



**WERRIS CREEK COAL
ENVIRONMENTAL
MANAGEMENT SYSTEM**

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WHC_PLN_WC_BLAST MANAGEMENT PLAN MP

WERRIS CREEK COAL

BLAST MANAGEMENT PLAN

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ACRONYMS USED THROUGHOUT THIS DOCUMENT

ACARP	-	Australian Coal Association Research Program
AEMR	-	Former Annual Environmental Management Report (pre 2015)
AR	-	Annual Review (incorporating AEMR requirements)
ARTC		Australian Rail Track Corporation
BFMS	-	Blast Fume Management Strategy
BMP	-	Blast Management Plan
CCC	-	Community Consultative Committee
DPE	-	Department of Planning & Environment
EA	-	Environmental Assessment
EPA	-	Environment Protection Authority
EPL	-	Environment Protection Licence
LOM	-	Life of Mine
LPSC	-	Liverpool Plains Shire Council
MIC	-	Maximum Instantaneous Charge
ML	-	Mining Lease
NIA	-	Noise (and Blasting) Impact Assessment
OCE	-	Open Cut Examiner
PA	-	Project Approval
WCC	-	Werris Creek Coal Pty Ltd
WCCM	-	Werris Creek Coal Mine



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1 INTRODUCTION

1.1 The Werris Creek Coal Mine

The Werris Creek Coal Mine (WCCM) is operated by Werris Creek Coal Pty Limited (WCC) and is located within the North West Slopes and Plains of New South Wales, approximately 45km south west from Tamworth (**Figure 1**). WCCM is located approximately 4km south of Werris Creek and 11km north-northwest of Quirindi.

WCC was granted Project Approval (PA) 10_0059 on the 25th October 2011 by the Minister of Planning and Infrastructure for the Life of Mine (LOM) project. The Project involves a northerly extension of the existing mine footprint, increasing the projected mine life by approximately 10 to 15 years. PA 10_0059 has subsequently been modified twice under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as follows:

- Modification 1 (10_0059 MOD1) dated 30th August 2012 allowing for the relocation of some surface infrastructure.
- Modification 2 (10_0059 MOD2) dated 3rd November 2015 allowing for minor overburden emplacement changes, agricultural water supply, coal deshaling plant and SB18, and is hereafter referred to as the Modified PA.

To satisfy Condition 13, Schedule 3 of the Modified PA, WCC is required to prepare and implement a Blast Management Plan for the project. The plan has also been prepared to meet the management plan requirements specified in Condition 2, Schedule 5 of the Project Approval, the commitments made in the LOM Project Environmental Assessments (EA), Environment Protection Licence (EPL) 12290 and other agreements related to blasting.

WCC has approval to mine in full, the Werris Creek coal measures which occur as a synclinal (bowl-shaped) formation to the immediate south of Werris Creek. The mining process involves the blasting of overburden and interburden material, to allow the waste rock to be removed by excavators and haul trucks, which in turn allows for the mining of coal. Specialised blasting techniques are employed when required, such as pre-split shots or underground collapse shots, to manage safety hazards or for production benefits.

This Blast Management Plan has been prepared in consultation with the relevant Government Departments, as required under Condition 13 (a), Schedule 2 of PA 10_0059

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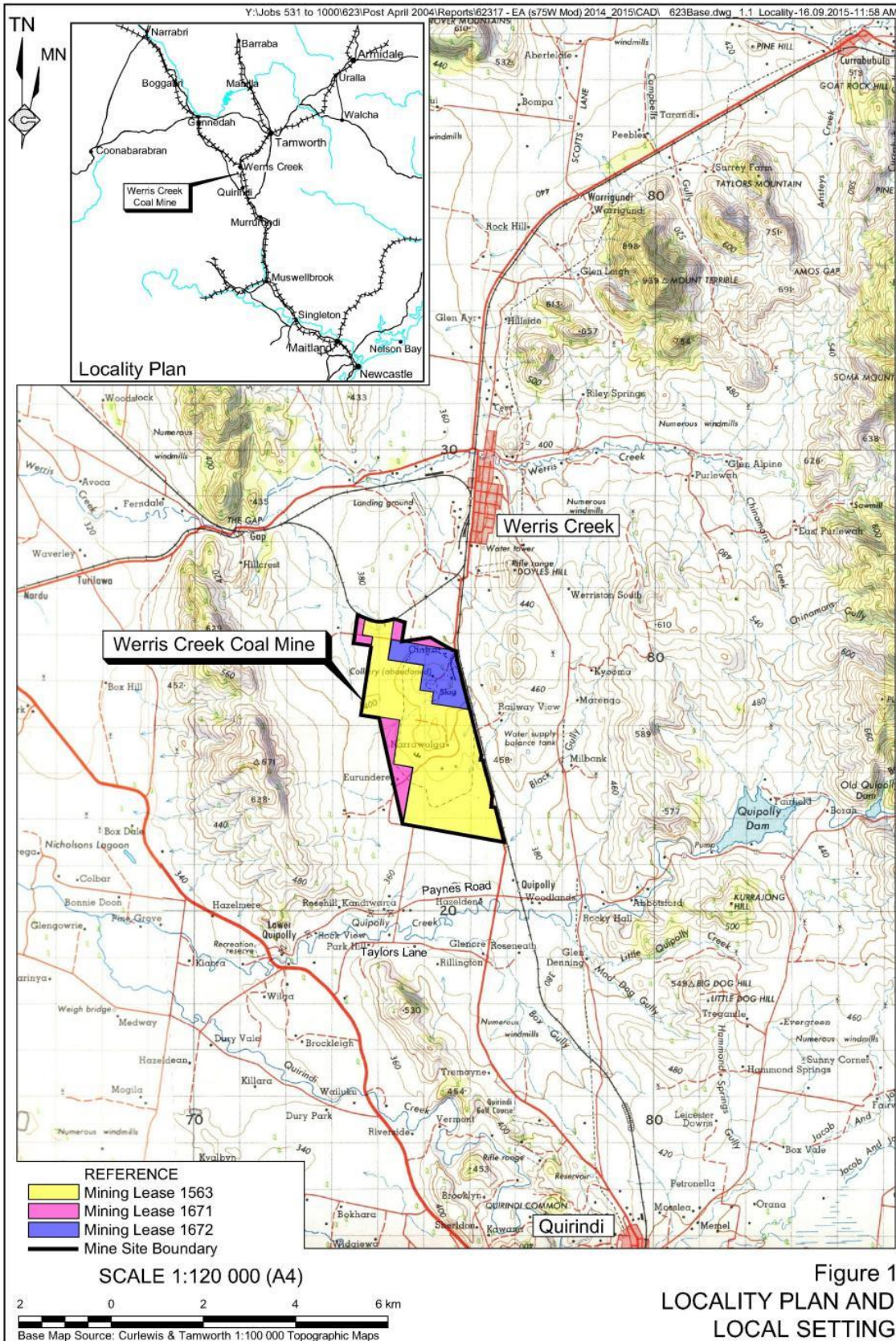


Figure 1 - Locality Plan and Local Setting (modified from Figure 1.1 of RWC, 2015a)



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2 REQUIREMENTS

The BMP has been prepared in accordance with the requirements established under various legislation. The requirements established under these instruments are outlined in the following sections.

2.1 Mining Leases ML1563, ML1671, and ML 1672

The BMP has been prepared in accordance with the conditions listed in each of the mining leases ML1563, ML1671, and ML1672, including the Mining Operations Plan for the Werris Creek Coal Mine, which covers mining operations at WCCM. **Table 1** summarises the key conditions relating to blasting required by the mining lease approvals.

