRP), developed by the NSW Environmental Protection Authority (EPA) has been incorporated as a new condition under WCC's Environmental Protection Licence (EPL number 12290). The PRP requires WCC to undertake a Best Management Practice (BMP) determination to identify the best practice measures to reduce emissions of particulate matter from coal mining activities.

The Coal Mine Particulate Matter Best Practice Report outlines the results of the BMP determination, including but not limited to:

- An estimation of baseline emissions and determination of the four mining activities that currently generate the most particulate matter;
- An estimation of the reduction in emissions that could be achieved by applying the identified best practice measures;
- An assessment of the practicability of implementing each of the best practice measures; and
- A proposed timeframe for the implementation of any practical measures.

The top four TSP and PM_{10} generating mining activities during the 2010-2011 reporting year were identified as:

- Vehicle dust generation;
- Stockpile wind erosion;
- Site wind erosion; and
- Trucks dumping coal.

The top four $PM_{2.5}$ generating mining activities during the 2010-2011 reporting year were identified as:

- Vehicle dust generation;
- Stockpile wind erosion;
- Site wind erosion; and
- Combustion emissions.

Best management practices were reviewed against WCC's current control measures and the practicability of implementing additional control measures were evaluated. The following additional control measures were identified:

- Construction of a wind break;
- Tarp covering a proportion of the coal stockpiles;
- Additional watering by water carts; and
- Implementation of a real time monitoring procedure.

Annual emission reductions as a result of the implementation of the additional control measures have been estimated to be 65.3 tonnes per year in TSP, 32.7 tonnes per year in PM_{10} emission reductions, and 4.9 tonnes per year in $PM_{2.5}$ emission reductions.

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APPENDICES

1. INTRODUCTION

Advitech Pty Limited was engaged by Werris Creek Coal Pty Limited (WCC) to conduct a site-specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities at Werris Creek Coal Mine. The Werris Creek Coal No.2 Coal Mine is operated by WCC, a wholly owned subsidiary of Whitehaven Coal Mining Pty Ltd, and is located within the North West Slopes and Plains of New South Wales. WCC Mine is located within Mining Lease (ML) 1563, approximately 4 km south of the town of Werris Creek and 11 km north-northwest of Quirindi as shown in **Figure 1**.

It should be noted that this report was prepared by Advitech Pty Limited for Werris Creek Coal ("the customer") in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

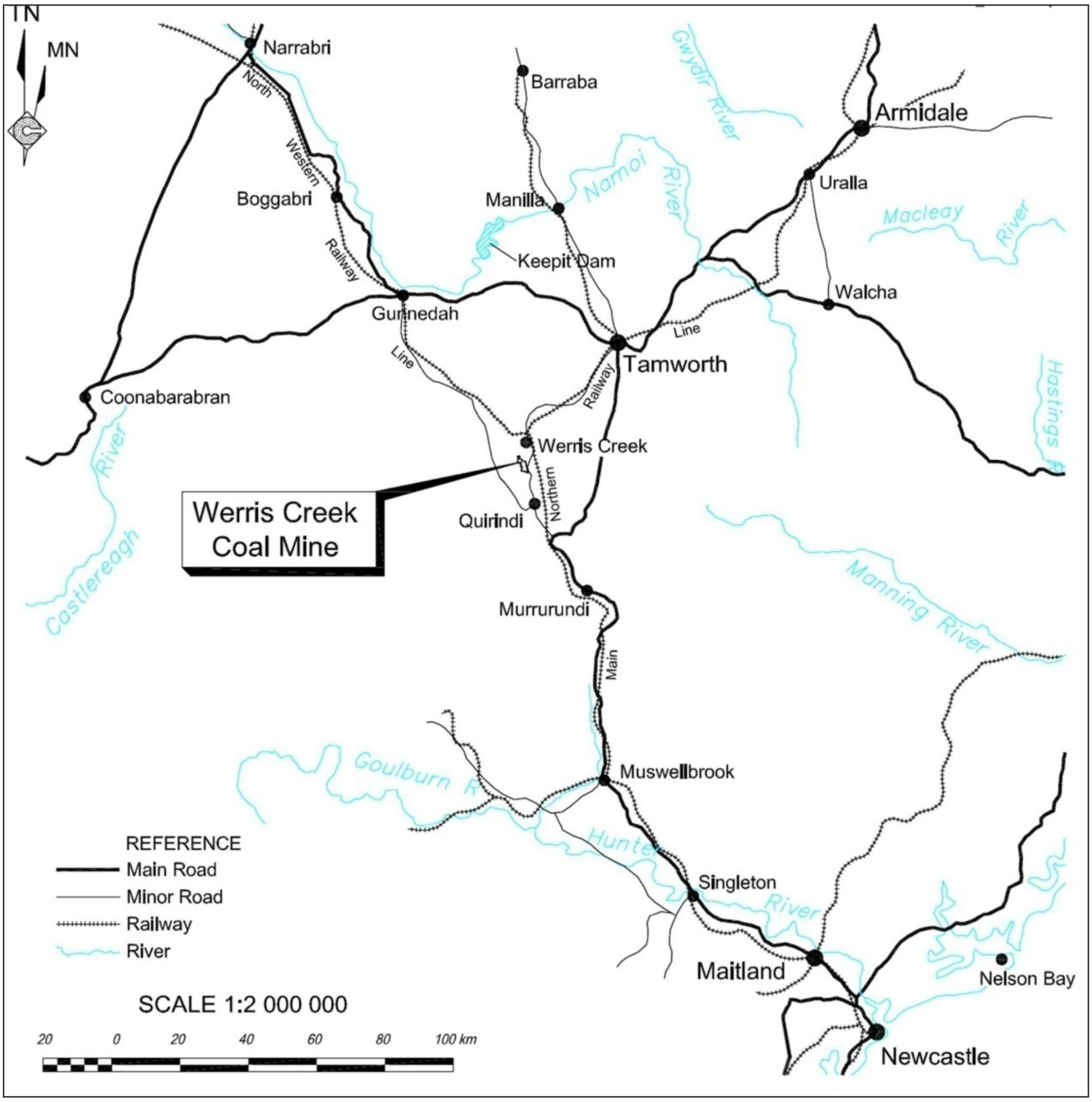

Figure 1: Regional Location (modified from Figure 1.1 R.W. Corkery & Co, 2010)

In consultation with the NSW Minerals Council, the NSW Environmental Protection Authority (EPA) has developed a Pollution Reduction Program (PRP). The PRP has been incorporated as a new condition under WCC's Environmental Protection Licence (EPL 12290). The PRP requires WCC to complete a site-specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities. A copy of the PRP has been included in **Appendix II**.

2. REQUIREMENTS

The Coal Mine Particulate Matter Best Practice Report for WCC has been prepared in accordance with the requirements established under EPL 12290. **Table** 1 summarises the requirements relating to the Coal Mine Particulate Matter Control Best Practice section of the EPL, and identifies where these requirements are addressed within this report.

Table 1: Conditions established in EPL 12290

Condition	Action	Response to Action
U1	**PRP 2: Coal Mine Particulate Matter Control Best Practice**	
U1.1	The Licensee must conduct a site specific Best Management Practice (BMP) determination to identify the most practicable means to reduce particulate emissions.	Section 8
U1.2	The Licensee must prepare a report which includes, but is not necessarily limited to the following:	
	▪ Identification, quantification and justification of existing measures that are being used to minimise particle emissions;	Section 5
	▪ Identification, quantification and justification of best practice measures that could be used to minimise particle emissions;	Section 7
	▪ Evaluation of the practicability of implementing these best practice measures; and	Section 8
	▪ A proposed timeframe for implementing all practicable best practice measures.	Section 9
	In preparing the report, the Licensee must utilise the document entitled Coal Mine Particulate Matter Control Best Practice - Site Specific Determination Guideline - November 2011.	
U1.3	All cost related information is to be included as Appendix 1 of the Report required by condition U1.2 above.	Section 8 & Appendix I
U1.4	The report required by condition U1.2 must be submitted by the Licensee to the Environmental Protection Authority, Manager Armidale Region, at PO Box 949 Armidale NSW 2350 by 29 June 2012.	To be completed by 29 June 2012
U1.5	The report required by condition U1.2 above, except for cost related information contained in Appendix 1 of the Report, must be made publicly available by the Licensee on the Licensee's website by 6 July 2012.	To be completed by 6 July 2012

3. OVERVIEW OF OPERATIONS

3.1 Process Description

WCC is an open cut mine that utilises conventional haulback mining methods. Operations at WCC are generally undertaken in accordance with the WCC Mine Operations Plan (MOP), the mining activities at WCC are presented in **Figure 2** and are detailed in the sections below. Activities are generally undertaken sequentially.

3.1.1 Vegetation removal

Pre-strip areas include the areas immediately in front of the direction of mining to enable the mine to advance into the next strip. Open cut coal mines are divided up into strips perpendicular to the direction of mining, which are then mined in sequence from the upper coal seams until the basal coal seam is extracted. That strip can then form a dump and can be progressively in-filled with overburden material from the following strip. Other areas of disturbance required for ancillary activities associated with mining are usually located adjacent to the open cut or infrastructure areas.

WCC attempts to mitigate the impacts of disturbance by adopting risk minimising practices for the pre-start inspection and actual clearing activities onsite. Disturbance areas are kept to the minimum area required and where practicable, clearing an area equivalent to one year's mine development.

Prior to vegetation clearing, the clearing area is surveyed and the boundary is clearly pegged. A pre-start clearing inspection is completed by an ecologist to identify the presence of fauna and flora species, biological resources (including habitat) and the availability of local providence seed.

If present, environmental and noxious weeds are controlled, seed collection is undertaken and habitat trees are inspected. A bulldozer is then used to rip the root zone around the base of large trees. The dozer then slowly pushed the tree to allow it to fall under its own weight, all while an ecologist is present. The toppled trees are left on the ground overnight to allow any other animals to relocate and are then reinspected before being relocated to the rehabilitation areas. Smaller vegetation is not removed until the soil stripping process is undertaken.

3.1.2 Drainage installation

Once the limit for each clearing campaign has been defined and vegetation has been removed, WCC undertake the construction of diversion drains on the upslope boundary of the area to be stripped to divert clean water into the clean water drainage system. At this time, catch drains or banks are also constructed and sediment fences are installed on the down-slope boundary of the area to be stripped. Runoff collected would then be directed to sediment basin to be treated before being discharged from Licensed Discharge Points or being used for dust suppression.

3.1.3 Soil stripping

The soil materials within the proposed areas of disturbance of WCC are assessed to determine their suitability for use as a final cover material on the post-mining landform and the need for specific stripping, stockpiling and erosion control measures. Topsoil is stripped using either a bulldozer and/or scraper with the soils stripped when sufficiently moist to minimise dust generation and not stripped when saturated to maintain soil structure.

Stripped soil is placed in soil stockpiles with management practices implemented to prevent soil degradation. Stockpiles are located away from mining, traffic areas and watercourses on level or gently sloping ground with a slightly roughened surface to minimise erosion. Topsoil and subsoil is stockpiled separately, no higher than 3 metres and seeded with a non-persistent cover crop as soon as possible after completion of stockpiling. WCC currently holds approximately 307 000m^3 of topsoil and 855 000m^3 of subsoil in stockpiles.

3.1.4 Blasting

The overburden and interburden needs to be removed to uncover the coal. The majority of overburden material needs to be blasted so that the material can be efficiently excavated, loaded, hauled to the dump and subsequently pushed and shaped using dozers. Interburden layers up to 2 metres thick are ripped with a bulldozer, interburden greater than 2 metres thick is blasted for subsequent loading and disposal. The material is then reused to create the final landform for rehabilitation post mining. Whitehaven Coal contract the blast design, explosives loading and firing activities to Orica Mining Services, while WCC manage the stemming and drilling activities.

3.1.5 Overburden and Interburden Removal

The majority of overburden and interburden is transported by haul truck to the overburden emplacement area. Where practicable, cast blasting is used to throw overburden and interburden materials in the mined-out void below to minimise the material required to be loaded and transported by haul truck. All external slopes of the overburden emplacement are shaped to slopes of 10° or less for final rehabilitation, excluding the final void.

3.1.6 Coal Recovery

Blasting is designed to develop a series of horizontal benches to intersect and expose the different coal seams within the pit. This enables the flexibility to mine different coal seams based on the required product quality and production needs. Dozers and excavators clean and prepare the surface of the uncovered coal seam, the coal seam is then ripped by the dozers to break up the coal, coal is then loaded by an excavator into haul trucks and transported to the ROM Coal Pad. Where the interburden and parting layers are greater than 0.3m thick, they are mined separately to the coal seams. Where they are less than 0.3m thick, they are mined with the coal.

3.1.7 Coal Processing

The coal is segregated at the ROM Coal Pad based on coal quality with the coal adjacent to the top and bottom of each seam stockpiled separately for use in blending to produce coal products with a higher ash specification. ROM coal is fed into a breaker for primary size reduction (to <250mm) and subsequently to a crushing and screening plant to reduce the coal to export quality size (<50mm).