Table 1 - Relevant Conditions from each Mining Lease Approval

Condition	Condition Requirement	Section
11	<p>(a) Ground Vibration The lease holder must ensure that the ground vibration peak particle velocity generated by any blasting within the lease area does not exceed 10 mm/second and does not exceed 5 mm/second in more than 5% of the total number of blasts over a period of 12 months at any dwelling or occupied premises as the case may be, unless determined otherwise by the Department of Environment and Conservation.</p> <p>(b) Blast Overpressure The lease holder must ensure that the blast overpressure noise level generated by any blasting within the lease area does not exceed 120 dB (linear) and does not exceed 115 dB (linear) in more than 5% of the total number of blasts over a period of 12 months, at any dwelling or occupied premises, as the case may be, unless determined otherwise by the Department of Environment and Conservation.</p>	5.1
ML1671 and ML1672		
Condition	Condition Requirement	Section
2.	<p>Environmental Harm (a) The lease holder must implement all practicable measures to prevent and/or minimize any harm to the environment that may result from the construction, operation or rehabilitation of any activities under this lease.</p>	6
10.	<p>(a) Ground Vibration The lease holder must ensure that the ground vibration peak particle velocity generated by any blasting within the lease area does not exceed 10 mm/second and does not exceed 5 mm/second in more than 5% of the total number of blasts over a period of 12 months at any dwelling or occupied premises as the case may be, unless determined otherwise by the Department of Environment, Climate Change and Water.</p> <p>(b) Blast Overpressure The lease holder must ensure that the blast overpressure noise level generated by any blasting within the lease area does not exceed 120 dB (linear) and does not exceed 115 dB (linear) in more than 5% of the total number of blasts over a period of 12 months, at any dwelling or occupied premises, as the case may be, unless determined otherwise by the Department of Environment, Climate Change and Water.</p>	5.1



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2.2 Project Approval 10_0059 MOD2

The BMP has been prepared in accordance with the requirements of the Modified PA. **Table 2** summarises the requirements relating to blast management from Schedule 3, Conditions 6 to 13 of the Modified PA, and identifies where these requirements are addressed within this BMP.

Table 2 - Relevant Conditions of the Modified PA

Schedule (Condition)	Requirement	Section															
Blasting Criteria																	
3(6)	<p>The Proponent shall ensure that blasting on site does not cause exceedances of the criteria in Table 5.</p> <p><i>Table 5: Blasting Criteria</i></p> <table border="1"> <thead> <tr> <th><i>Location</i></th> <th><i>Airblast Overpressure (dB(Lin Peak))</i></th> <th><i>Ground Vibration (ppv(mm/s))</i></th> <th><i>Allowable Exceedance</i></th> </tr> </thead> <tbody> <tr> <td rowspan="2">Any residence on privately-owned land</td> <td>115</td> <td>5</td> <td>5% of the total number of blasts over a period of 12 months</td> </tr> <tr> <td>120</td> <td>10</td> <td>0%</td> </tr> <tr> <td>All public infrastructure</td> <td>-</td> <td>50</td> <td>0%</td> </tr> </tbody> </table> <p>However, these criteria do not apply if the Proponent has a written agreement with the relevant owner, and has advised the Department in writing of the terms of this agreement.</p>	<i>Location</i>	<i>Airblast Overpressure (dB(Lin Peak))</i>	<i>Ground Vibration (ppv(mm/s))</i>	<i>Allowable Exceedance</i>	Any residence on privately-owned land	115	5	5% of the total number of blasts over a period of 12 months	120	10	0%	All public infrastructure	-	50	0%	5.1
<i>Location</i>	<i>Airblast Overpressure (dB(Lin Peak))</i>	<i>Ground Vibration (ppv(mm/s))</i>	<i>Allowable Exceedance</i>														
Any residence on privately-owned land	115	5	5% of the total number of blasts over a period of 12 months														
	120	10	0%														
All public infrastructure	-	50	0%														
Blasting Hours																	
3(7)	The Proponent shall only carry out blasting on site between 9 am and 5 pm Monday to Saturday inclusive. No blasting is allowed on Sundays, public holidays, or at any other time without the written approval of the Secretary.	5.1 6.1															
Blasting Frequency																	
3(8)	<p>The Proponent shall not carry out more than:</p> <p>(a) 1 blast a day on site, unless an additional blast is required following a blast misfire; and</p> <p>(b) 15 blasts a month on site.</p> <p>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 blasts required to ensure the safety of the mine or its workers.</p> <p><i>Note: For the purposes of this condition, a blast refers to a single blast event, which may involve a number of individual blasts fired in quick succession in a discrete area of the mine.</i></p>	6.1															
Property Inspections																	
3(9)	<p>If the Proponent receives a written request from the owner of any privately-owned land within 2 kilometres of the approved open cut pit on site for a property inspection to establish the baseline condition of any buildings and/or structures on their land, or to have a previous property inspection report updated, then within 2 months of receiving this request the Proponent shall:</p> <p>(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary to:</p> <ul style="list-style-type: none"> • establish the baseline condition of the buildings and/or structures on the land or update the previous property inspection report; and • identify any measures that should be implemented to minimise the potential blasting impacts of the projects on these buildings and/or structures; and <p>(b) give the landowner a copy of the new or updated property inspection report.</p>	6.1															
Property Investigations																	



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Schedule (Condition)	Requirement	Section
3(10)	<p>If the owner of any privately-owned land claims that the buildings and/or structures on their land have been damaged as a result of blasting on site, then within 2 months of receiving this claim the Proponent shall:</p> <ul style="list-style-type: none"> (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to investigate the claim; and (b) give the landowner a copy of the property investigation report. <p>If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damage to the satisfaction of the Secretary.</p> <p>If the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution.</p>	6.1
Operating Conditions		
3(11)	<p>The Proponent shall:</p> <ul style="list-style-type: none"> (a) implement best practice blasting management on site to: <ul style="list-style-type: none"> • protect the safety of people and livestock in the surrounding area; • protect private or public property in the surrounding area; • minimise the dust and fume emissions of the blasting; and (b) minimise the duration and frequency of any road closures for blasting; (c) operate a suitable system to enable the public to get up-to-date information on the proposed blasting schedule on site, <p>to the satisfaction of the Secretary.</p>	6
3(12)	<p>The Proponent shall not carry out blasting on site that is within 500 metres of:</p> <ul style="list-style-type: none"> (a) Werris Creek Road without the approval of RMS; (b) the Main Northern Railway without the approval of ARTC; and (c) any land outside the site that is not owned by the Proponent unless: <ul style="list-style-type: none"> • the Proponent has a written agreement with the relevant landowner to allow blasting to be carried out closer to the land, and the Proponent has advised the Secretary in writing of the terms of this agreement; or • the Proponent has: <ul style="list-style-type: none"> ○ demonstrated to the satisfaction of the Secretary that the blasting can be carried out closer to the land without compromising the safety of people or livestock on the land, or damaging the buildings and/or structures on the land; and ○ updated the Blast Management Plan to include the specific measures that would be implemented while blasting is being carried out within 500 metres of the land. 	6
Blast Management Plan		
3(13)	<p>The Proponent shall prepare and implement a Blast Management Plan for the project to the satisfaction of the Secretary. This plan must:</p> <ul style="list-style-type: none"> (a) be prepared in consultation with EPA, RMS and ARTC; (b) be submitted to the Secretary for approval by the end of April 2012; (c) describe the mitigation measures that would be implemented to ensure compliance with the relevant conditions of this approval; (d) describe the measures that would be implemented to ensure that the public can get up-to-date information on the proposed blasting schedule on site; and (e) include a blast monitoring program for evaluating the performance of the project, including: <ul style="list-style-type: none"> • compliance with the applicable criteria; and • minimising the fume emissions from the site. 	<p>6.4 Ed. 1 Rev 3 6 6 7 5 7.3</p>

2.3 Statement of Commitments

The BMP has been prepared to address the commitments made under Appendix 6 of the Modified PA. **Table 3** summarises the Statement of Commitments related to blasting, along with where these requirements are addressed within the BMP.



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Table 3 - Statement of Commitments

Objective	Task	Timeframe	Section Ref.
8. Blasting			
Minimise impacts from blasting on surrounding receptors and infrastructure.	8.1 Undertake blasting in accordance with an approved Blast Management Plan (BMP).	Ongoing	6
	8.2 Continue to monitor blasting impacts in accordance with BMP.	All blasts	7

2.4 Environment Protection Licence 12290

WCCM operates under EPL 12290, issued under Section 55 of the *Protection of the Environment Operations Act 1997*. **Table 4** summarises the blast management, monitoring and reporting requirements established in EPL12290 for scheduled activities undertaken at the WCCM.

Table 4 - Relevant Requirements from EPL12290

Condition	Action	Section
L5 Blasting		
L5.1	The overpressure level from blasting operations at the premises must not exceed 120dB (Lin Peak) at any time. Error margins associated with any monitoring equipment used to measure this are not to be taken into account in determining whether or not the limit has been exceeded.	5.1.1
L5.2	The airblast overpressure level from blasting operations at the premises must not exceed 115dB (Lin Peak) at any noise sensitive locations for more than five per cent of the total number of blasts over each reporting period. Error margins associated with any monitoring equipment used to measure this are not to be taken into account in determining whether or not the limit has been exceeded.	5.1.1
L5.3	Ground vibration peak particle velocity from the blasting operations at the premises must not exceed 10mm/sec at any time at any noise sensitive locations. Error margins associated with any monitoring equipment used to measure this are not to be taken into account in determining whether or not the limit has been exceeded.	5.1.1
L5.4	Ground vibration peak particle velocity from the blasting operations at the premises must not exceed 5mm/sec at any noise sensitive locations for more than five per cent of the total number of blasts over each reporting period. Error margins associated with any monitoring equipment used to measure this are not to be taken into account in determining whether or not the limit has been exceeded.	5.1.1
L5.5	Blasting operations at the premises may only take place between 9:00am-5:00pm Monday to Saturday. Blasting is not permitted on public holidays. Blasting outside the hours specified above can only take place with the written approval of the EPA.	6.1
L5.6	The hours of operation for blasting operations specified in this licence may be varied by the EPA, having regard to the effect that the proposed variation would have on the amenity of the residents in the locality, gives written consent to the variation.	6.1
L5.7	Blasting at the premises is limited to 1 blast on each day on which blasting is permitted. Note: Additional blasts are permitted where the EPA and neighbours have been notified of the intended blast prior to the additional blast being fired; and - it is demonstrated to be necessary for safety reasons; or - the previous blast generated ground vibration levels of less than 0.5 mm per second at all non-project related residences.	6.1
L5.8	To determine compliance with condition(s) L5.1, L5.2, L5.3 and L5.4	7.2.1
	a) Airblast overpressure and ground vibration levels must be measured and electronically recorded at any point within 30 metres of any non-project related residential building or other sensitive locations such as a school or hospital for all blasts carried out in or on the premises; and	7.2.2



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Condition	Action	Section												
	<p>b) Instrumentation used to measure the airblast overpressure and ground vibration must meet the requirements of Australian Standard AS 2187.2-2006.</p> <p>Note: A breach of the licence will still occur where airblast overpressure or ground vibration levels from the blasting operations at the premises exceeds the limit specified in this licence at any "noise sensitive locations" other than the locations identified in the above condition.</p>													
L7.1	<p>No condition in this licence identifies a potentially offensive odour for the purposes of section 129 of the Protection of the Environment Operations Act 1997.</p> <p>Note: Section 129 of the Protection of the Environment Operations Act 1997 provides that the licensee must not cause or permit the emission of any offensive odour from the premises but provides a defence if the emission is identified in the relevant environment protection licence as a potentially offensive odour and the odour was emitted in accordance with the conditions of a licence directed at minimising odour.</p>	5.1.3												
O4 Other Operating Conditions														
O4.2	<p>Offensive blast fume must not be emitted from the premises.</p> <p>Definition: Offensive blast fume means post-blast gases (whether visible or invisible, odorous or odourless) from the detonation of explosives at the premises that by reason of their nature, duration, character or quality, or the time at which they are emitted, or any other circumstances:</p> <p>(i) are harmful to (or is likely to be harmful to) a person that is outside the premises from which it is emitted, or</p> <p>(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.</p>	5.1.3												
O4.3	<p>The licensee must maintain, and implement as necessary, a current Pollution Incident Response Management Plan (PIRMP) for the premises. The PIRMP must document systems and procedures to deal with all types of incidents (e.g. spills, explosions, fire) that may occur at the premises or that may be associated with activities that occur at the premises and which are likely to cause harm to the environment.</p>	8.1												
M8 Blasting														
M8.1	<p>To assess compliance with the blast limits presented at L5, blast monitoring must be undertaken in accordance with L5 at the following locations:</p> <p>Within 30 metres of the residences at the locations marked as "R98 Kyooma", "R11 Glenara" and "R62 43 Kurrara St, Werris Ck", and within 30 metres of the location marked as "R92 Werris Creek Middle" on the figure titled "EPL 12290 Licensed Monitoring Points", received by the EPA via email on 17 December</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">2015 (DOC16/111380). Parameter</th> <th style="width: 20%;">Units of Measure</th> <th style="width: 20%;">Frequency</th> <th style="width: 30%;">Sampling Method</th> </tr> </thead> <tbody> <tr> <td>Blast Noise</td> <td>dB (Lin Peak)</td> <td>Every Blast</td> <td>Type 1 Noise/Blast Logger</td> </tr> <tr> <td>Blast Vibration</td> <td>mm/s</td> <td>Every Blast</td> <td>Geophone Logger or similar</td> </tr> </tbody> </table>	2015 (DOC16/111380). Parameter	Units of Measure	Frequency	Sampling Method	Blast Noise	dB (Lin Peak)	Every Blast	Type 1 Noise/Blast Logger	Blast Vibration	mm/s	Every Blast	Geophone Logger or similar	7.2
2015 (DOC16/111380). Parameter	Units of Measure	Frequency	Sampling Method											
Blast Noise	dB (Lin Peak)	Every Blast	Type 1 Noise/Blast Logger											
Blast Vibration	mm/s	Every Blast	Geophone Logger or similar											


2.5 Blast Fume Management Implementation Strategy

In consultation with the NSW Minerals Council, the DPE requires coal mines to implement a two-stage blast fume management implementation strategy. The WHC Blast Fume Management procedure (**Appendix 1**) describes the WCCM management approach to achieving this strategy.

3 BASELINE CONDITION

3.1 Background Blasting and Inspections

Limited blasting occurs in the local area outside of WCCM, and is restricted to the various quarries and small scale specialist mines operating in the local area, such as the Werris Creek zeolite mine, which is located less than 5 kilometres northwest of WCCM. The soils in the local urban environment are dominated by black and red-brown earths and red and brown clays, while rural developments in

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the Quipolly area also containing alluvial soils. These soils pose moderate to very high limitations to urban land use with widespread foundation hazards. Investigations into the effects of blasting on local communities have shown significant geomechanical impacts on homes in Werris Creek as a result of these dynamic landscapes, with no discernible impacts from blasting.

3.2 Meteorological Conditions

Meteorological conditions have the potential to affect blasting processes and exacerbate impacts at WCCM. A meteorological station has been in operation at WCCM since 2005 to assess local meteorological conditions, most notably wind speed and direction in relation to blasting.

4 POTENTIAL ENVIRONMENTAL IMPACTS

4.1 Introduction

Blasting has the potential to impact on the surrounding environment as follows.

1. Airblast overpressure - The pressure wave generated at the time of blast detonation, which is often measured by the audible noise impact.
2. Ground vibration - The extent and rate of ground movement (in mm/s) created by the blast.
3. Dust - The energy expelled during each blast will cause particulate matter to lift and this may disperse beyond the immediate area surrounding the blast zone.
4. Blast fumes - A combination of geology, ground conditions, explosive type and blast design can result in the emission of gases, most notably oxides of nitrogen (NO_x), which may disperse from the blast zone. NO_x emissions can have adverse health impacts if inhaled in high concentrations.
5. Fly-rock - The energy used to fracture the rock can lead to material being projected from the blast zone.

4.2 Air Overpressure and Ground Vibration

Spectrum Acoustics (2010) completed a Noise (and Blasting) Impact Assessment for WCCM (supporting the application for the LOM development) and calculated air blast overpressure (OP) and vibration (PPV) levels for a range of MIC values. The results indicate that the ground vibration criterion of 5mm/s would not be exceeded at any receiver for the range of likely blast sizes.

Section 6 describes the management measures that are implemented to ensure that air overpressure and ground vibration comply with blast criteria.