3.1.8 Coal Transportation

The majority of coal produced is sold to export markets and is delivered via the Main Northern Railway Line to the Port of Newcastle. Coal is transported daily from the CPP to the Product Coal Stockpile at the Rail Loud-Out Facility using road-registered semi trailers. The Rail Load-out Facility loads coal into train wagons on the Werris Creek Rail Siding located just off the Main Northern Railway Line. The wagons are shunted from the Main Northern Railway Line onto the siding beyond the train loading bin and then loaded from the overhead bin as they move forward and return towards the Main Northern Railway. During loading periods, the bulldozer operated continuously to ensure the train loading bin is near full. In addition, domestic nut coal is loaded using a Front End Loader and dispatched from the Rail Load-out Facility in shipping containers bound for the Pacific Carbon facility at Newcastle. The remainder of the coal is transported by road to domestic customers, with approximately 90% of all road transport going to the Newcastle Pacific Carbon facility.

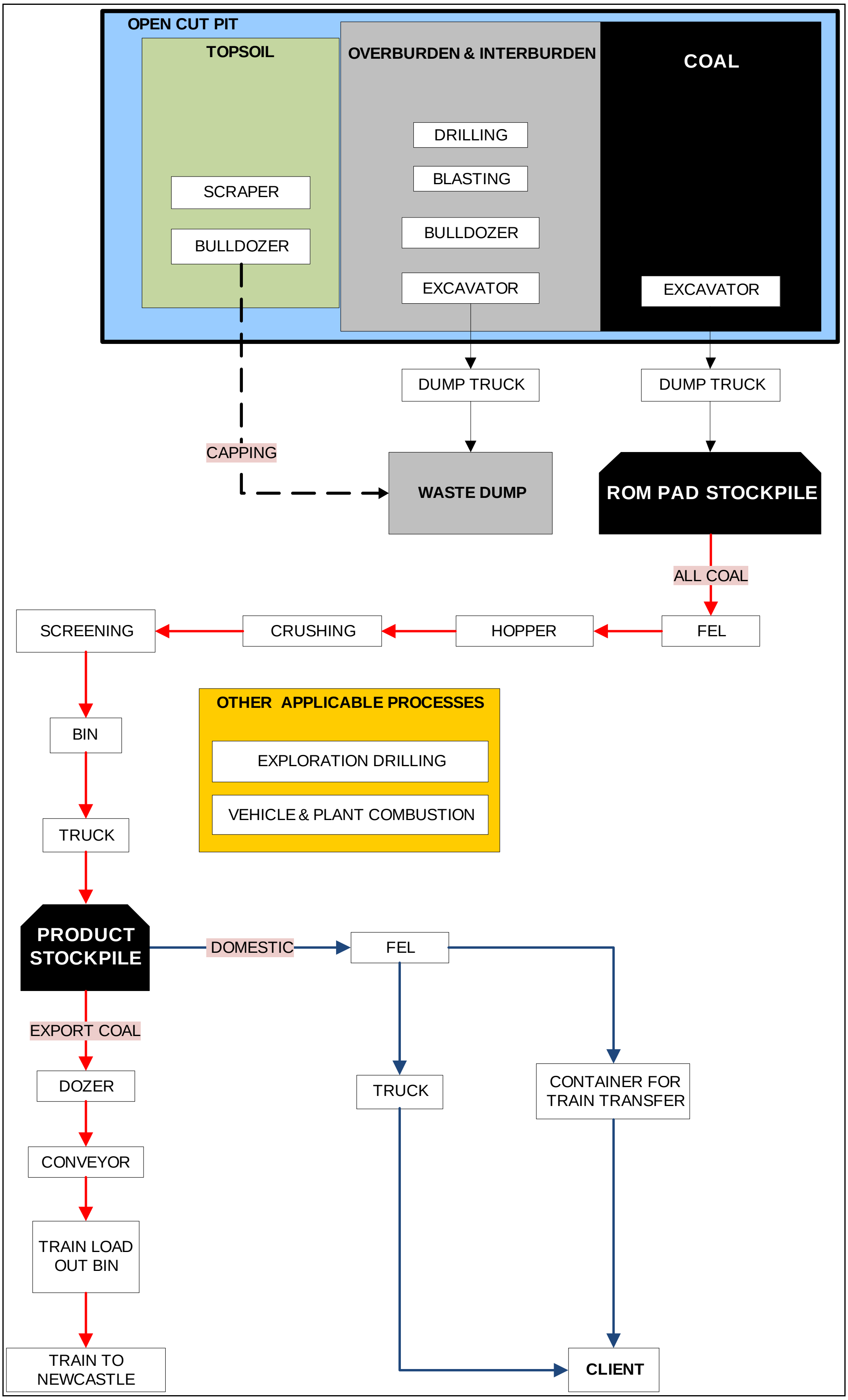

Figure 2: Mining Activities Flowchart

3.2 Potential Emission Producing Mining Activities

Air emissions from operations at WCC are emitted predominantly from the disturbance of soil, overburden and coal as well as diesel exhaust emissions. Sources of significant air emissions from the WCC operations include:

- Overburden removal, including use of scraper on topsoil and excavator;
- Coal extraction operations, including drilling and blasting, bulldozer and excavator use;
- Placement of materials within the site, including topsoil, subsoil, overburden/interburden and mined coal;
- Coal processing activities, including emissions from front-end loader, crushing, handling and transfers, conveying, product bin loading coal into trucks;
- Wind erosion from exposed surfaces, including the open cut area, soil stockpiles, overburden emplacement and coal stockpiles;
- Wheel generated dust from the general movement of heavy vehicles on unsealed roads;
- Operation of the Rail Load-out Facility; and
- Combustion engine exhaust.

3.3 WCC Air Quality Management and Monitoring

Ongoing management of air quality is undertaken in accordance with the WCC Air Quality and Greenhouse Gas Management Plan (AQGHGMP).

The AQGHGMP outlines the control measures to be implemented as a part of the continued operations at WCC to minimise the potential for air quality and greenhouse gas impacts on the local community and the environment. The air quality monitoring program in the AQGHGMP was developed to quantify the potential air quality impacts of the operation, to assess compliance against the relevant air quality criteria and to measure the effectiveness of the air quality control measures. Monitoring is undertaken in accordance with WCC's EPL 12290 and Project Approval (PA 10_0059) conditions, which specify the required methods of sampling, analysis and frequency of monitoring.

The air quality monitoring network will be made up of one High Volume Air Sampler (HVAS) measuring Total Suspended Particulates (TSP), three HVAS measuring Particulate Matter less than 10 micrometres (PM_{10}) and a network of static dust deposition gauges monitoring ambient dust deposition surrounding WCC and from rail transport in Quirindi township. In addition, WCC has committed to installing a Tapered Element Oscillating Microbalance (TEOM) during 2012 to measure continuous PM_{10} and Particulate Matter less than 2.5 micrometres ($PM_{2.5}$) concentrations, allowing the real time data to be used for operational response.

4. METHODOLOGY

The key elements of the site determination process are as follows:

- Identification of the main activity sources of particulate matter (TSP, PM_{10} and $PM_{2.5}$) and rank them in order of significance for offsite impacts;
- Identification of current operational practices and emission controls for minimising particle emissions from coal mining;

- Identification of best practice measures to prevent and/or minimise particulate emissions from the top four emitting coal mining activities;
- Estimation of the likely reduction in particulate emissions associated with adopting each best practice measure;
- Evaluation of the practicability of implementing the best practice measures at WCC; and
- Preparation of a particulate matter best management practice pollution reduction program report.

Site specific data used in the WCC National Pollutant Inventory (NPI) report for the 2010-2011 reporting year has been used as the basis of the input data for emissions calculations, current operations are considered to be consistent with operations from the 2010-2011 NPI reporting year. The emission factor equations applied in this assessment are detailed in **Appendix III**. Emissions have been calculated for each mining activity using the United States Environmental Protection Agency (USEPA) AP42 emission estimation techniques and control factors sourced from *Katestone Environmental, NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, 2011*. Where emission factors or control factors were not available from the USEPA AP42 emission estimation techniques or the Katestone Environmental report, the values supplied in NPI Emission Estimation Technique (EET) manuals have been utilised.

The NPI EET and US EPA AP42 contain emission factors for TSP and PM_{10}. Few factors are provided for $PM_{2.5}$ as little research has been undertaken to assess the fraction of PM_{10} from the wide range of sources which would emit $PM_{2.5}$. Some research has been conducted by the Midwest Research Institute (MRI) with findings published within '*Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'.* The $PM_{2.5}$ to PM_{10} ratios provided by the MRI have been used in this assessment to calculate $PM_{2.5}$ emissions, where $PM_{2.5}$ emission factors were not available. This method is consistent with what was used in the WCC Life of Mine (LOM) Air Quality Impact Assessment (AQIA).

Emissions from future operations, including the LOM Project, have not been estimated. However, mitigation measures adopted in the LOM MOP and AQGHGMP have been considered when discussing the implementation of mitigation measures further in the report.

5. EXISTING EMISSIONS AND CONTROL MEASURES

Baseline emissions of TSP, PM_{10} and $PM_{2.5}$ were calculated from each mining activity with no particulate matter controls in place, and with current particulate matter controls in place. Existing particulate matter control measures implemented at WCC are detailed in the following sections.

5.1 Disturbance Areas

In preparing pre-strip or other disturbance areas to become available for the next strip of mining, vegetation will need to be cleared and the soil stripped. Given the sparse nature of the vegetation communities at WCC, only large paddock trees are required to be cleared. This activity generates little dust. The cleared timber is stockpiled by WCC to be reused on rehabilitation areas for habitat augmentation. If there is excess timber, then the timber will be buried in pit and will not be burnt.

The ground cover and soil is left untouched until the area is required to be drilled for the next blast design pattern. Only then is the soil disturbed for the immediate area required for the drill pattern in the next strip. This process ensures that only the minimum area required for mining is disturbed at any one time, minimising the amount of land open to wind erosion and potential dust generation. Soil is only stripped when sufficiently moist to minimise dust generation. At WCC, scrapers are principally used to strip soil. Scrapers generate less dust as they move soil in one pass, as opposed to using dozers to strip soil into wind rows and then Front End Loaders and trucks to haul material to the soil stockpiles. If required, water carts are used to increase soil moisture to minimise dust generation during stripping. Topsoil and subsoil stripped will be placed into stockpiles directly by the scrapers and a cover crop will be sown as soon as practicable after completion of stockpiling.

5.2 Rehabilitation

WCC progressively rehabilitates areas disturbed by mining activities, including the overburden emplacement area.

The first stage of revegetation activities as part of WCC rehabilitation programs is to sow a cover crop. The cover crop is used to stabilise the soil surface which mitigates erosion that causes dust generation. The cover crop step is called temporary rehabilitation, which is a short term step prior to further revegetation to achieve the desired final land use. Disturbed areas that are no longer required for mining or ancillary activities in the short or longer term will be temporarily rehabilitated to mitigate wind erosion and potential dust generation. This includes topsoil and subsoil stockpiles at WCC which are regularly sown with a cover crop to maintain the temporary rehabilitation ground cover.

5.3 Dust Suppression

WCC utilises water carts as the principle daily control measure to actively control dust emissions from operations (**Figure 3**). The application of water from water carts to exposed surfaces aims to increase the moisture content of the surface material and resist forces (for example, wind and wheel movement) mechanically causing dust generation. Water carts focus on the areas subject to frequent vehicle and equipment movements which may cause dust generation and dispersion. Water carts are used to water exposed surfaces at excavator loading faces and dump sites to minimise dust generation in these high activity areas.

WCC aims to achieve a level of watering equivalent to 2 L/m^2/hr for the actively used haul roads on any given shift. WCC has three dedicated water carts for the open cut operations, one water cart for coal processing and the Rail Load-out Facility and one water cart for campaign activities, such as for the scrapers. Water cart capacity varies across the year based on maintenance requirements and seasonal conditions that can result in higher potential dust emissions.

ROM coal is generally moist when mined from the pit due to coal seams acting as aquifers within coal measure strata. However, to further mitigate dust emissions from handling coal at the Coal Processing Plant (CPP) and Rail Load-out Facility, water sprays have been set up at conveyor transfer points. Approximately 1 ML of void water is used for dust suppression at both facilities per month. Water carts are installed with water cannons allowing them to water stockpiles when required.

Figure 3: 30,000L Volvo Wobbly Water cart in operations at Werris Creek

5.4 Vehicle Operation

All operators at WCC are trained and certified as competent to operate all equipment onsite such as 785 trucks. As part of the training, operators are instructed that trucks and other mobile equipment must be driven to the conditions to minimise trafficable dust generation and utilise existing tracks onsite. Truck operators are encouraged to slow down and contact the water cart operator to water particular sections of haul roads, as well as loading and dump faces that are at risk of drying out. All personnel are trained as part of the induction process on the speed limit restrictions for vehicles and equipment at WCC.