4.3 Dust

Immediately following each blast, particulate matter is lifted from the ground and disperses into the air. This particulate matter, if small enough may remain airborne and is generally categorised by the diameter of the particulate matter as follows.

- PM_{2.5}: refers to particulate matter of diameter 2.5µm or less.
- PM₁₀: refers to particulate matter of diameter 10µm or less.



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- Total Suspended Particulates: refers to all airborne particulate matter.

Predictive modelling, air quality monitoring and the low number of complaints received with respect to dust from blasting indicates this is a relatively minor environmental issue, measures to reduce blast dust emissions are undertaken at WCCM and described within **Section 6**.

4.4 **Blast Fume**

See procedure WHC-PRO-WC-Blast Fume Management

4.5 **Fly-Rock**

The potential for fly rock, while unlikely, has been considered in the design of the blast parameters. The Division of Resources & Energy (DRE) generally recommends a safe exclusion distance of 500m for open cut coal mines, with Werris Creek Road and the Main Northern Rail Line occurring within this distance from the approved open cut. **Section 6** describes the management measures that are implemented to minimise the risk of impacts from fly rock on surrounding properties and public infrastructure.

5 **CRITERIA**

5.1 **Blast Criteria**

5.1.1 **Air Overpressure and Ground Vibration**

Table 5 presents the criteria for air overpressure and ground vibration for WCCM. These reflect the conditional requirements of the Modified PA and EPL 12290 outlined in **Section 2**.

Table 5 - Blast Criteria


<i>Location</i>	<i>Airblast Overpressure (dB(Lin Peak))</i>	<i>Ground Vibration (ppv) (mm/s)</i>	<i>Allowable Exceedance</i>
Any residence on privately-owned land	115	5	5% of the total number of blasts over a period of 12 months
	120	10	0%
All public infrastructure*	-	50	0%

*Public Infrastructure includes ARTC rail culvert 406-099 and rail line including embankments and cuttings within the rail corridor.

The criteria of **Table 5** do not apply where a private agreement is in place between WCC and the landowner or at residences owned by WCC. In the event of such an agreement, WCC will advise the DPE and EPA of the alternative blast criteria negotiated.

In addition to the above blasting criteria, there are other administrative compliance criteria that WCC must adhere to. Exemptions to these criteria are available in certain circumstances, and are outlined in **Section 6.1**. Administrative compliance criterion requires that:

- Blasts can only be fired between 9am to 5pm Monday to Saturday.
- No blasting on Sundays or Public Holidays.

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- No more than one blast per day, unless an additional blast is required following a blast misfire
- No more than 15 blasts per month.

The blasting frequency conditions (blasts per day and per month) do not apply to blasts that generate ground vibration of 0.5mm/s or less at any residence on privately-owned land, or blasts required to ensure the safety of the mine or its workers. The methods for evaluating compliance with these blast criteria are presented in **Section 7**.

5.1.2 Dust

There are no criteria specific to blast-related dust. Criteria for the overall dust emissions of WCCM are described and discussed in the *WCCM Air Quality and Greenhouse Gas Management Plan*.

5.1.3 Blast Fume

Blasting is required to be undertaken without emission of offensive blast fume from the premises. EPL 12290 defines an offensive blast fume as post-blast gases that by reason of their nature, duration, character or quality, or the time at which they are emitted, or any other circumstances:

- (i) Are harmful to (or is likely to be harmful to) a person that is outside the premises from which it is emitted; or
- (ii) Interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.

5.1.4 Fly Rock

There are no criteria applicable to fly rock.

6 MANAGEMENT STRATEGIES AND MEASURES

Management strategies and measures are described in the following sections for:

- Air overpressure & ground vibration;
- Dust;
- Fly rock
- Rail and Road Closures

A number of the controls, safeguards and management measures implemented to mitigate impacts on the environment and community are common to one or more of these environmental emissions / impacts. In such cases, management is described in detail when first identified, with only variations described in subsequent sections.

6.1 Air Overpressure and Ground Vibration Management Strategies

WCC have implemented a range of management strategies to minimise the impact of air overpressure and ground vibration from blasting activities on neighbours. These management strategies include:



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Buffer Management - WCC has acquired a number of adjacent properties through private negotiation since the commencement of mining to alleviate any current or future environmental impacts on these residents.

Blast Design - Given the environmental and community aspects associated with the proximity of Werris Creek Road and Werris Creek town to WCCM, blasts are designed with consideration of the predicted vibration of the shot, geology, ground conditions, explosives selection, initiation sequence/timing, powder factor, history/experience, the sleeping time of the shot

Pre-Blast Vibration Prediction – Part of the blast design process involves calculating the predicted ground vibration for the Werris Creek Township, with the objective to maintain ground vibration less than 0.8mm/s. Where this is not practical for operational or other reasons, the Operations Manager may approve a predicted ground vibration greater than 0.8mm/s.

Burden Profiling – As part of the blast design process, the drill area will be surveyed (face profiling) to ensure adequate burden width, to minimise the risk of high overpressure levels and fume generation. Where relevant, the erection of “dig fences” at a 10 meter stand-off between the excavation face and drill preparation areas will be undertaken. This physical control provides a visual marker for the excavator operator so they do not over dig the face and ensuring sufficient burden remains between the dig face and the new blast.

Drilling – Drillers are required to log details of each hole such as broken ground and water. This information is provided back to the Blasting Engineer to confirm their blast design and is also an important consideration in the Pre-Blast Hazard Analysis.

Shot-firer Inspections - Following drilling of holes, the Shot-firers visually assess the surface of the shot and hole collars looking at the ground for cracks, slumping, missing holes and the drill cuttings, with this information used to confirm blast design and explosives selection.

Explosive Product Selection and Loading – A range of explosive products are available for use at Werris Creek Mine, with explosives selection dependent on ground type, the presence of water, and temperature of the holes. In the event of poor column rise during loading, the shot-firer will stop loading explosives and stem off the holes.

Stemming Height and Quality - To ensure the stemming volume is sufficient, the shot-firer will dip each hole to confirm that the column height is as per the load sheet. WCC requests stemming supply contractors to provide quality specifications, to minimise the risk of elevated air overpressure from rifling.

Initiation Sequence – A number of initiation strategies are used at various times to minimise vibration and air overpressure impacts.

Sleeping Shots - The period between blast loading and detonation will be minimised to avoid potential deterioration of product.

Blast Times and Frequency - WCC aims to fire all blasts in the middle of the day, generally between 12:00pm and 2:00pm, Monday to Friday. This is during the crib (lunch) break of production operators and is also when atmospheric mixing is generally highest. Circumstances may arise due to production scheduling or weather conditions that require blasts to be fired



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outside that time period. In accordance with the blast criteria (**Section 5.1**), blast times and frequency are constrained by the following with exceptions outlined in **Table 6** below:

- Blast between 9am to 5pm Monday to Saturday¹;
- No blasting on Sundays or Public Holidays¹;
- Limited to one blast per day²; and
- Limited to 15 blasts per month³.

Table 6 - Exemptions to Blast Times and Frequency Limits


Specific Condition	Action Required
1 Blast required to be fired before 9am or after 5pm or on a Sunday or Public Holidays because of: <ul style="list-style-type: none"> • Misfire and safety hazard to operations; • Potential for lightning to trigger blast; • Underground fire potential to trigger blast; • Other justified safety concern for a blast. 	1. Notify Environmental Officer/Operations Manager and describe the safety hazard or issue 2. Environmental Officer/Operations Manager to obtain written approval from DPE and EPA prior to firing (EPL 12290 Condition L5.5 and PA 10_0059 Schedule 3 Condition 7) 3. Implement any further conditions imposed by DPE and EPA
2 Second blast ¹ required to be fired between 9am and 5pm Monday to Saturday because of: <ul style="list-style-type: none"> • First blast did not exceed 0.5mm/s at any community monitoring location; • Misfire and safety hazard to operations; • Potential for lightning to trigger blast; • Underground fire potential to trigger blast; • Other justified safety concern for a blast. 	1. Notify Environmental Officer/Operations Manager and describe the safety hazard or issue 2. Check blast monitoring results if vibration <0.5mm/s 3. Environmental Officer/Operations Manager to notify the EPA and community prior to firing second blast (EPL 12290 Condition L5.7)
3 More than 15 blasts required for any calendar month because of: <ul style="list-style-type: none"> • Blasts during the month were less than 0.5mm/s at any community monitoring location; • Misfires; • Other justified safety concern for a blast. 	None

Note 1: WCC defines a second blast as being triggered more than one minute after the first blast regardless whether it is in the same or different area/location in pit. Two shots from different areas of the pit can be fired together as one blast as long as they are initiated together within 60 seconds of start to finish.

Blast Notification - Prior to every blast, the Blast Notification Webpage on the Whitehaven Coal website will be updated to include the blast date and time.

Daily Blast Planning – On the morning of any planned blast the weather forecast is reviewed, which may be used to guide proposed blast times and other management controls.

Pre-Blast Hazard Assessment – The *Environmental Blast Hazard Checklist* will be completed prior to any blast to assess the individual risk characteristics for vibration and air overpressure, as well as fume and dust generation. If the relevant blast hazard is considered “Negligible”, no additional controls are required to be implemented in the blast design or at the time of firing the shot. If the hazard is considered “Elevated” or “Substantial”, then additional controls will be implemented in the blast design, loading, or at the time of firing and documented in the *Environmental Blast Hazard Analysis* checklist. Personnel involved in completing the checklist will sign off on the agreed hazard ratings and controls.

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Pre-Blast Weather Assessment – Prior to blast initiation, real-time meteorological conditions are reviewed to confirm suitability. While exceptions may occur to satisfy safety or production requirements (including warm and hot shots where there is a risk of unplanned detonation), blasting is generally not undertaken when the 5 minute average weather conditions present:

- Wind direction is towards Werris Creek town (wind arc determined for each individual shot for blasts with elevated or substantial hazard rating) at any wind speed;
- Wind speed is greater than 8.9m/s in any direction; and/or
- Temperature inversion is present (i.e. positive lapse rate $>+0^{\circ}\text{C}/100\text{m}$).

Structural Inspections - In the event of a claim of property damage due to blasting by a resident of Werris Creek or Quipolly, WCC will organise a Property Investigation in accordance with PA 10_0059 Schedule 3 Condition 10.

In accordance with a risk assessment completed as part of the executed “Blasting Deed 22nd April 2010 between Australian Rail Track Corporation Limited and Whitehaven Coal Limited”, WCC coordinates structural inspections of the ARTC Railway Culvert every 12 months; and in the event of vibration results being greater than 50% of the allowable PPV limit of 50mm/s or as requested by ARTC.

6.2 Dust Management Strategies

WCC have implemented a range of management strategies to limit the generation of dust from blasting activities and reduce its impact on neighbours. These management strategies include:

Buffer Management – As described above, WCC has acquired a number of adjacent properties thorough private negotiation since the commencement of mining to alleviate any current or future environmental impacts on these residents.


Blast Design – Further to the controls described above, consideration will be given to blasting weathered material in the upper horizons of the pit where dust generation potential is elevated.

Drilling – In order to minimise dust generation during drilling, drill rigs utilise a combination of curtains and water sprays.

Stemming Height and Quality – Effective stemming as described in the previous subsection can ensure the energy of the blast is contained within the burden, reducing the generation of dust.

Electronic detonation - Generally, the use of Nonel, or electronic detonation is undertaken for production blasts removing the requirement for detonating cord downlines which prevents the dust cloud that is formed when cord trunklines detonate on dry dusty surfaces.

Blast Times and Frequency – As described above, WCC aims to fire all blasts in the middle of the day when the circulation of the lower atmosphere has reached its maximum mixing depth and improves dispersion of any potential overpressure, dust or fume that could be generated by the blast.

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Blast Notification – As described above, the Blast Notification Webpage on the Whitehaven Coal website will be updated prior to every blast to include the blast date and time.

Daily Blast Planning – On the morning of any planned blast the weather forecast is reviewed, which may be used to guide proposed blast times and other management controls, especially in the event of significant changes in wind speed and direction.

Pre-Blast Hazard Assessment – As previously described, the *Environmental Blast Hazard Checklist* will be completed prior to any blast to assess the individual risk characteristics related to dust generation.

Pre-Blast Weather Assessment – As previously described, the shot-firer will seek confirmation prior to blast initiation that weather conditions are suitable for blasting.

6.3 Fly Rock Management Strategies

WCC have implemented a range of management strategies to minimise the potential of personal injury or equipment damage from fly rock projected from blasts. These management strategies include:

Buffer Management – As described above, WCC has acquired a number of adjacent properties thorough private negotiation since the commencement of mining to alleviate any current or future environmental impacts on these residents.

Blast Exclusion Zone - Minimum exclusion zones maintained by sentries are established prior to any blasting activity at WCCM, including all personnel at least 500m away and all mine equipment at least 300m away, unless agreed by shot-firer and Blast Coordinator.

Blast Design – As described above, effective blast design will minimise the generation of fly rock from blasting activities.

Blast Notification – As described above, the Blast Notification Webpage on the Whitehaven Coal website will be updated prior to every blast to include the blast date and time, including whether the Werris Creek Road may be closed for the blast.

Daily Blast Planning – As part of the daily blast planning process, sentry positions are identified to ensure blast exclusion zones are maintained.

Road and Rail Closures – When blasts are planned within 500m of Werris Creek Road and the Main Northern Rail Line, road and rail closures are undertaken as described in the previous subsection. These closures will ensure protection of the public from fly rock.

6.4 Road and Rail Closures

When blasts are planned within 500m of Werris Creek Road and the Main Northern Rail Line, road and rail closures are undertaken as summarised below:

Blasts Within 500m:



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- Werris Creek Road will be closed, however, the Main Northern Rail Line will remain open.
- Signage on Werris Creek Road day of the blast
- Notification of road closure will be provided 7 days ahead of a required road closure to Liverpool Plains Shire Council (LPSC) and local emergency services.
- Sentries will be placed on Werris Creek Road. The sentries will close the road when advised by the Shot-firer. Once the blast is completed the sentries will inspect the road for debris, remove (in the unlikely event of occurrence) and re-open the road within 15 minutes of closure.
- If weather conditions change following road closure, such that they are no longer favourable for blasting, the road will be reopened as soon as practicable to allow stopped traffic to pass.

Blasts Within 200m

- Werris Creek Road and the Main Northern Rail Line will be closed.
- Closure procedures for Werris Creek Road will be as above.
- A short-notice possession of the rail line will be organised with the Australian Rail Track Corporation (ARTC) who will reschedule rail pathways around the blast.
- ARTC recognised Protection Officers will escort WCC personnel to inspect the rail line.

WHC_PRO_WC_Road and Rail Closure Procedure has been approved by LPSC and Roads and Maritime Service who are the gazetted road authority for Werris Creek Road and is in accordance with the executed "Blasting Deed 22nd April 2010 between Australian Rail Track Corporation Limited and Whitehaven Coal Limited".

Werris Creek Road may also be closed to reduce potential dust impacts to drivers when blasting further than 500m from the road, as determined by the Pre-Blast Hazard Assessment and pre-blast weather assessment.

7 **BLAST MONITORING PROGRAM**

7.1 **Introduction**

Monitoring is undertaken in accordance with *Condition 3(13) (e)* of the Modified PA and Condition L5.8 of EPL 12290.

The blast monitoring methodology aims to provide measurement of blasting impacts that are representative of the most affected community residences or sensitive locations to the north, east and south of WCCM (and which are not company owned or subject to a private agreement).

7.2 **Air Overpressure and Ground Vibration**

7.2.1 **Monitoring Locations**

Four privately owned properties have been selected to monitor potential blasting impacts against compliance criteria and are representative of the most affected community locations in proximity to WCCM (**Table 7** and **Figure 2**).