5.5 Haul Roads

To maximise the load to be hauled, 785 trucks with fixed tailgates are utilised for coal transportation to minimise the number of truck loads required to haul the coal, and therefore reduce potential trafficable dust.

In addition to the regular watering of internal haul roads by water carts, haul roads and other frequently trafficked roads onsite are constructed so that the road condition can be adequately maintained, which in turn assists in reducing wheel generated dust emissions. A speed limit of 60 km/hr is enforced within the pit, and 80 km/hr on sealed roads; however, in practice, haul truck operators drive to the conditions and actual speeds are estimated to be closer to 50 km/hr. Graders that are operating with the blade down will work at lower speeds to minimise dust generation. Sealed roads onsite are routinely swept to remove potential dust generating debris and silt. All unsealed haul roads are routinely sheeted with local gravel found onsite to improve road surfaces.

5.6 Drilling

If possible, prior to drilling, a water cart will spray the surface of the drill site to create a surface crust and minimise dust developing on the surface. Once the holes are drilled, it is not possible for a water cart to access the site until after it has been blasted.

The drill rigs at WCC utilise a combination of curtains, vacuum extraction and water sprays to minimise dust after the hole has been started. At completion of a hole, the drill rig will spray water on the cuttings that have accumulated on the surface to prevent cuttings generating dust around the hole collar.

5.7 Blasting

As outlined in the Blast Management Plan, WCC will not fire blasts towards Werris Creek township based on 5 minute average wind direction between 182^{o} and 204^{o}. Blasting is also limited in PA 10_0059 and EPL 12290 to one blast per day (some exemptions) and blasting between 9am to 5pm Monday to Saturday (excluding public holidays). WCC aims to fire all blasts (depending on scheduling) in the middle of the day between 1pm and 2pm during crib break. Blasting in the middle of the day is favourable as circulation in the lower atmosphere has reached its maximum mixing depth, improving dispersion of any dust generated by the blast. WCC on average fires 100 blasts per year.

Cast blasting will be used where practicable to minimise the material required to be loaded and transported and reducing handling and wheel dust emissions. Cast blasting is only possible towards the base of coal measures lower in pit because of the need to uncover the basal coal seam.

5.8 Conveyors

In addition to water sprays, conveyors at the CPP and Rail Load-out Facility have been fitted with cleaning and collection devices to minimise the amount of material falling from the return conveyor belt and prevent build-up of fines, which has the potential to generate dust. Conveyors are also enclosed to reduce wind erosion when in operation.

5.9 Off-site Coal Transport

Coal is transported offsite to domestic and export markets by rail and road. The majority of coal is transported by trains (greater than 98%) at the Rail Load-out Facility. The coal is generally moist which mitigates dust generation. In addition, the rail load out bin is enclosed and each loaded train wagon sprayed with water to create surface crust to minimise dust generation. The new generation wagons are also designed to be taller and concave which reduces the coal surface area, thereby reducing wind erosion during rail transport.

All trucks that transport coal offsite are road-registered. In accordance with standard road safety practices, all trucks are not filled above gunnel level of each trailer and are tarped to cover their loads preventing spillage and dust emissions.

5.10 Equipment and Plant Maintenance

Each individual item of plant on-site is tracked within the maintenance system which identifies the required routine maintenance based on hours worked. By undertaking preventative maintenance of earthmoving equipment and trucks on-site improves operational performance; as well as ensuring that exhaust emissions are within the required standard for the relevant machines.

5.11 Coal Stockpile Dust Management

In general, the inherent moisture within ROM and Product coal mitigates coal dust emissions. However, during periods of dry conditions or high winds, the water carts are installed with canons which can be used to spray coal stockpiles.

5.12 Applied Control Efficiencies

Table 2 outlines the control efficiencies that have been applied and are based on control factors available from Katestone (2011). Where emission factors or control factors were not available from the USEPA AP42 emission estimation techniques or Katestone (2011), the values supplied in NPI EET manuals have been utilised.

Table 2: Applied Control Efficiencies

Activity	Control Efficiency (%)		
	TSP	PM_{10}	$PM_{2.5}$
Scraper and bulldozer removing topsoil - travel routes and material moist[4]	50%	50%	50%
Minimised coal truck dumping height[4]	30%	30%	30%
Combined minimised coal truck dumping height and water application[6]	65%	65%	65%
Enclosed conveyor belt on the Rail Load-out Facility[3]	95%	96%	92%
Water applied at the feed hopper, crusher and at all conveyor transfer and discharge points[1]	50%	50%	50%[2]
Water carts are used to control emissions of particulate matter from haul roads. Haul roads are watered on a consistent routine basis, equivalent to "Level 2 watering" of >2L/m²/hr, under normal weather conditions[1]	75%	75%	75%
Water carts are installed with water cannons allowing them to water overburden and coal stockpiles[4]	50%	50%	50%
Graders are limited to 8km/hr[4]	75%	75%	75%
Primary crushing is enclosed[1]	70%	70%	70%[2]
Screening is enclosed with water sprays[3]	91%	91%	96%
Water sprays at screening point - coal is sufficiently wet during subsequent handling to the bin at the CPP and by dump trucks[1]	50%	50%	50%
Conveyors at the CPP are enclosed[3]	95%	96%	92%
Disturbed areas are progressively rehabilitated once they are no longer required for mining[5]	30% - 99%	30% - 99%	30% - 99%
Water sprays on drill cuttings are used on drill rigs[1]	70%	70%	70%
Train load is enclosed and all product coal is watered during rail loading and to the surface of each wagon[1]	70%		
All activities occurring within the pit have had a pit retention factor applied[1]	50%	5%	

[1] NPI Mining EET
[2] Particulate size ratio from "transfer"
[3] USEPA AP42 Western Surface Coal Mining Table 11.19.2-1
[4] Katestone (2011)
[5] NPI Mining EET manual for Mining (2011), 30% control for primary rehabilitation, 40% control for non-proven rehabilitation, 70% for revegetation, 99% control for rehabilitation.
[6] Control efficiency from the NPI EET Manual for Mining (2011), and Katestone (2011). The method for calculating combined control efficiency was taken from NPI EET Manual for Mining (2011).

There are a number of control efficiencies that are not quantifiable, such as emission reductions due to progressive rehabilitation and modifying/ceasing operation during adverse meteorological conditions.

5.13 Ranking of Coal Mining Activities

Table 3 ranks each mining activity in order of its relative potential to produce emissions of particulate matter.

Table 3: Ranking of Coal Mining Activities

Activity	Rank of Particulate Emissions		
	TSP	PM_{10}	$PM_{2.5}$
Drilling Emissions on Overburden	12	13	12
Blasting Overburden	8	7	9
Topsoil Removal - Scraper	15	16	17
Dozer on Overburden	7	9	6
Overburden Handling - Excavator	13	11	10
Overburden Handling - Dump Truck	11	10	10
Dozer on Coal	9	8	5
Coal Extraction - Excavator	16	15	15
Coal Handling - Dump Truck	3	4	7
Coal Processing - CPP	5	5	8
Export Coal Load-out	6	14	14
Domestic Coal Load-out	14	17	15
Vehicle Dust Generation	1	1	1
Grader	10	12	13
Site Wind Erosion (Exposed Area)	4	3	4
Stockpile Wind Erosion	2	2	2
Combustion Engine (>450kW)	*	6	3
Exploration Drilling	17	18	18

* No emission estimation equation or factors available

Table 3 shows that particulate matter generated by vehicle wheel dust generates the greatest amount of TSP, PM_{10} and $PM_{2.5}$. Overburden and coal stockpile wind erosion ranked second highest for TSP, PM_{10} and $PM_{2.5}$. Site wind erosion from exposed areas ranked number four for TSP and $PM_{2.5}$ and number three for PM_{10}. Emissions from combustion engines with a power rating over 450 kW ranked number three for $PM_{2.5}$. Trucks dumping ROM coal ranked number three for TSP and number four for PM_{10}.

5.13.1 TSP

Table 4 and **Figure 4** show the proportion of total TSP emissions that are produced by various activities conducted at WCC. **Table 4** indicates that the top four activities produce 89% of the TSP emissions associated with the operations at WCC, whilst the top ten activities produce 99% of TSP emissions.

Table 4: Proportion of Total TSP Emissions Produced by Coal Mining Activities at WCC

Source Type	Rank	TSP Emissions (kg/year)	Proportion	Cumulative Proportion
Vehicle Dust Generation	1	899 182	65.57%	65.57%
Stockpile Wind Erosion	2	158 457	11.56%	77.13%
Coal Handling - Dump Truck	3	84 877	6.19%	83.32%
Site Wind Erosion - (Exposed Area)	4	81 201	5.92%	89.24%
Coal Processing - CPP	5	51 525	3.76%	93.00%
Export Coal Load-out	6	27 821	2.03%	95.03%
Dozer on Overburden	7	18 143	1.32%	96.35%
Blasting Overburden	8	15 030	1.10%	97.45%
Dozer on Coal	9	13 034	0.95%	98.40%
Grader	10	6 754	0.49%	98.89%
Overburden Handling - Dump Truck	11	5 922	0.43%	99.32%
Drilling Emissions - Overburden	12	4 292	0.31%	99.63%
Overburden Handling - Excavator	13	2 961	0.22%	99.85%
Domestic Coal Load-out	14	866	0.06%	99.91%
Topsoil Removal & Handling (Scraper)	15	756	0.06%	99.97%
Coal Extraction - Excavator	16	433	0.03%	100.00%
Exploration Drilling	17	17	0.00%	100.00%
Grand Total		**1 371 273**		**100.00%**

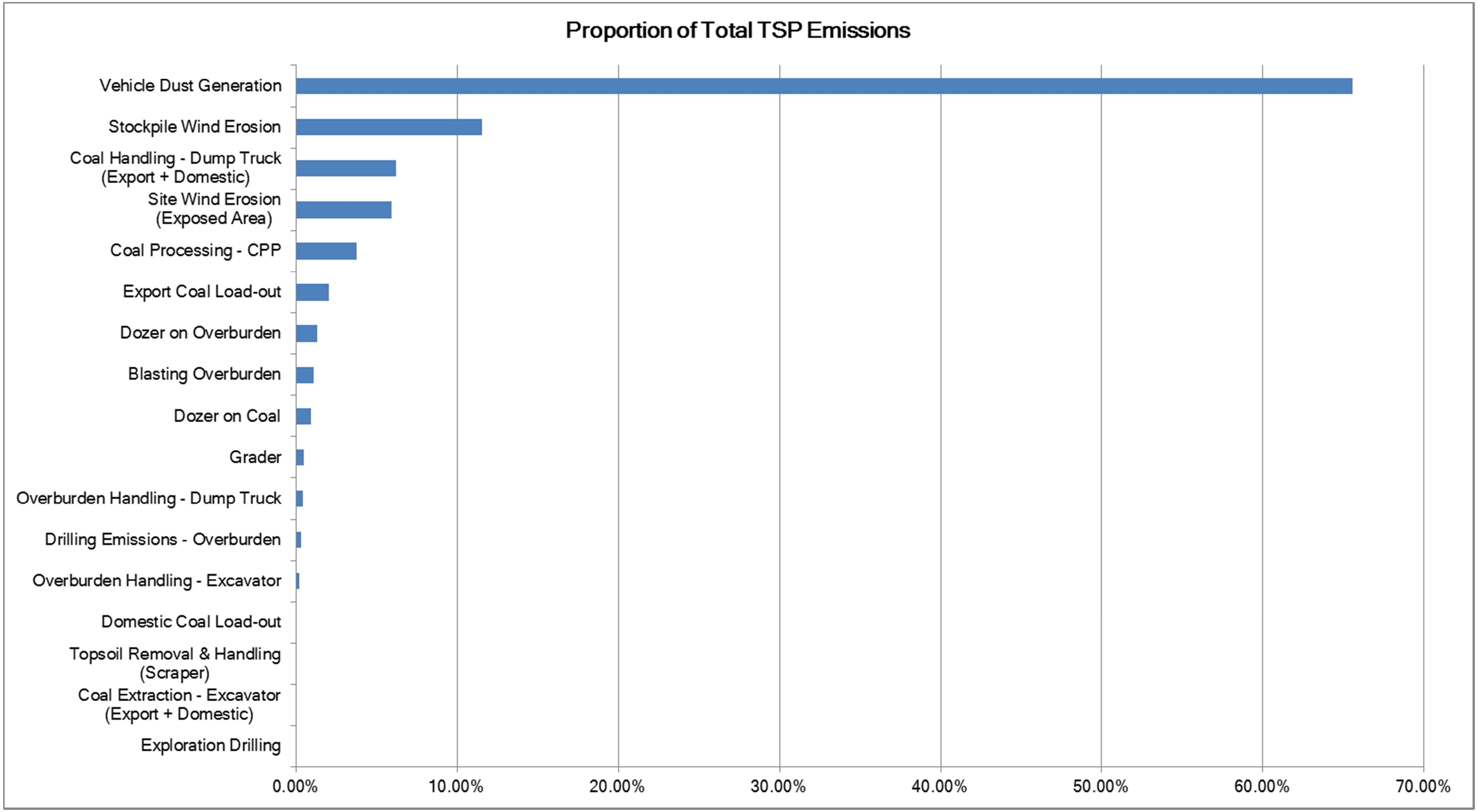

Figure 4: Proportion of Total TSP Emissions Produced by Various Coal Mining Activities at WCC

5.13.2 PM_{10}

Table 5 and **Figure 5** show the proportion of total PM_{10} emissions that are produced by various activities conducted at WCC. **Table 5** indicates that the top four activities produce 87% of the PM_{10} emissions associated with the operations at WCC, whilst the top ten activities produce 97% of PM_{10} emissions.