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Table 7 - Blast Monitoring Locations

Monitor Type	Purpose	Property/Location Description	Frequency	Orientation to WCCM	Distance (km)
Permanent	Community	R11 "Glenara"	Every Blast	South	3.2
Permanent	Community	R98 "Kyooma"	Every Blast	East	2.9
Permanent	Community	R62 Werris Creek South	Every Blast	Northeast	3.7
Permanent	Community	R92 Werris Creek Middle	Every Blast	Northeast	4.4
Portable	Infrastructure	Railway Culvert #406-099	Every Blast within 500m of Rail Line	East	0.3

Note: Grey shading indicates blast monitoring will be undertaken infrequently

The four permanent community monitoring locations have been established to record the air overpressure and ground vibration for each blast event. Two of the monitoring locations are to the north of WCCM within the town of Werris Creek (R62 and R92), in recognition of the increasing exposure to blasting as WCCM develops to the north toward this urban population. Monitoring of residences to the east (R98) and south (R11) are representative of community receptors in those locations. In addition, a portable blast monitor will be used to monitor air overpressure and vibration when blasting within 500 metres of the railway line.

7.2.2 Inspections

A Post blast inspection of the Railway culvert #406-099km will be undertaken when Category B blasting has occurred (<100m from ARTC infrastructure), as per Schedule A of the Blasting Deed.

7.2.3 Blast Monitoring Equipment


The permanent blast monitors are fixed units installed at each community location and are installed in compliance with Australian Standard AS2187.2-2006. Monitoring is recorded via a website interface which enables blast results to be reported (by SMS and email), with the complete waveform/trace available via the website for detailed analysis) in near real time.

A portable blast monitor is used for every blast within 500m of the Main Northern Rail Line in accordance with the executed "Blasting Deed 22nd April 2010 between Australian Rail Track Corporation Limited and Whitehaven Coal Limited".

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Figure 2 - Blast Monitoring Sites at WCCM

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7.3 **Blast Fume**

Monitoring of blast fume is undertaken as per procedure WHC-PRO-WC-Blast Fume Management (**Appendix 1**).

8 **REPORTING**

8.1 **Incident Reporting**

In the event of an environmental incident such as an exceedance of blasting limits, the relevant agencies will be notified as soon as practicable after WCCM personnel become aware of the incident.

In the event of a pollution incident, such as the movement of blast fume off the mine lease, the WCCM PIRMP will be implemented and relevant PIRMP reporting requirements adhered to.

Within 7 days of the date of the incident, WCC will provide the relevant agencies with an incident report inclusive of:

- Describe the date, time, duration and nature of the exceedance/incident;
- Identify the type and concentration of every pollutant discharged;
- Identify the cause (or likely cause) of the exceedance/incident;
- Describe what action has been taken to date; and
- Describe the proposed measures to address the exceedance/incident.

8.2 **Complaints**

WCC maintains a designated community complaints line (02 6768 7001) which is regularly published through community newsletters, in the Werris Creek Flyer and sign-posted on the front entrance to WCCM. Formal complaints are investigated and reported both internally and externally on the Whitehaven Coal Website.

8.3 **Regular Reporting**

WCC will provide regular reporting on the environmental performance of blasting on the Whitehaven Coal website, via EPL reports and Annual Reviews.

9 **REVIEW**

This document will be reviewed in accordance with the requirements of Schedule 5, Condition 4 of the Modified PA.



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10 CONTINGENCY PLAN

WCC is required to implement a contingency plan to manage any unpredicted impacts and their consequences. In regards to contingency plans for blast management, WCC have a number of management strategies that would identify unpredicted blast impacts and management measures to mitigate or ameliorate those impacts.

The need to implement blast contingency plans will be identified by WCC using the reporting processes in **Table 8**.


Table 8 - Identification of Blast Contingency Plan Triggers

Reporting Process	Frequency	Method	Section
Community Complaint	As required	Complaint investigation identifies blast impact outside predicted impact or exceeds blast criteria	8.1
Air Quality Non-compliance (Incident)	As required	Incident investigation identifies blast impact outside predicted impact, non-compliance or exceeds blast criteria	8.1
Annual Review	Annual	Blast monitoring results trend outside predicted impact or blast management measures not effective at mitigating blast impacts	8.3

A number of management measures and actions already discussed in the BMP can be implemented as blast contingency plans are outlined in **Table 9**.

Table 9 - Blast Management Contingency Plans

Contingency Plan	Method	Section
Community Complaint	Response to community complaint outlining contingency plan actions to be implemented to the satisfaction of the complainant and DPE/EPA if involved	9
Blast Non-compliance (Incident)	Response to relevant government departments regarding non-compliance outlining contingency plan actions to be implemented to the satisfaction of the relevant government departments	8.1
Blast Design	Modify future blast designs to prevent further blast impacts	6
Predictive Vibration Site Limits	Develop specific predictive vibration site limits for complainant to prevent further blast impacts	6
Pre-Blast Weather Check	Modify pre-blast adverse weather wind rose to prevent further blast impacts	6
Blast Notification	Modify blast notification process to prevent further blast impacts	6
Structural Inspections	Engage independent structural engineer to undertake Property Investigation to determine blast impact. If blast impact has damaged structural, WCC undertake repairs	6

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11 REFERENCES

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AS 2187.2-2006 Explosives - Storage and use - Use of explosives.

AS 2923 -1987: Guide for measurement of horizontal wind for air quality applications. Assessing Vibration: A Technical Guideline (DEC, 2006).

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Spectrum Acoustics Pty Ltd, Noise (and Blast) Impact Assessment for Werris Creek Coal Mine Life of Mine Project 2010

The Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).

Werris Creek Coal Pty Ltd, Life of Mine Mining Operations Plan for the Werris Creek, December 2015

WHC-PRO-WC-Blast Fume Management

WHC_WC_PRO_Pollution Incident Response Management Plan

WHC-PRO-WC-Road and Rail Closure Procedure

WHC_WC_PRO_Pre-Blast Environment Management Procedure



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12 Appendix 1

***WHITEHAVEN COAL
PROCEDURE
Werris Creek Coal
Blast Fume Management***

Edition	Rev.	Comments	Author	Authorised By	Date
1	1	Original	Environmental Officer	Operations Manager WCC	14 September 2014
2	1	Draft for comment	Environmental Officer	Operations Manager WCC	29 th September 2016




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1 SCOPE

This procedure outlines the specific management actions to be implemented by Werris Creek Coal (WCC) in line with the strategies outlined in WHC_PRO_OC_BLAST FUME MANAGEMENT and the Australian Explosives Industry and Safety Group (AEISG, 2011) Code of Practice – Prevention and Management of Blast Generated NOx Gases in Surface Blasting

This procedure applies to the Project Area and all personnel involved in the purchasing of explosives, blast design, drilling, loading and firing of explosives.

2 MAJOR HAZARDS

WHC_PRO_OC_BLAST FUME MANAGEMENT and AEISG (2011) outline in detail what blast fume is, however a brief description is the gases released from the incomplete detonation of explosives during a blast include nitric oxide (NO); nitrogen dioxide (NO₂) and other gases which are collectively known as fume. NO₂ gas produces the visible yellow to reddish colour plume.

The health and other hazards posed by blast fume at WCC include:

- Mine personnel exposed to fume;
- Werris Creek Road commuter exposed to fume;
- Near neighbours (tenants in Whitehaven Coal owned properties) exposed to fume;
- Werris Creek town or Quipolly resident exposed to fume;
- Non-compliance with Environment Protection Licence 12290 and Project Approval 10_0059 due to fume travelling off the mine lease boundary; and
- Community complaints due to fume causing visual impact and potential health concerns.

3 PROCEDURE

WHC_PRO_OC_BLAST FUME MANAGEMENT and AEISG (2011) outline in detail the causes of blast fume and general management strategies that can be employed to mitigate fume generation. This procedure addresses the specific management actions employed by WCC to reduce the risk of fume generation and the response/investigation/reporting resulting from any fume generated by blasts.

3.1 Blast Design

Blast designs will be developed to consider:

- Geological constraints such as weak or hard bands of overburden, coal bands and faults.
- Blast performance requirements in terms of fragmentation, heave, dig rates, etc.
- Control of potential blast impacts including flyrock, fume, overpressure, vibration etc.

Blasts design mitigations may include:

- Reducing bench heights or ensuring adequate relief in deep holes.
- Selecting explosives products appropriate to the blast design and ground conditions.
- Following manufacturer's recommendations for priming, timing and sleep time of bulk explosives.
- Increasing the level of control and QA/QC checks on deeper shots.
- Providing appropriate separation of blast holes and explosive decks.
- Reducing the powder factor or modifying the timing, depth or size of a blast.
- Reviewing forecasted weather conditions and proposed design pattern proximity to Werris Creek Road prior to design.



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3.2 Weather Conditions Prior to and During Explosive Loading

The WCC Drill and Blast Engineer will review the weekly weather forecast in the lead up to commencing loading explosives and if required, revise the blast design during loading based on the daily forecast and actual weather conditions in particular for rain. Given the maximum sleep time for shots at WCC (**Section 3.4**), the WCC Drill and Blast Engineer will modify the blast design if rain is forecast by changing explosive product selection for a water resistant product or if practicable; cutting off/reducing the planned shot size to fire a blast early. Firing a blast early minimises/eliminates the effect of wet weather on explosive desensitization/deterioration or the risk that wet weather will extend the sleep time beyond the limit of selected product.

3.3 Geology and Ground Conditions

The below table summarises the geology WCCM and outlines the strata with a previous history of generating fume from blasting. Based on the expected/known ground conditions encountered; each strata has been ranked as high, medium or low risk of fume generation during blasting activities.

Relative Level	Strata	Ground Condition		Fume History/Risk		
Natural Surface RL430m	Weathered Conglomerate	Clayey/Weathered		HIGH		
	Black Seam					
RL350m	Weathered Conglomerate	Clayey/Weathered		HIGH		
	A Seam					
	Sandstone Interburden	Wet	Dry	Medium	Low	
	B Seam					
	Sandstone Interburden	Wet	Dry	Medium	Low	
	C Seam					
	Sandstone Interburden	Wet	Dry	Underground	Medium	Low
DE Seam						
Sandstone Interburden	Wet	Dry	Medium	Low		
F Seam						
RL250m	Very Competent Sandstone	Wet		HIGH		
	G Seam					

The high/medium/low risk categories for the different strata/ground conditions are used to inform the WCC Drill and Blast Engineer blast design and planning process. For example, planned blast in high fume risk areas will consider shorter sleep times, conservative product selection appropriate to the fume risk and if during loading; planning the loading direction so in size in case of wet weather will allow the blast area to be cut off/reduced if practicable.

3.4 Sleep Time

Where possible blasts will be designed and planned to be fired within 5 days of first being loaded. Approval from the Operations Manager is needed for shots requiring longer sleep times up to a maximum of 7 days. The prevailing and forecast weather conditions as well as the fume history and risk rating will be taken into account when planning the required blast sleep time.

3.5 Pre-Blast Weather Assessment

WHC_PRO_WC_Pre-Blast Environment Management outlines the required steps that must be undertaken prior to firing a blast including the Pre-Blast Weather Check. Unless required under safety reasons, WCC generally does not blast when the 5 minute average weather conditions are:

- Wind Direction is 180° to 214° (towards Werris Creek town) at any wind speed;



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- Wind Speed is greater than 8.9m/s in any direction (Operations Manager approval required for wind speeds between 6 and 8m/s); and
- Temperature Inversion are present (i.e. positive lapse rate $>+0.0\text{C}/100\text{m}$).

If there is believed to be an increased risk of potential fume from a blast and forecast weather conditions or proximity to Werris Creek Road increases the risk of fume (if generated) leaving the mine site boundary; wind direction/speed criteria maybe increased and road closures as previously identified are in place.

3.6 Explosive Product/Precursor Manufacturer/Supplier

Whitehaven Coal has contractors that supply and load down hole bulk explosive products for WCC. The explosives contractor specialises in low density hybrid explosives that can impart the required energy to break rock with less explosives (reduced powder factor) and minimising potential fume generation. Indicative explosive product range typically used by WCC for the known ground conditions experienced include:

Clayey/Weathered	Wet	Dry	Underground
XLoad XL90, XL100	Generic Pumped Emulsion GPE70, GPE80 Load Through Water LTW70	XLoad XL90, XL100	Ambient Temperatures XLoad, XL90, XL100 Warm/Hot Temperatures HiDEX

WCC preferentially uses hybrid explosives which differentiates from standard explosives as the base material used in the manufacture is Ammonium Nitrate Mineral Oil (ANMO – not Ammonium Nitrate Fuel Oil as diesel is not used) and includes EPS (Expanded Polystyrene balls) to lower the explosive density. XLoad explosive product range numbering indicates the product density (i.e. XL100 = $1.0\text{g}/\text{cm}^3$) while Generic Pumped Emulsion and Load Through Water product range numbering indicates percentage emulsion (i.e. GPE70 = 70% Emulsion).


The explosives contractor routinely tests and calibrates load cells on auger or pump explosive load trucks and implement a QA system to test and confirm the specification of the bulk explosive formulation.

3.7 On Bench Practices and Shot Crew Education

The standard for drill bench preparation is subject to signoff/hand over process between the WCC Production and Drill & Blast departments requiring the bench surface to have been appropriately cleaned that it is safe for a drill, light vehicles and operators/shotfirers to work on. Consideration of drainage off the drill pad must also be installed in field to minimise water ingress down hole prior to and during explosives loading.

Given the likelihood of encountering wet holes (wet holes are defined as the presence of moisture or free water in the base of a drill hole) across all interburden strata at WCC; shotfirers will quantify the presence of water and preferentially dewater each hole to enable auger explosive loading trucks to load downhole. If the drill hole water recharges, the Drill & Blast Engineer will modify the planned explosive to a wet product (density $>1.0\text{g}/\text{cm}^3$) and use pump trucks with hoses to load the explosive to the base of the hole so that the explosive displaces the water. If WCC shotfirers identify dynamic water present in the planned blast area then the sleep time will be reduced and if practicable, will be cut off/reduced in size to blast earlier to mitigate potential fume generation.

Both WCC Drill & Blast Engineer and Shotfirers will plan the method and direction of loading that will allow the blast area to be cut off/reduced in size in case of wet weather. Shotfirers will also inspect holes for

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slumping after being loaded to give an indication of fume potential from the blast. WCC shotfirers will follow other Drill & Blast Management Plans and procedures including WHC_PRO_OC>Loading and Stemming Blast Holes and WHC_PRO_OC>Blast Clearance and Firing.

In accordance with the Whitehaven Coal Safety and Training Management System, all the WCC Blast Crew will be trained in new or modified procedures and retrained at two yearly intervals.

3.8 **Blast Exclusion Zones**

WHC_PRO_OC>Blast Clearance and Firing specifies the minimum exclusion zones for equipment and safety of personnel during blasting activities. A blast exclusion zone of 500m maintained by sentries is sufficient for the majority of blasts to protect the health and safety of personnel from exposure to blast fume; however, in the event that blast fume is generated and is travelling then the WCC shotfirer will call the fume rating and if required; advise the closest sentries to increase the exclusion zone.

3.9 **Road and Rail Closures**

When blasts are planned within 500m of Werris Creek Road and the Main Northern Rail Line, road and rail closures are undertaken as summarised below:

Blasts Within 500m:

- Werris Creek Road will be closed, however, the Main Northern Rail Line will remain open.
- Sentries will be placed on Werris Creek Road. The sentries will close the road when advised by the Shot-firer. Once the blast is completed the sentries will inspect the and re-open the road.
- If weather conditions change following road closure, such that they are no longer favourable for blasting, the road will be reopened as soon as practicable to allow stopped traffic to pass.

Blasts Within 200m


- Werris Creek Road and the Main Northern Rail Line will be closed.
- Closure procedures for Werris Creek Road will be as above.
- A short-notice possession of the rail line will be organised with the Australian Rail Track Corporation (ARTC) who will reschedule rail pathways around the blast.

WHC_PRO_WC>Road and Rail Closure Procedure has been approved by LPSC and Roads and Maritime Service who are the gazetted road authority for Werris Creek Road and is in accordance with the executed "Blasting Deed 22nd April 2010 between Australian Rail Track Corporation Limited and Whitehaven Coal Limited".