Table 5: Proportion of Total PM_{10} Emissions Produced by Coal Mining Activities at WCC

Source Type	Rank	PM_{10} Emissions (kg/year)	Proportion	Cumulative Proportion
Vehicle Dust Generation	1	171 410	49.45%	49.45%
Stockpile Wind Erosion	2	79 229	22.99%	72.44%
Site Wind Erosion (Exposed Area)	3	40 600	11.78%	84.22%
Coal Handling - Dump Truck	4	11 197	3.25%	87.47%
Coal Processing - CPP	5	9 230	2.68%	90.15%
Combustion Engine (> 450kW)	6	8 030	2.33%	92.48%
Blasting Overburden	7	7 816	2.27%	94.75%
Dozer on Coal	8	3 473	1.01%	95.75%
Dozer on Overburden	9	2 997	0.87%	96.62%
Overburden Handling - Dump Truck	10	2 801	0.81%	97.44%
Overburden Handling - Excavator	11	2 661	0.77%	98.21%
Grader	12	2 360	0.68%	98.89%
Drilling Emissions - Overburden	13	2 255	0.65%	99.55%
Export Coal Load-out	14	987	0.29%	99.83%
Coal Extraction - Excavator	15	389	0.11%	99.95%
Topsoil Removal & Handling (Scraper)	16	113	0.03%	99.98%
Domestic Coal Load-out	17	62	0.02%	100.00%
Exploration Drilling	18	9	0.00%	100.00%
Grand Total		**344 620**		**100.00%**

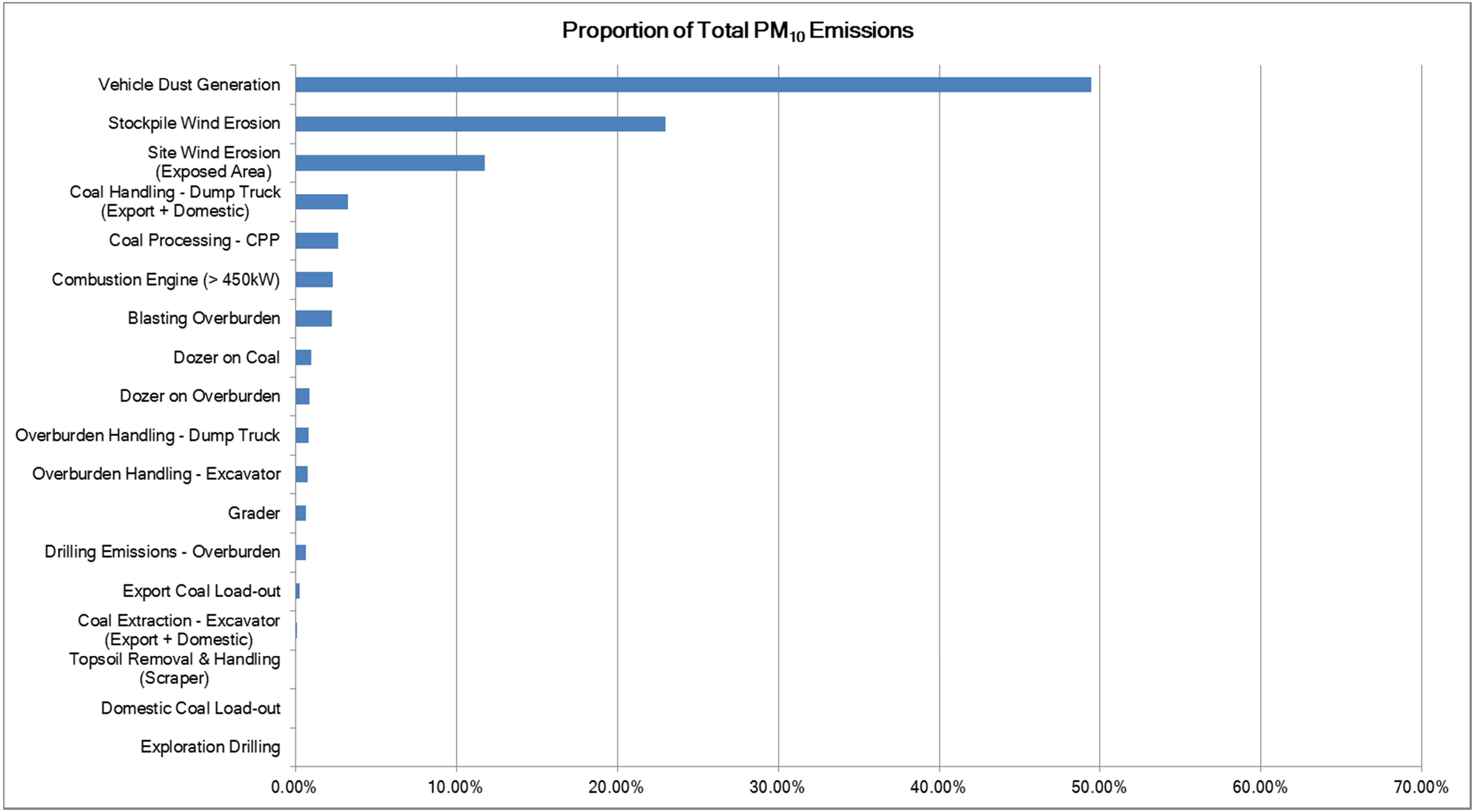

Figure 5: Proportion of Total PM_{10} Emissions Produced by Various Coal Mining Activities at WCC

5.13.3 $PM_{2.5}$

Table 6 and **Figure 6** show the proportion of total $PM_{2.5}$ emissions that are produced by various activities conducted at WCC. **Table 6** indicates that the top four activities produce 81% of the $PM_{2.5}$ emissions associated with the operations at WCC, whilst the top ten activities produce 98% of $PM_{2.5}$ emissions.

Table 6: Proportion of Total $PM_{2.5}$ Emissions Produced by Coal Mining Activities at WCC

Source Type	Rank	$PM_{2.5}$ Emissions (kg/year)	Proportion	Cumulative Proportion
Vehicle Dust Generation	1	29 588	46.26%	46.26%
Stockpile Wind Erosion	2	11 884	18.58%	64.85%
Combustion Engine (> 450kW)	3	7 422	11.61%	76.45%
Site Wind Erosion (Exposed Area)	4	6 090	9.52%	85.97%
Dozer on Coal	5	2 007	3.14%	89.11%
Dozer on Overburden	6	1 905	2.98%	92.09%
Coal Handling - Dump Truck	7	1 613	2.52%	94.61%
Coal Processing - CPP	8	1 297	2.03%	96.64%
Blasting Overburden	9	451	0.71%	97.35%
Overburden Handling - Excavator	10	424	0.66%	98.01%
Overburden Handling - Dump Truck	11	424	0.66%	98.67%
Drilling Emissions - Overburden	12	338	0.53%	99.20%
Grader	13	209	0.33%	99.53%
Export Coal Load-out	14	148	0.23%	99.76%
Coal Extraction - Excavator	15	62	0.10%	99.86%
Domestic Coal Load-out	16	62	0.10%	99.95%
Topsoil Removal & Handling (Scraper)	17	28	0.04%	100.00%
Exploration Drilling	18	1	0.00%	100.00%
Grand Total		**63 955**		**100.00%**

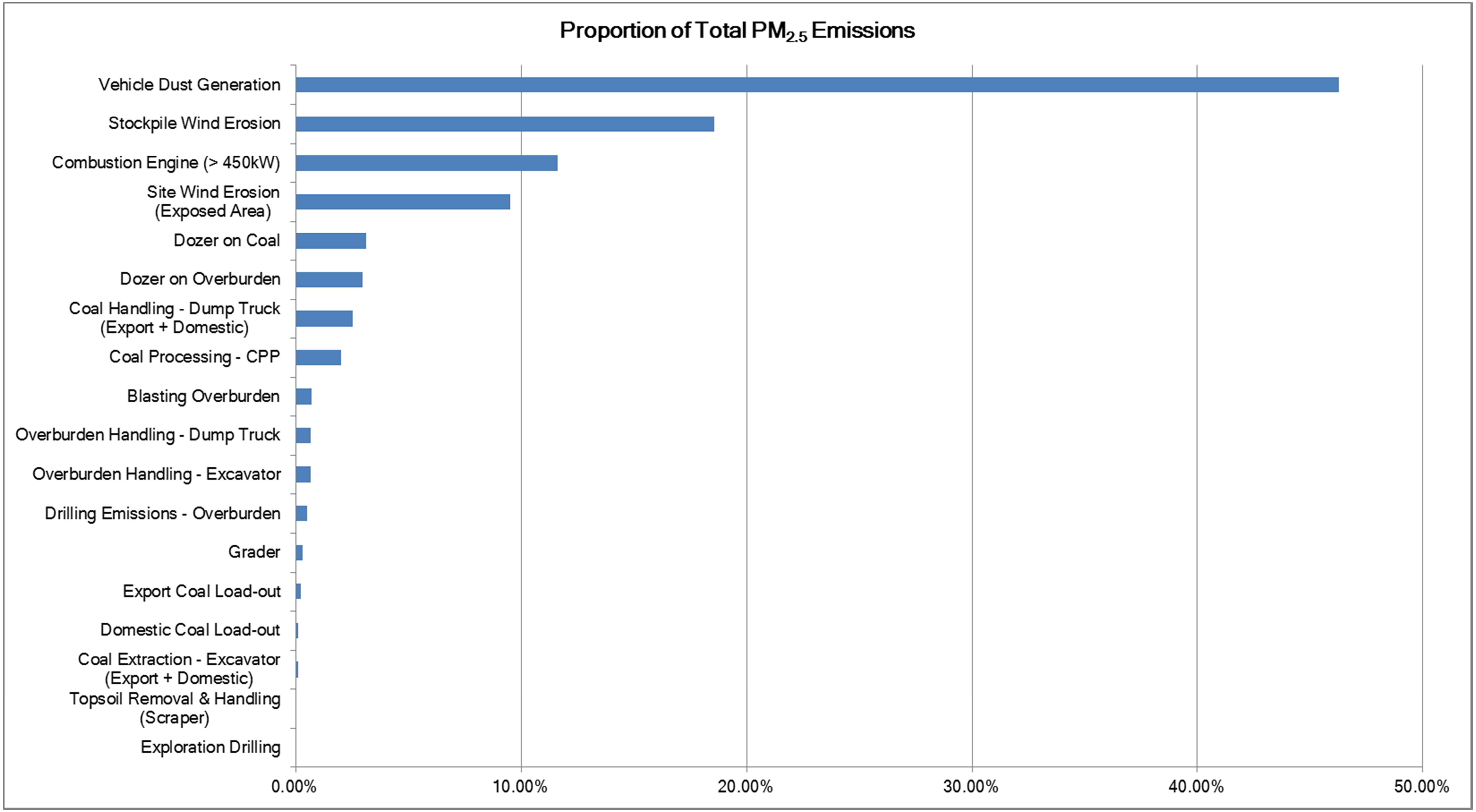

Figure 6: Proportion of Total $PM_{2.5}$ Emissions Produced by Various Coal Mining Activities at WCC

6. LIFE OF MINE EXTENSION PROJECT

In 2010, an application was made under Part 3A of the *Environmental Planning & Assessment Act 1979* (EP&A Act) to obtain approval for the LOM extension project. WCC was granted Project Approval (PA) on 25 October 2011. The project involves a northerly extension of the current mine footprint, increasing the projected mine life by approximately 15 to 20 years. The main activities associated with the LOM project include the following component activities and operations, and as shown in **Figure 7**:

- Northerly continuation of the existing approved open cut mine to mine the entire Werris Creek outlier of the Greta Coal Measures;
- Extension of the out-of-pit overburden emplacement area to the west over the current footprint of the Coal Processing Area and Site Administration and Facilities Area (out-of-pit emplacement), extend around the eastern and northeastern perimeter of the open cut as a "Acoustic and Visual Amenity Bund", and extend northwards over the completed sections of the open cut (in-pit emplacement);
- Relocation of coal processing infrastructure (Coal Processing Area) and increase ROM coal stockpile (ROM Coal Pad) capacity of 200000 t;
- Maintaining road transportation of coal to domestic markets at 50000tpa to meet the needs of local customers for low ash coal (R.W. Corkery & Co, 2011) and only to destinations in accordance with PA 10_0059;
- Production of up to 2.5 Mtpa of thermal and Pulverised Coal Injection (PCI) coal for the domestic and international markets;
- Increased storage capacity of the Product Coal Storage Area at the Rail Load-out Facility and extend the pad to the east to increase the capacity of the stockpile area to approximately 250000 t;
- Increase in the approved hours of operation to 24 hours, 7 day per week for all activities excluding blasting and road transport of coal from the WCC;
- Relocation of the administration and workshop areas (Site Administration and Facilities Area);
- Construction of a new entrance to WCC off Escott Road for direct access to the relocated coal processing infrastructure, offices and facilities. The use of Escott Road as the primary access point to the WCC would require the existing Escott Road and the intersection of Escott Road with Werris Creek Road to be upgraded;
- Construction of a second feed point to the Rail Load-out Facility to allow for product separation and reduced inter-product contamination;
- Construction of a 'turn-around' rail loop which would take off from the Werris Creek Rail Siding to the immediate west of the Rail Load-out Facility;
- Continued dewatering the underground workings of the former Werris Creek Colliery (approved under DA 172-7-2004) to enable open cut mining through all of these workings;
- Construction of a Void Water Dam for the storage of water which accumulates in the open cut; and
- Rehabilitation and new Biodiversity Offset Strategy (BOS) focusing on restoring Grassy White Box Woodland.

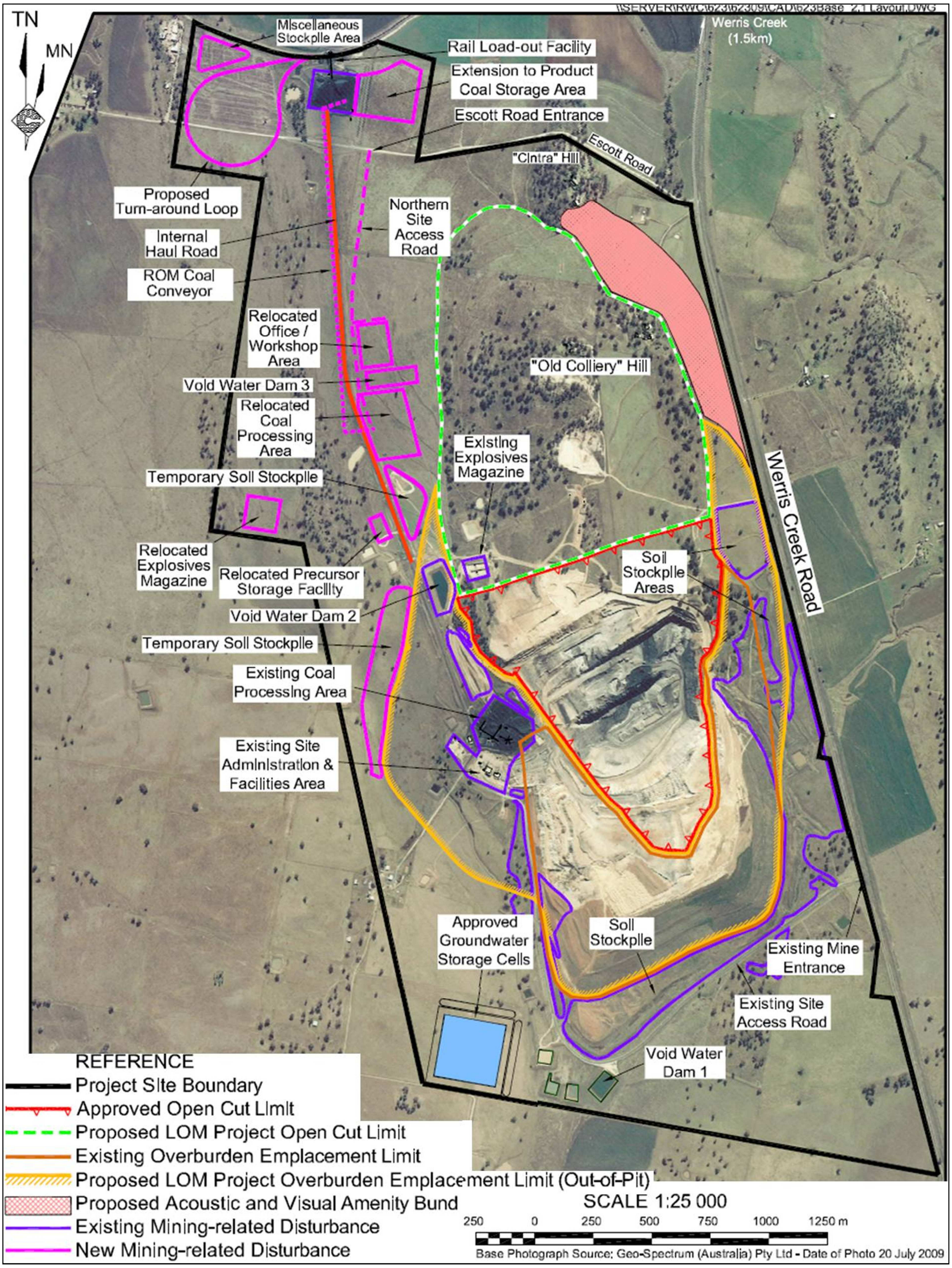

Figure 7: LOM Project Layout (modified from Figure 2.1 R.W. Corkery & Co, 2010)

6.1 Particulate Emissions from the LOM Project

Due to the change in operations, emissions from the LOM Project are expected to vary from current emissions. A detailed Environmental Assessment (EA) was prepared to support the project application, and outlines the potential impacts and control measures to appropriately manage environmental impacts. Emissions of TSP, PM_{10} and $PM_{2.5}$ for the LOM Project were calculated for the three scenarios as part of the LOM AQIA, undertaken as part of the EA.

The three scenarios were as follows:

- Year 3 – coal extraction at the southernmost point of the current open cut area.
- Year 7 – coal extraction in the mid-point of the LOM Project and construction of the Acoustic and Visual Amenity Bund will be undertaken and includes the new location of the Coal Processing Area.
- Year 15 – coal extraction activities at the northernmost point of the LOM Project area.

The calculated total emissions of TSP, PM_{10} and $PM_{2.5}$ for the LOM Project for the three scenarios are presented in **Table 7**.

Table 7: Total Particulate Emissions from the LOM Project

Pollutant	Modelled Scenario (tonnes per annum)		
	Scenario 1	Scenario 2	Scenario 3
TSP	1 538	1 445	1 553
PM_{10}	426	500	592
$PM_{2.5}$	63	74	85

7. BEST MANAGEMENT PRACTICE MEASURES FOR TOP SOURCES

The concept of best practice, as described in the Katestone benchmark study (2011), attempts to incorporate various technical, logistical, economic, environmental and managerial considerations of the methods of production into a balanced and optimal outcome for all stakeholders.

As part of the Katestone benchmark study (2011), research was undertaken into international techniques for controlling particulate emissions from coal mining, with the aim of identifying techniques that are used in the coal mining industry that have been demonstrated to achieve a reduction in emissions of particulate matter.

7.1 Potential Control Measures

This section outlines the possible control measures, primarily sourced from Katestone (2011) that could be implemented in order to reduce emissions from the top four emission source mining activities at WCC, as identified in **Section 5.13**.

7.1.1 Vehicle Dust

Of all sources of particulate matter for coal mining activities at WCC, wheel generated dust emissions, primarily from haulage trucks travelling on unsealed haul roads, has been ranked number one in terms of emissions of TSP PM_{10} and $PM_{2.5}$.

The amount of wheel generated particulate matter from an unpaved road is affected by the erodibility of the wearing course and the erosivity of the actions to which the wearing course is subjected. These two factors can be influenced by road design and road maintenance and management.

As determined by Katestone (2011), best practice haul road design, maintenance and management should include:

- Haul Road Design:
  - Reduce VKT by minimising the distance travelled by taking the most direct route to the destination and minimising trips by using larger trucks.
  - Minimise steepness of ramps to less than 8%, eliminate sweeping intersections and avoid potential for equipment interactions.
  - Reduce haul road deterioration by optimising surface drainage, particularly at intersections.
  - Optimise base materials to reduce silt content and increase the retention of larger aggregates, particularly at intersections.
  - Restrict vehicle speeds on roads to 40km/hr or less.
- Haul Road Maintenance:
  - Scheduled grading and gravelling of heavy traffic areas.
  - Watering, application of chemical suppressants or paving of light traffic areas.
  - Regular resurfacing of high traffic areas to reduce silt build up.
  - Regular maintenance of draining design features.
- Haul Road Management:
  - Diligent monitoring and application of controls as surface dries out to avoid excessive emissions. Real-time triggers should be used to identify problem areas for targeted application of controls.
  - Regular watering of haul roads, and when notified by haul truck operators.
  - Do not allow haul roads to become saturated as this will increase emissions once it dries out.
  - Regular grading and maintenance of intersections.

7.1.2 Wind Erosion

Wind erosion of exposed areas and stockpiles can cause significant particulate matter emissions. Due to the nature of coal mining activities, large areas of erodible material may need to be exposed for extended lengths of time. Of all sources of particulate matter for coal mining activities at WCC, wind erosion from overburden and coal stockpiles ranked in the top four emission generating activities for TSP, PM_{10} and $PM_{2.5}$, and wind erosion from exposed areas ranked in the top four emission generating activities for TSP and PM_{10}. Wind erosion from material stockpiles has been estimated to contribute 11.6% of TSP, 23.0% of PM_{10} and 18.6% of $PM_{2.5}$. Additionally, wind erosion from exposed areas has been estimated to contribute 5.9% of TSP and 11.8% of PM_{10}.

As determined by Katestone (2011), best practice measures to control emissions of particulate matter from exposed areas should include:

- Exposed Areas:
  - Minimising pre-strip to a maximum of one block ahead.
  - Maximise rehabilitation works, through the use of vegetation and land-contouring to produce the final post-mining landform.
  - Reduce ambient wind speeds by constructing fencing, bunding or shelterbelts.
  - If exposed areas is a potential source of particulate matter emissions and is likely to be exposed for more than three months, revegetation should take place.
  - Strategic use of watering, suppressants and hydraulic mulch seeding to minimise emissions of particulate matter depending on circumstances.
  - Pave areas where practical, such as around offices, car parks, maintenance and storage areas.
- Coal Stockpiles:
  - Reduce ambient wind speeds by constructing fencing, bunding or shelterbelts.
  - Stockpile watering on continuous cycle with modification of cycle depending on prevailing weather conditions to allow greater or lesser watering intensity.
  - Chemical suppressants to bind loose fine surface material in response to adverse weather conditions.
  - Minimise residence time of coal in stockpiles.
  - Spillage clean-up.
  - Surface covering.
  - Bypassing stockpiles to load directly into ROM bin or onto train.

7.1.3 Vehicle Combustion

Diesel engines during combustion produce soot or particulate matter. Of all sources of $PM_{2.5}$ for coal mining activities at WCC, emissions from combustion engines with a power rating over 450 kW ranked number three in $PM_{2.5}$ emission generating activities.

A reduction in particulate emissions from combustion engines could either be achieved by replacing older existing vehicles with newer vehicles with cleaner engines or retrofit vehicles with emission control devices. The NPI EET manual for Combustion Engines, provides a summary determining if the various available diesel emission reduction technologies increase or decrease particulate matter emissions. Due to insufficient data, the NPI EET does not quantify the control measures. Possible PM_{10} reduction measures from the NPI EET manual are reproduced in **Table 8**.

Table 8: Diesel Engine Emission Control Technologies

Technology	Increase	Decrease
Fuel Modifications		
Sulfur content increase	✓	
Aromatic content increase	✓	
Cetane number		✓
10% and 90% boiling point		✓
Fuel additives		✓
Engine Modifications		
Injection timing retard	✓	
Fuel injection pressure	✓	
Injection rate control		✓
Rapid spill nozzles		✓
Electronic timing and metering		✓
Injection nozzle geometry		✓
Combustion chamber modifications		✓
Turbocharging	✓	
Exhaust recirculation	✓	
Oil consumption control		✓
Exhaust After - Treatment		
Particulate traps		✓
Oxidation catalysts		✓

A Diesel Particulate Filter (DPF) is a device designed to remove diesel particulate matter from the exhaust of diesel engines. Caterpillar offers a DPF verified by the US Environmental Protection Agency and the California Air Resources Board (CARB). The high-efficiency ceramic filter is CARB-verified as a Level 3+ particulate matter reduction technology and can reduce particulate matter emissions by more than 85%. Caterpillar advertises their product as being able to be used on a wide range of Cat and Non-Cat Machines.

7.1.4 Coal Handling

Trucks dumping ROM coal was ranked number three in TSP and number four in PM_{10} emission producing activities. The ROM pad is used to store coal as required prior to being processed at the CPP. Emissions from trucks dumping coal at the CPP are effected by the moisture level of the coal. The coal being dumped at the ROM pad has not had water application and therefore produces more particulate matter emissions.