Werris Creek Road may also be closed to reduce potential dust impacts to drivers when blasting further than 500m from the road, as determined by the Pre-Blast Hazard Assessment and pre-blast weather assessment.

3.10 **Downwind Management, Near Neighbour Communication and Emergency Response**

If the above management actions are not adequate to mitigate the risk of blast fume to near neighbours and the community, then WCC will plan to manage the forecasted downwind area of the blast including communicating in advance with the four near neighbours ("Cintra", "Railway View", "Hillview" (company owned residence) and Zeolite Australia). If required, WCC can organise road closures for blasts >350m

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from Werris Creek Road in accordance with WHC_PRO_WC_Road and Rail Closure to minimise the risk to road commuters if easterly winds are not forecasted.

In the event that a significant fume event is generated by a blast and does travel leaving the mine site, WCC will implement WHC_PLN_WC_Pollution Incident Response management plan which includes a trigger for blast fume incidents and the relevant regulatory/emergency and community notifications (including the four near neighbours to WCC). The **Appendix** includes information on Blast Fume exposure and details on potential health impacts.

4 BLAST FUME RECORDING AND REPORTING

Blast fume is monitored by observation and all blast previously identified as a risk of producing fume will be captured through video footage and stored for a minimum of 1 year. Videos will capture the extent of any fume until it has dissipated. The blast fume is rated when at its greatest extent AEISG Code (2011) and the rating determined through consensus between key blasting personnel who observe the blast.

Blast fume reporting includes:

- Significant blast fume events Level 3 and above are investigated in accordance with WHC_PRO_OC_BLAST FUME MANAGEMENT;
- Blast fume events Level 3 that leave the mine site or Level 4 & 5 are to be reported to relevant agencies at the earliest opportunity; and
- All blast fume events leaving the mine site boundary trigger the WHC_PLN_WC_Pollution Incident Response management plan regulatory/emergency and community notification protocols.

5 SUPPORTING DOCUMENTATION

WCC Blast Management Plan
 WHC_PRO_WC_Road and Rail Closure
 WHC_PRO_OC>Loading and Stemming Blast Holes
 WHC_PRO_OC>Tying up Shots
 WHC_PRO_OC>Working in a Blast Area
 WHC_PRO_OC>Blast Clearance and Firing
 WHC_PRO_OC>Blast Planning and Record Keeping
 WHC_PRO_OC>BLAST FUME MANAGEMENT
 WHC_PLN_WC>Pollution Incident Response

Revisions	Revision Description	Who Consulted	Date
1	First Edition	WCC Operations Manager, Technical Services & D&B Engineer	10/09/2014
2	Updated to reflect changes to the Blast Management Plan	WCC Operations Manager, Technical Services, Environmental Officer, Health and Safety Specialist, D&B Engineer. DPE, EPA, LPSC, ARTC.	29/09/2016



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6 APPENDIX 1

Information for Medical Staff treating Patients exposed to NO_x (AEISG, 2011)

Those exposed to NO_x gases should seek immediate medical treatment and consideration should be given to placing those exposed under observation for at least 24 hours after exposure.

To assist medical staff the following guide should be provided.

Advice to Medical Staff

in the Treatment of Those Who Have Been Exposed to NO_x Gases.

The patient may have been exposed to NO_x. This is a gas usually produced on mines after the use of explosives. NO_x consists of multiple combinations of nitrogen and oxygen (N₂O, NO, NO₂, N₂O₄, N₂O₃, N₂O₅). Nitrogen dioxide (NO₂) is the principle hazardous nitrous gas. NO_x irritates the eyes and mucous membranes primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. But this is not the only mechanism by which injury may occur. Inhalation results in both respiratory tract irritation and pulmonary oedema. High level exposure can cause methhaemoglobinaemia. Some people, particularly asthmatics, can experience significant broncospasm at very low concentrations.

The following effects are commonly encountered after NO_x exposure:

ACUTE

- Cough
- Shortness of breath
- Irritations of the mucous membranes of the eyes, nose and throat

SHORT TERM

- Pulmonary oedema which may be delayed for up to 4-12 hours

MEDIUM TERM

- R.A.D.S. (Reactive Airways Dysfunction Syndrome)
- In rare cases bronchiolitis obliterans which may take from 2-6 weeks to appear


LONG TERM

- Chronic respiratory insufficiency

High level exposure particularly associated with methhaemoglobinaemia can cause chest pain, cyanosis, and shortness of breath, tachapnea, and tachycardia. Deaths have been reported after exposure and are usually delayed. Even non irritant concentrations of NO_x may cause pulmonary oedema. Symptoms of pulmonary oedema often don't become manifest until a few hours after exposure and are aggravated by physical effort. Prior to transfer to you the patient should have been advised to rest and if any respiratory symptoms were present should have been administered oxygen. The patient will need to be treated symptomatically but as a base line it is suggested that the following investigations are required:

- Spirometry
- Chest x-ray
- Methheamoglobin estimation

Because of the risk of delayed onset pulmonary edema it is recommended that as a precaution the patient be observed for up to 12 hours. As no specific antidote for NO_x exists, symptoms will have to be treated on their merits.

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Toxicology of NO_x (AEISG, 2011)

Only one study (CSIRO Australia, 2007) has been found which attempts to quantify the size, concentration and longevity of post-blast gas plumes under realistic conditions pertaining to open cut mining [1].

However, the toxicology of NO_x is well understood from controlled medical studies and this knowledge is embodied in exposure limits defined by organisations such as the US Environmental Protection Agency (EPA) and US National Institute for Occupational Safety and Health (NIOSH).

The US EPA has compiled sets of Acute Exposure Guideline Levels (AEGs) which represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours [2].

The other relevant standards are known as IDLH levels (Immediately Dangerous to Life and Health) which have been determined by NIOSH [3]. These exposure limits are not considered relevant for public health scenarios, but are generally applied when selecting respirators in an industrial situation.

The toxicology of NO_x is summarised below, but more information including detailed definitions of AEGs and IDLH is contained in Appendix 6.

Nitric Oxide (NO)

Under normal conditions, NO is actually formed at low levels in the body and it serves as an important regulator molecule for the human cardiovascular, immune and nervous systems [4]. NO is even used therapeutically for the treatment of several conditions (for example: adult respiratory distress syndrome and frequent pulmonary hypertension in newborns). However nitric oxide can be toxic in larger amounts because it combines with haemoglobin in the blood and prevents its normal oxygen-absorbing function. The toxicology of NO is complicated by the spontaneous formation of NO₂ which has its own adverse effects on the body. As a consequence, the toxicity of NO_x is guided by the levels set for NO₂.

Nitrogen Dioxide (NO₂)

The first toxic effects observed with NO₂ exposure [5] are related to irritation of the airways and eyes. These effects have been studied many times with human volunteers in control environments. Because NO₂ is not very soluble in the moist airways, some gas can reach deep into lungs, causing delayed effects, notably pulmonary oedema (fluid in the lung), which can cause death. Normally, asthmatics or people with chronic lung conditions (eg bronchitis) are considered to be the individuals most 'at risk' in the general population. As with many toxic substances, the observed effects depend on both the concentrations and duration of exposure (Table 1).



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Table 1. Summary of toxic effects verses NO₂ levels

NO₂ (ppm)	Exposure period	Response in Healthy Adults
0.04-5		Odour threshold
0.3-0.5	2 hr	Decreased lung function, cough and dry throat and mouth.
20	30 min	IDLH level (Immediately Dangerous to Life or Health)*
30	40 min	Tickling sensation in nose and throat
30	70 min	Burning sensations and cough
30	2 hr	Deep chest burning sensations, shortness of breath
80	3-5 min	Chest tightness
90	40 min	Fluid in the lung

* IDLH is defined by the US National Institute for Occupational Safety and Health (NIOSH) as the exposure that is “likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment”. The IDLH standard was developed to assist in selecting respirators in a work situation. It should be noted that delayed pulmonary oedema may not be accompanied by any other significant symptoms. This has been considered in the Acute Exposure Guideline Levels (AEGl) (see Appendix 6). It is recommended to consult other authorities (medical) for further advice.