As stated in Katestone (2011), where particulate emissions from coal dumped into the ROM hopper can be effectively controlled, there are no controls identified in the reviewed literature for reducing emissions from trucks dumping coal onto the ROM pad. Best practice measures to control emissions of particulate matter from the dumping of ROM coal could include:

- Coal could bypass the ROM stockpile which would result in a reduction in emissions of particulate matter associated with the dumping of coal, stockpile formation and transfer by Front End Loader into the ROM hopper.
- If coal was to bypass the ROM stockpile, emissions from the ROM hopper could be controlled by enclosure and application of water.
- Water may be applied at the ROM pad to minimise dumping emissions.
- Minimise truck drop height.

7.2 Particulate Emission Reductions

A summary of the emissions reductions that would be achieved by implementing each best practice measure individually is provided in **Table 9**.

Table 9: Possible Emission Reductions

Control Measure		Effectiveness	Reference
Wheel Generated Dust			
Vehicle Restrictions	Reduction on sealed roads from 75 km/hr to 50 km/hr	40-75%	Katestone (2011)
	Reduction on haul roads from 65 km/hr to 30 km/hr	50-80%	Katestone (2011)
Surface Improvements	Pave the surface	> 90%	Katestone (2011)
	Low silt aggregate	30%	Katestone (2011)
	Oil and double chip surface	80%	Katestone (2011)
Surface Treatments	Suppressants	84%	Katestone (2011)
	Hygroscopic salts	45% over 14 days	Katestone (2011)
	Lignosulphonates	66-70% over 23 days	Katestone (2011)
	Polymer emulsions	70% over 58 days	Katestone (2011)
	Tar and bitumen emulsions	70% over 20 days	Katestone (2011)
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips	20% (140t to 220t)	Katestone (2011)
		45% (140t to 360t)	Katestone (2011)
	Use conveyors in place of haul roads	> 95%	Katestone (2011)

Control Measure		Effectiveness	Reference
Exposed Areas			
Avoidance	Minimise pre-stip. EMP should specify a benchmark for optimal performance and report annually against benchmark	100% per m^2 of pre-strip avoided	Katestone (2011)
Surface Stabilisation	Chemical suppressants	70-84%	Katestone (2011)
	Apply gravel to stabilise disturbed open areas	84%	Katestone (2011)
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal	99%	Katestone (2011) Katestone (2011)
	Hydromulch seeding	99%	
Wind Speed Reduction	Fencing, bunding, shelterbelts or in-pit dump	30%, 70-80%[1]	Katestone (2011)
	Vegetative ground cover	70%	Katestone (2011)
Rehabilitation	Fully rehabilitated (release) vegetation	100%	NPI EET Mining v3.0 (2011)
	Rehabilitation	99%	Katestone (2011)
	Revegetation	90%	NPI EET Mining v3.0 (2011)
	Secondary Rehabilitation	60%	NPI EET Mining v3.0 (2011)
	Established but not self-sustaining vegetation	40%	NPI EET Mining v3.0 (2011)
	Primary Rehabilitation	30%	NPI EET Mining v3.0 (2011)
Stockpiles			
Avoidance	Bypass stockpiles	100%	Katestone (2011)
Surface Stabilisation	Chemical wetting agents	80-90%, 85%, 90%[1]	Katestone (2011)
	Surface crusting agent	95%	Katestone (2011)
	Carry over wetting from load in	80%	Katestone (2011)
Enclosure	Cover storage pile with a tarp during high winds	99%	Katestone (2011)
Wind Speed Reduction	Vegetative wind breaks	30%	Katestone (2011)
	Reduced pile height	30%	Katestone (2011)
	Wind screens/wind fences	100%, 95-99%, 99%[1]	Katestone (2011)
	Pile shaping/orientation	< 60%	Katestone (2011)
	Erect 3-sided enclosure around storage piles	75%	Katestone (2011)

Control Measure		Effectiveness	Reference
Loading & Dumping ROM Coal			
Avoidance	Bypass ROM stockpiles	50% in dumping emissions 100% in dozer emissions	Katestone (2011)
Truck or Loader Dumping Coal	Minimise drop height from 10m to 5m	30%	Katestone (2011)
	Water sprays on ROM pad	50%	Katestone (2011)
Truck or Loader Dumping to ROM Bin	Water sprays on ROM bin or sprays on ROM pad	50%	Katestone (2011)
	Three sided and roofed enclosure of ROM bin	70%	Katestone (2011)
	Combined three sided and roofed enclosure of ROM bin plus water sprays	85%	Katestone (2011)
	Enclosure with control device	94%[9]	Katestone (2011)
Combustion Emissions			
Fuel Modifications	Cetane Number	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	10% and 90% boiling point	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Fuel additives	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Injection rate control	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Rapid spill nozzles	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Electronic timing and metering	Not quantified	NPI EET Combustion Engines V3.0 (2008)
Engine Modifications	Injection nozzle geometry	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Combustion chamber modifications	Not quantified	NPI EET Combustion Engines V3.0 (2008)
	Oil consumption control	Not quantified	NPI EET Combustion Engines V3.0 (2008)
Exhaust After Treatment	Particulate traps	85%	Caterpillar (2009)
	Oxidation catalyst	Not quantified	NPI EET Combustion Engines V3.0 (2008)

[1]Various control factors provided in Katestone (2011)

7.3 Potential Additional Controls for Top Four Mining Activities

Based on the identified best practice control measures, a gap analysis was undertaken against WCC's current control measures, and potential additional controls were identified.

7.3.1 Vehicle Dust

Wheel generated dust from haul trucks travelling on unpaved roads is a significant source of particulate matter. WCC currently implements the majority of the haul road design, maintenance and management particulate reduction measures identified; including minimising the Vehicle Kilometres Travelled (VKT) through taking the most direct route and grading, gravelling of heavy traffic areas and water application to high use areas. Based on the gap analysis, the following possible additional measures were identified:

- Minimising VKT by using larger trucks and replacing haul roads with conveyors;
- Restrict vehicle speeds on roads to 40km/hr or less;
- Application of chemical suppressants; and
- The use of real-time triggers.

7.3.2 Wind Erosion

WCC currently implements a number of the best practice measures identified in **Section 7.1.2** for wind erosion of exposed areas and stockpiles. Current controls include limiting soil disturbance until the area is required to be drilled, progressively rehabilitating areas disturbed by mining, paved areas around administration areas and car parks and, when required, watering stockpiles using canons installed on water carts. Based on the gap analysis, the following possible additional measures were identified:

- Construction of fencing, bunding or shelterbelts;
- Use of suppressants and hydraulic mulch seeding on exposed areas;
- The use of chemical suppressants on stockpiles;
- Covering stockpiles; and
- Bypassing stockpiles to load directly into ROM bin or onto train.

7.3.3 Vehicle Combustion

Vehicle and plant combustion emission control techniques are not addressed in Katestone (2011). The NPI EET Manual for Combustion Engines provides a summary of the various available diesel emission reduction technologies that decrease particulate matter emissions; however, due to insufficient data, the control measures are not quantifiable. Caterpiller does advertise a DPF that can reduce particulate matter emission by at least 85%. Currently, all earthmoving equipment and on-site vehicles are fitted with exhaust controls which satisfy the Department of Environment, Climate Change and Water (DECCW), (now the Office of Environment and Heritage (OEH)) emission requirements. For the above reasons, and considering current practices at WCC, additional diesel emission reduction controls will not be considered at this time.

7.3.4 Coal Handling

Minimising the drop height of trucks dumping coal is currently the only control measure that WCC adopts to minimise particulate emissions from dumping coal at the CPP. Additional best practice control measures that could be adopted include:

- Bypassing the ROM stockpile; and
- Applying water at the ROM pad.

8. PRACTICABILITY OF IMPLEMENTING BEST PRACTICE MEASURES

8.1 Evaluation of Each Best Practice Measure

The following sections outlines the practicability of implementing the main best practice measures evaluated in **Section 7**. The practicability of implementing the additional control measures at WCC have been evaluated taking into consideration:

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

8.1.1 Vehicle Dust

Particulate matter emissions from using conveyors to transport ROM coal would be 95% less than using haul trucks. While haul roads could be replaced by conveyors, conveyors are costly and are most likely permanent fixtures.

The replacement of the current fleet of haul trucks with larger capacity trucks is the most cost effective control measure for reducing wheel generated dust. As shown in Katestone (2011), replacing vehicles with larger capacity ones is shown to have cost savings, due to the reduction in the number of vehicles required to be purchased and the reduced operating costs. Currently, Cat 785 haul trucks with a capacity of 140 tonnes are used to haul overburden and coal at WCC. Using larger capacity haul trucks would reduce the number of trips required to transport the material and would, in turn, reduce particulate matter emissions. However, replacing the current fleet with larger capacity haul trucks is not a feasible option for WCC due to the large capital expenditure required to purchase larger trucks and the small size of the pit dictating the size of the trucks that can be utilised.

Katestone (2011) provides no justification or control efficiency for a speed limit of 40km/hr as best practice. A speed limit of 60 km/hr is enforced within the pit, and 80 km/hr on sealed roads; however, in practice, haul truck operators drive to the conditions and actual speed are estimated to be closer to 50km/hr. Further speed reduction should be applied by haul truck operators to reduce dust generation when weather conditions are unfavourable or when increased dust levels are visible; however, a vehicle speed restriction of 40 km/hr is not considered a practical restriction for the WCC site as it would be overly prohibitive to production rates and would affect the viability of the mines production operations.

Watering is a relatively inexpensive and accessible form of emission control which WCC predominantly utilises for dust suppression on haul roads; however, the benefits are short term and water needs to be applied consistently and regularly. Chemical suppressants provide a longer term and higher reduction in particulate matter emissions. Chemical suppressants can include wetting agents, binding agents or crusting agents. A standard cost of $0.14 per square metre has been determined in Katestone (2011).

WCC recently increased its water cart fleet from four to five water carts; three dedicated water carts for the open cut operations, one water cart for coal processing and the Rail Load-out Facility and one water cart for the scrapers. The application of water will be applied to exposed surfaces, with emphasis on those areas subject to frequent vehicle and equipment movements which may cause dust generation and dispersion. Katestone (2011), noted that visual monitoring of dust above the deck, wheels or tray of the haul trucks could be used as a trigger for the application of additional watering. Haul truck drivers would be a central driver of this trigger.

The cost of water has been estimated to be $1.70 per kL in the Katestone (2011). Costs were based on additional volume of water and truck operating costs, including fuel consumption and wages. Based on the daily load counts, WCC used approximately 190 ML of void water for dust suppression during 2011/2012, which was up 50 ML from 140 ML in 2010/2011. The additional water use is estimated to be $85 000 per year, based on a cost of $1.70 per kL.

WCC will install a real-time particulate monitor (TEOM) for measuring continuous PM_{10} and $PM_{2.5}$ concentrations, with the real-time data used for operational response. The TEOM will be located at the "Werris Creek Centre" monitoring site location, representative of residences on the elevated eastern section of Werris Creek township. The eastern location minimises the influence of road and rail dust emissions as well as other urban dust sources, while still at the same distance from WCC and representative of mining dust emissions in Werris Creek. The TEOM analyser which will provide real time PM_{10} and $PM_{2.5}$ dust monitoring by a dedicated website. The system that collates the real time data from the TEOM will be set up so that an SMS and/or email alarm will be sent to the Environmental Officer and Project Manager when PM_{10} dust concentration levels reach the following trigger levels:

- Short Term Event Trigger: >90 µg/m3 over two consecutive 15 minute periods; and
- 24 Hour Event Trigger: Rolling 24 hour average >40 µg/m3.

The data from the TEOM can be analysed in conjunction with local Bureau of Meteorology (BOM) and mine site weather station data in real-time to determine the contribution of dust levels from the direction of WCC compared to dust levels from other wind directions. Upon receiving the SMS alarm, the Environmental Officer can investigate the source of dust emissions, and if found to be as a result of WCC operations the Project Manager and Open Cut Examiner will take actions to mitigate dust emissions by modifying operations and/or suspending certain actives until conditions improve. While the rolling 24 hour trigger value is similar to the compliance criteria, the trigger values are designed to identify dust events (whether or not as a result of WCC) that may require further management.

8.1.2 Wind Erosion

8.1.2.1 Land Clearing Procedure

Reducing the pre-strip area is not a feasible option for WCC, vegetation clearing has to be done annually during the autumn to have the least ecological impact. Clearing cannot be carried out during the breeding period of birds and bats.

Disturbance areas will be kept to the minimum area required and where practicable, clearing an area equivalent to one year's mine development and outside of periods of faunal breeding or hibernating/torpor. The clearing area is surveyed and the boundary clearly pegged in the field. While trees are removed annually, grass vegetation is removed closer to the mining period to reduce wind-blown dust. Soils are stripped when sufficiently moist to minimise dust generation. If required, water carts are used to increase soil moisture and minimise dust generation during stripping. If this activity cannot be adequately managed, they will be suspended until conditions improve. WCC clearing schedule for the LOM Project is outlined in **Table 10**.

Table 10: WCC MOP Clearing Schedule

Period		Grassy White Box		Other (ha)	Annual Total (ha)	Cumulative Total (ha)
		Class 3 (ha)	Class 4 (ha)			
Year 1	2012	59.2	0.8	31.6	91.6	91.6
Year 2	2013	20.3	0.6	3.4	24.3	115.9
Year 3	2014	13.0	1.8	0.0	14.8	130.7
Year 4	2015	10.9	3.6	0.3	14.8	145.5
Year 5	2016	10.5	9.4	3.0	22.9	168.4
Year 6	2017	5.9	4.9	1.0	11.8	180.2
Year 7	2018	35.9	19.4	3.5	58.8	239.0
Total		**155.7**	**40.5**	**42.8**	**239.0**	**239.0**

8.1.2.2 Windbreak

Enclosure and windbreaks around particulate prone areas can control emissions by 70% by reducing wind speed. While natural windbreaks do prevent some wind erosion, it is not as effective as man-made windbreaks. The cost of construction and maintenance was estimated to be ten million dollars for a 4km non-metallic enclosure, with ongoing annual operating cost of 7% of the capital costs. The estimated cost of a metal enclosure was five times per linear metre more than the shade-cloth material.

Overburden and interburden will either be placed within the in-pit section of the overburden emplacement or in an extension of the out-of-pit overburden emplacement, within the Acoustic and Visual Amenity Bund to be constructed to the northeast of the LOM Project. An estimated 3.7 million loose cubic metres of material will be used to construct the 8 m to 2 5m high bund (the maximum height allowed under the PA 10_0059), occupying a length of 2.2 km. Once constructed, the bund will increase the protection of mining operations from wind erosion, providing significant protection to neighbouring residences and properties and assist in retaining a significant proportion of the generated particulate matter within the site boundary. It has been estimated that the Acoustic and Visual Amenity Bund will reduce particulate emissions from the overburden stockpiles by 79% resulting in an annual reduction of 14 tonnes of TSP, 7 tonnes of PM_{10} and 1 tonne of $PM_{2.5}$.

8.1.2.3 Rehabilitation

Rehabilitation is one of the most effective control measures for reducing emissions of particulate matter from exposed areas caused by windblown dust. Rehabilitation involves the reshaping of the land, the spreading of topsoil and reseeding. Rehabilitation is not always a practical control measure. The rehabilitation process also takes a few years to take full effect from seeding until the area is fully rehabilitated. The estimated cost of rehabilitation is $10 000 per hectare. Hydro-seeding is an alternative to the conventional rehabilitation process. Hydro-seeding allows for the spreading of seeds, mulch and fertiliser in one application. The binder sets within hours, meaning that the emission reduction benefits are achieved immediately. The final emission reduction benefit of rehabilitation and hydro-seeding are the same; however, the estimated cost of hydro-seeding is three times the price of conventional rehabilitation at $30 000 per hectare.

As of the end of March 2012, WCC has rehabilitated 54.7ha of disturbed land which is 4.2ha ahead of the rehabilitation targets set in the LOM Project Mining Operations Plan (MOP) approved by Department of Resources and Energy (DRE) on 29 November 2012. The MOP forms the basis of the Rehabilitation Management Plan, also approved by the Department of Resources and Energy in April 2012. **Table 11** summarises the annual rehabilitation targets proposed by WCC in the MOP and Rehabilitation Management Plan, which as well as achieving the required final land uses (for WCC is Woodland Ecological Communities and Agriculture), also provides a significant control for fugitive dust emissions from wind erosion.

Table 11: LOM Rehabilitation Targets

Period		Annual Total (ha)	Cumulative Total (ha)
Year 1	2012	76.2	76.2
Year 2	2013	97.8	97.8
Year 3	2014	120.2	120.2
Year 4	2015	143.7	143.7
Year 5	2016	158.8	158.8
Year 6	2017	182.8	182.8
Year 7	2018	197.1	197.1
Total		**197.1**	**197.1**

Each hectare of rehabilitated land produces 99% less particulate emissions than exposed land. The additional 25.7 hectares of rehabilitated land achieved in 2012 is expected to reduce annual wind blown particulate emissions from exposed areas by 18.3 tonnes of TSP, 9.1 tonnes of PM_{10} and 1.4 tonnes of $PM_{2.5}$ at an estimated cost of $257 000.

8.1.2.4 Stockpiles

Topsoil and subsoil is stockpiled no higher than 3 metres and seeded with a non-persistent cover crop as soon as possible after completion of stockpiling. All sides of the overburden emplacement will be shaped to slopes of 10^{o} or less excluding the final void. With the section within the final void being shaped to approximately 18^{o} (1V:3H) or less in the final landform.

In general, the inherent moisture within ROM and Product coal mitigates coal dust emissions. However, during periods of dry conditions or high winds, water carts can be used to spray coal stockpiles. In addition, WCC highest value product coal known as SAIL is a very fine semi coking coal that is covered by a tarp when stockpiled at the Rail Load-out Facility to prevent moisture content increasing (risk to coal quality) but also prevents dust generation. SAIL coal is produced periodically dependent on availability of low ash coal and ship arrival.

Covering of half of the SAIL stockpile is expected to reduce stockpile emissions by 33.2 tonnes of TSP, 16.6 tonnes of PM_{10} and 2.5 tonnes of $PM_{2.5}$.

8.1.3 Exhaust Emissions

All earthmoving equipment and on-site vehicles purchased will be fitted with exhaust controls which satisfy the OEH emission requirements by optimising and scheduling vehicle operations, maintaining engines according to manufacturers' guidelines and keeping tyres at optimum pressure and minimising vehicle idling time. Regular locomotive maintenance will be undertaken to ensure compliance with exhaust emission standards.

8.1.4 Trucks Dumping Coal

WCC currently attempts to minimise particulate emissions from the dumping coal at the CPP by minimising the drop height of trucks dumping coal. In addition, WCC modify operations during periods of high winds or dry conditions causing significant dust dispersal. If these activities, including dumping coal at the CPP, continue to generate excessive dust from a visual inspection by the Open Cut Examiner, the activities will be suspended until conditions improve.

8.2 Estimation of Emission Reductions

Annual emission reductions estimated due to the implementation of the additional control measures identified at WCC are presented in **Table 12**.

Table 12: Annual Emission Reductions Estimation from Additional Control Measures to be Implemented

Mining Activity	Current Emissions (tonnes/yr)			Emissions with Additional Controls (tonnes/yr)			Emissions Savings (tonnes/yr)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wheel Generated Dust	899.2	170.4	29.6	899.2	170.4	29.6	Unquantifiable		
Wind Erosion - Site	81.2	40.6	6.1	63.1	31.6	4.7	18.1	9.0	1.4
Wind Erosion - Stockpiles	158.5	79.2	11.9	111.2	55.6	8.3	47.3	23.6	3.5
Total							**65.3**	**32.7**	**4.9**

9. IMPLEMENTATION TIMELINE

Table 13: Implementation Timeline

Source	Additional Control Measure	Implementation Timeline
Wheel Generated Dust	Additional watering - purchasing of additional water cart	Already Implemented
	Real time dust monitoring	2012
Wind Erosion - Site	Rehabilitation	Ongoing (as per **Table 11**)
Wind Erosion - Stockpiles	Construction of Acoustic and Visual Amenity Bund	2012 to 2018
	Covering SAIL stockpile with tarp	As soon as practicable

10. REFERENCES

The following information was used in the preparation of this report:

1. Caterpillar, *Cat Diesel particulate Filter: Off-Road Machines*, 2009.
2. Caterpillar, *Mining Trucks-Cat*, https://mining.cat.com/products/surface-mining/mining-trucks, 29 February 2012.
3. Katestone Environmental, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, June 2011.
4. Midwest Research Institute, *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors*, November 2006.
5. National Pollutant Inventory, *Emission Estimation Technique Manual for Mining Version 3.0*, June 2011.
6. National Pollutant Inventory, *Emission Estimation Technique Manual for Combustion Engines Version 3.0*, June 2008.
7. Office of Environment and Heritage, *Coal Mine Particulate Matter Control Best Practice: Site-specific Determination Guideline*, November 2011.
8. R.W Corkery & Co, *Environmental Assessment for Werris Creek Coal Mine Life of Mine Project*, 2010.
9. Werris Creek Coal Pty Ltd, *Life of Mine Mining Operations Plan for the Werris Creek Coal Mine*, November 2011.

Appendix I

Cost Related Information

Cost Related Information

The cost of implementing the various control measures has been estimated using site specific information and cost information available in Katestone (2011).

Costs of Control Measures not being Implemented

Control Measure	Cost
Chemical Suppressants	$0.14 per square metre
Hydroseeding	$30 000 per hectare
Conveyor	$4 000 per metre
CAT 769 Purchase Cost	$1 706 204
CAT 769 Operating Cost	$18 636
CAT 773 Purchase Cost	$1 200 000
CAT 777 Operating Cost	$18 910
CAT 789 Purchase Cost	$1 924 789
CAT 789 Operating Cost	$20 632
EUCLID R100 Purchase Cost	$3 218 382
EUCLID R100 Operating Cost	$41 226
FORD LN9000 Purchase Cost	$1 706 204
FORD LN9000 Operating Cost	$18 636
KOMATSU HD 785-3 Purchase Cost	$1 200 000
KOMATSU HD 785-3 Operating Cost	$18 910
VOLVO F724 Purchase Cost	$1 706 204
VOLVO F724 Operating Cost	$18 636

Costs of Control Measures to be Implemented

Control Measure	Estimated Cost	Source
Additional Watering	$85 000	Katestone (2011) based on $1.70 per kL
Water Truck Purchase Cost	$1 849 875	Katestone (2011) estimated cost for "Unidentified Water Truck"
Water Truck Operating Cost	$23 663	Katestone (2011) estimated cost for "Unidentified Water Truck"
Acoustic and Visual Amenity Bund	$5 750 000	Site specific estimation. Based on a cost of $2.50 per bcm for scraper and 2.3 million bcm required for bund.
Rehabilitation (2012)	$257 000	Katestone (2011) based on $10 000 per hectare
Real Time Monitoring (initial cost)	$95 000	Site specific estimation
Real Time Monitoring (ongoing annual operating cost)	$15 000	Site specific estimation

Appendix II

PRP Requirements

Office of Environment & Heritage

NSW GOVERNMENT

Our reference:	LIC07/2029-12 & DOC11/55852
Contact:	Michael Lewis (02) 6773 7009

Mr Danny Young
Group Environmental Manager
Whitehaven Coal Limited
PO Box 600
GUNNEDAH NSW 2380

6 December 2011

Dear Mr Young

COAL MINE PARTICULATE MATTER – BEST MANAGEMENT PRACTICE
DRAFT POLLUTION REDUCTION PROGRAM

In 2010, the Office of Environment and Heritage (OEH) commissioned Katestone Environmental Pty Ltd to prepare a report on best practice measures to prevent and/or minimise emissions of particulate matter from coal mines in the Greater Metropolitan Region of NSW. The report found that a range of technically and economically feasible measures could be applied to significantly reduce particulate matter emissions from coal mines. To ensure the most practicable measures are implemented by each mine site, the report recommended that site specific best management practice reviews be carried out to reduce particulate matter emissions. A copy of the final report may be obtained from OEH's website, at the following links:

Main report - http://www.environment.nsw.gov.au/resources/air/KE1006953volumeI.pdf
Appendices - http://www.environment.nsw.gov.au/resources/air/KE1006953volumeII.pdf

Please note that the regulatory responsibilities of the Office of Environment and Heritage are now carried out by the Environment Protection Authority (EPA).

In consultation with the NSW Minerals Council, EPA has developed a Pollution Reduction Program (PRP) that requires the preparation of a report on the practicability of implementing best practice measures to reduce particle emissions by each coal mine. A timetable is required for the implementation of any practicable measures that are identified. This approach will mean that the most up to date information about an individual coal mine's operations will be used to determine the best approaches for improving air quality.

Below is the proposed PRP to be included in the environment protection licence EPL 12290 (Werris Creek Coal Mine).

U2 Coal Mine Particulate Matter Control Best Practice - Assessment and Report

U2.1 The Licensee must conduct a site specific Best Management Practice (BMP) determination to identify the most practicable means to reduce particle emissions.

U2.2 The Licensee must prepare a report which includes, but is not necessarily limited to, the following:
- identification, quantification and justification of existing measures that are being used to

minimise particle emissions;
- identification, quantification and justification of best practice measures that could be used to minimise particle emissions;
- evaluation of the practicability of implementing these best practice measures; and
- a proposed timeframe for implementing all practicable best practice measures.

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

U2.3 All cost related information is to be included as Appendix 1 of the Report required by condition U2.2 above.

U2.4 The report required by condition U2.2 must be submitted by the Licensee to the EPA's Regional Manager, **Simon Smith, at PO Box 494 Armidale NSW 2350 by 29 June 2012**.

U2.5 The report required by condition U2.2 above, except for cost related information contained in Appendix 1 of the Report, must be made publicly available by the Licensee on the Licensee's website by **6 July 2012.**

A copy of the Guideline to assist with the preparation of the Report required by the PRP is attached, a copy of the Guideline may also be obtained at the following link:

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

In addition you will note some changes to the format of the licence which has occurred as a result of the computer system used by the EPA to store and process licences has been upgraded. These upgrades are not intended to change the substance of the licence. Any comments you wish to make on the enclosed draft notice should be provided by **16 December 2011**. If no comment is received by this date, the notice may be issued as currently drafted.

Should you have any queries regarding this matter, please contact Michael Lewis at the Armidale Office of the EPA by telephoning (02) 6773 7009.

Yours sincerely

Michael Lewis
Regional Operations Officer
Regional Operations Unit
Environment Protection Authority

Encl. Report preparation guidelines

Appendix III

Emissions Estimation

Emission Estimation Method

Annual TSP, PM_{10} and $PM_{2.5}$ emissions have been calculated for each mining activity using the USEPA AP42 emission estimation techniques, and where available, taking into account site specific material properties, meteorology, mine activity rates and control measures. Where emission factors were not available from the USEPA AP42 emission estimation the values supplied in NPI Emission Estimation Techniques have been utilised.

The NPI EET and US EPA AP42 contain emission factors for TSP and PM_{10}. Few factors are provided for $PM_{2.5}$ as little research has been undertaken to assess the fraction of PM_{10} from the wide range of sources which would emit $PM_{2.5}$. Some research has been conducted by the Midwest Research Institute (MRI) with findings published within '*Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'.* The $PM_{2.5}$ to PM_{10} ratios provided by the MRI have been used in this assessment to calculate $PM_{2.5}$ emissions, where $PM_{2.5}$ emission factors were not available.

The emission factor equations applied in this assessment are detailed in the following sections.

<u>Drilling on Overburden</u>

The TSP emissions factor for drilling on overburden was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

$$TSP = 0.59 \text{ (kg/hole)}$$

There are no PM_{10} and $PM_{2.5}$ emission factors for drilling given by USEPA AP42. Therefore, the PM_{10} emissions factor for drilling on overburden was taken from *NPI EET Manual for Mining v3.0* (June 2011) and a PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied:

$$PM_{10} = 0.31 \text{ (kg/hole)}$$
$$PM_{2.5} = PM_{10} \times 0.15 \text{ (kg/hole)}$$

<u>Blasting Overburden</u>

The emissions factor for blasting overburden was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

$$TSP = 0.00022(A)^{1.5} \text{ (kg/blast)}$$
$$PM_{10} = TSP \times 0.52 \text{ (kg/blast)}$$
$$PM_{2.5} = TSP \times 0.03 \text{ (kg/blast)}$$

Where:

A = horizontal area (m^2), with blasting depth ≤21 m.

Topsoil Scraper

Topsoil Removed by Scraper

The TSP emissions factor for topsoil removed by scraper was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

$$TSP = 0.029 \text{ kg/t}$$

There are no PM_{10} and $PM_{2.5}$ emission factors for drilling given by USEPA AP42. Therefore, the emissions factor for scrapers removing overburden was taken from *NPI EET Manual for Mining v3.0* (June 2011):

$$PM_{10} = 0.0073 \text{ kg/t}$$
$$PM_{2.5} = PM_{10} \times 0.25 \text{ kg/t}$$

Scraper unloading (batch drop)

The TSP emissions factor for scraper unloading topsoil was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

$$TSP = 0.02 \text{ kg/t}$$

There are no PM_{10} and $PM_{2.5}$ emission factors for scraper unloading topsoil by USEPA AP42 or the NPI.

Bulldozer

The emission factors for bulldozing on overburden and coal was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

Material	TSP	PM_{10}	$PM_{2.5}$	Units
Overburden	$\frac{2.6\,(s)^{1.2}}{(M)^{1.3}}$	$\frac{0.45\,(s)^{1.5}}{(M)^{1.4}} \times 0.75$	$\frac{2.6\,(s)^{1.2}}{(M)^{1.3}} \times 0.105$	kg/hr
Coal	$\frac{35.6\,(s)^{1.2}}{(M)^{1.3}}$	$\frac{8.44\,(s)^{1.5}}{(M)^{1.4}} \times 0.75$	$\frac{35.6\,(s)^{1.2}}{(M)^{1.3}} \times 0.022$	kg/hr

Where:

s = material silt content (%)
M = material moisture content (%)

Grader

The emissions factor for graders was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

TSP	PM_{10}	$PM_{2.5}$	Units
0.0034 (S)2.5	0.0056 $(S)^{2.0}$ x 0.6	TSP x 0.31	kg/VKT

Where:

S = mean vehicle speed (km/h)

Dumping Overburden

The emissions factors for dumping overburden by Front End Loader, excavator and truck was taken from *USEPA AP42 Chapter 13.2.4 Aggregate Handling And Storage Stockpiles* (November 2006) equation for drop operations:

$$E = k\,(0.0016)\left(\frac{U}{2.2}\right)^{1.3} x \left(\frac{M}{2}\right)^{-1.4}$$

Where:

E = emission factor
k = particle size multiplier (dimensionless)
U = mean wind speed, meters per second (m/s)
M = material moisture content (%)

The typical Hunter Valley value from the NPI Mining EET has been adopted for the mean wind speed.

Dumping Coal

The emissions factors for dumping coal by excavator and truck was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998):

TSP	PM_{10}	$PM_{2.5}$	Units
$\frac{0.58}{(M)^{1.2}}$	$\frac{0.0596}{(M)^{0.9}}$ x 0.75	TSP x 0.019	kg/Mg

Where:

M = material moisture content (%)

Unpaved Roads

The emissions factor for unpaved roads was taken from *USEPA AP42 Chapter 13.2.2 Unpaved Roads* (November 2006):

$$E = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

Where:

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)

Constants applied:

Constant	TSP (assumed equivalent to PM_{30})	PM_{10}	$PM_{2.5}$
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

The metric conversion from lb/VMT to grams per vehicle kilometre travelled (g/VKT) is as follows:

$$1 \text{ lb/VMT} = 281.9 \text{ g/VKT}$$

Natural Mitigation

Including natural mitigation, under the assumption that annual average emissions are inversely proportional to the number of days with measurable precipitation:

$$E_{ext} = E\,[(365-P)/365]$$

Where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (lb/VMT)
E = unpaved road emission factor
P = number of days in a year with at least 0.254 mm of rain

<u>Paved Roads</u>

The emissions factor for unpaved roads taken from *USEPA AP42 Chapter 13.2.1 Paved Roads* (January 2011):

$$E = K\,(sL)^{0.91} \times (W)^{1.02}$$

Where:

E = Emissions Factor (g/VKT)
k = particulate size multiplier
sL = road surface silt loading (g/m^2)
W = average weight (tons) of the vehicles traveling on the road

Constants applied:

Constant	TSP (assumed equivalent to PM_{30})	PM_{10}	$PM_{2.5}$
K (g/VKT)	3.23	0.62	0.15

Primary Crushing

There are no emission factors for primary crushing provided in USEPA AP42. Therefore, the emissions factors for primary crushing of "high moisture content ores" was taken from *NPI EET Manual for Mining v3.0* (June 2011) and a PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied:

Source	TSP (kg/t)	PM_{10} (kg/t)	$PM_{2.5}$ (kg/t)[1]
Primary crushing	0.01	0.004	0.0006[1]
Primary crushing (enclosed)[2]	0.003	0.0012	0.00018

[1] No $PM_{2.5}$ emission factor provided. A PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied.

[2] 70% control factor for enclosure taken from *NPI EET Manual for Mining v3.0* (June 2011)

Screening

The emissions factor for screening was taken from *USEPA AP42 Chapter 11.9.2 Crushed Stone Processing and Pulverized Mineral Processing* (August 2004):

Source	TSP (kg/t)	PM_{10} (kg/t)	$PM_{2.5}$ (kg/t)
Screening	0.0125	0.0043	0.000645[1]
Screening (controlled)	0.0011	0.00037	0.000025

[1] No $PM_{2.5}$ emission factor provided. A PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied.

Conveyor Transfer Point

The emissions factor for conveyor transfer points was taken from *USEPA AP42 Chapter 11.9.2 Crushed Stone Processing and Pulverized Mineral Processing* (August 2004):

Source	TSP (kg/t)	PM_{10} (kg/t)	$PM_{2.5}$ (kg/t)
Conveyor Transfer Point	0.0015	0.00055	0.000083[1]
Conveyor Transfer Point (controlled)	0.00007	0.000023	0.0000065

[1] No $PM_{2.5}$ emission factor provided. A PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied.

Miscellaneous Transfer

There are no emission factors for miscellaneous transfers provided in USEPA AP42. Therefore, the default emissions factors for miscellaneous transfer points was taken from *NPI EET Manual for Mining v3.0* (June 2011) and a PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied:

Source	TSP (kg/t/transfer point)	PM_{10} (kg/t/transfer point)	$PM_{2.5}$ (kg/t/transfer point)[1]
Miscellaneous Transfer	0.00032	0.00015	0.000023[1]
Miscellaneous Transfer (with water spray)[2]	0.00016	0.000075	0.000011[1]

[1] No $PM_{2.5}$ emission factor provided. A PM_{10} to $PM_{2.5}$ ratio from *Midwest Research Institute, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* (November 2006) was applied.

[2] 50% control factor for water sprays taken from *NPI EET Manual for Mining v3.0* (June 2011)

Active Coal Storage Pile (Wind Erosion)

The emission factor for wind erosion from coal stockpiles was taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998). There are no PM_{10} and $PM_{2.5}$ emissions factors for wind erosion of active stockpiles, the PM_{10} and $PM_{2.5}$ to TSP ratio has been sourced from the particle size distribution provided in *USEPA AP42 Chapter 13.2.5 Industrial Wind Erosion* (November 2006):

TSP (kg/hectare/hr)	PM_{10} (kg/hectare/hr)	$PM_{2.5}$ (kg/hectare/hr)
1.8 x u	TSP x 0.5	TSP x 0.075

Where:

U = mean wind speed (m/s)

Overburden and Exposed Areas (Wind Erosion)

The emission factors for wind erosion from overburden stockpiles and exposed areas were taken from *USEPA AP42 Chapter 11.9 Western Surface Coal Mining* (October 1998). There are no PM_{10} and $PM_{2.5}$ emissions factors for wind erosion of active stockpiles, the PM_{10} and $PM_{2.5}$ to TSP ratio has been sourced from the particle size distribution provided in *USEPA AP42 Chapter 13.2.5 Industrial Wind Erosion* (November 2006):

TSP (kg/hectare/hr)	PM_{10} (Mg/hectare/hr)	$PM_{2.5}$ (Mg/hectare/hr)
0.85	TSP x 0.5	TSP x 0.075

Combustion Emissions

Emission factors for combustion emissions was taken from *NPI EET Combustion Engines v3.0* (June 2008) based on fuel use:

$$E_i = Q_f \times LF \times EF_i$$

Where:

E_i = Emission of substance i for a specific engine type (kg/y)
Q_f = Quantity of fuel combusted during the reporting year (kg/yr or L/y)
LF = Load factor utilised in facility operations for equipment type (sourced from Appendix B of the EET)
EF_i = Emission factor of substance i, for given engine and fuel type (kg/hWh)
i = Substance i (-)

Input Data

A summary of the input data used in the emission estimations calculations is provided in the table below.

Description	Units	Value	Source
Material Properties			
Estimated proportion of time topsoil is moist	%	16.0	Calculated from BOM rain days data
Topsoil moisture	%	3.4	USEPA 42 Geometric Mean for "Exposed Ground"
Topsoil silt	%	15.0	USEPA 42 Geometric Mean for "Exposed Ground"
Unpaved road silt content	%	6.4	Used in LOM AQIA
Moisture content of overburden	%	5.5	Used in LOM AQIA
Silt content of overburden	%	10.0	Used in LOM AQIA
Moisture content of coal	%	6.0	Used in LOM AQIA
Silt content of coal	%	7.0	Used in LOM AQIA
Silt content of scraper route	%	17.0	USEPA 42 Geometric Mean
Vehicle Information			
Scraper gross mass	tonnes	48	USEPA 42 Geometric Mean
Average grader speed	km/h	8	Site specific
Coal truck gross mass	tonnes	249.5	Site specific
ROM to TLO truck gross mass	tonnes	42.5	Site specific
Overburden truck gross mass	tonnes	249	Site specific
Meteorological Conditions			
Mean wind speed	m/s	3.6	Typical Hunter Valley value from Mining EET
Average annual rain days	days	60	BOM data