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1.0 INTRODUCTION

Maules Creek Coal Pty Ltd (MCC) is required to prepare a Blast Management Plan (BLMP) for the Maules Creek Coal Mine (MCCM) in accordance with Project Approval (PA) 10_0138 Condition 25. The MCC project involves the development of a 21 year open cut coal mining operation and associated infrastructure.

1.1 Background

The ownership of the Project currently lies with the Maules Creek Coal Joint Venture (MCCJV), which is 75% owned by Aston Coal 2 Pty Limited (a company 100% owned by Whitehaven Coal), 15% owned by Itochu Coal Resources Australia Maules Creek Pty Ltd (ICRA MC) and 10% owned by J-Power Australia (J-Power).

The Project is an open-cut coal mine located on the northwest slopes and plains of NSW in the Gunnedah Coal basin.

Land-use in the local area is dominated by agricultural operations and open cut mining, with rural residential holdings mainly located to the north and west of the Project. The Project boundary is situated on land largely occupied by the Leard State Forest (which has historically been predominantly utilised for forestry, recreation and more recently mining related activities). Various coal mines exist within close proximity to the Project including Boggabri Coal Mine, Tarrawonga Coal Mine and Goonbri Exploration Lease located to the southeast of the Project boundary.


There are several isolated rural residences associated with the surrounding farms within the vicinity of the Project, as well as the Fairfax Public School located in the Maules Creek Village. The surrounding terrain is gently undulating in the north, with steeper slopes emerging near ridgelines towards the central portion of the project. Much of the higher ground and steeper slopes retain moderately dense woodland cover, which forms part of the National Parks and State Forests occurring within the region.

1.2 Project Description

MCC submitted a Project Application to the NSW Department of Planning and Environment (DP&E) (formerly Department of Planning and Infrastructure (DP&I)) in August 2010 for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to enable the construction and operation of the MCCM. The application was supported by an Environmental Assessment (EA). Project Approval 10_0138 (PA 10_0138) was granted on 23 October 2012 by the Planning Assessment Commission under delegation of the then Minister for Planning and Infrastructure. The location of the MCCM project is presented in **Figure 1**.

The approval for the MCCM allows for the construction and operation of an open cut coal mine until 2034. In particular, the approvals allow for the following aspects and activities:

- Open cut mining operation extracting up to 13 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal to the Templemore Seam;
- Open cut mining fleet including excavator / shovels and fleet of haul trucks, dozers, graders and water carts utilising up to 470 permanent employees;
- Coal Handling and Preparation Plant (CHPP) with a throughput capacity of 13 Mtpa ROM coal;

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- Tailings Drying Area;
- Rail spur, rail loop, associated load out facility and connection to the Werris Creek to Mungindi Railway Line;
- Water Management infrastructure including a water pipeline, pumping station and associated infrastructure for access to water from the Namoi River;
- Supporting power and communications infrastructure;
- Explosive magazine and storage areas;
- Mine Access Road; and
- Administration, workshop and related facilities.

1.3 Scope

This BLMP has been prepared in accordance with the requirements of PA 10_0138. The aim of this plan is to manage project specific and cumulative blast impacts associated with the operation of the MCCM. This BLMP is a requirement of Schedule 3, Condition 25 of PA 10_0138.

1.4 Objectives

The objectives of this BLMP are to:

- Ensure that operational blast ground vibration and overpressure from activities associated with the MCCM are minimised;
- Maintain compliance with those conditions of the Project Approval, Environment Protection Licence 20221 (EPL 20221) and relevant legislation relating to blasting;
- Provide a protocol for monitoring and evaluation of blast impacts on surrounding private residences and sensitive receivers;
- Manage MCCM specific and cumulative blast impacts associated with the mining operations; and
- Effectively communicate with the local community and regulators regarding blasting related activities to ensure that they are kept informed of these activities.

Approval requirements relating to the MCCM's blasting activities are addressed in **Section 2.0**.

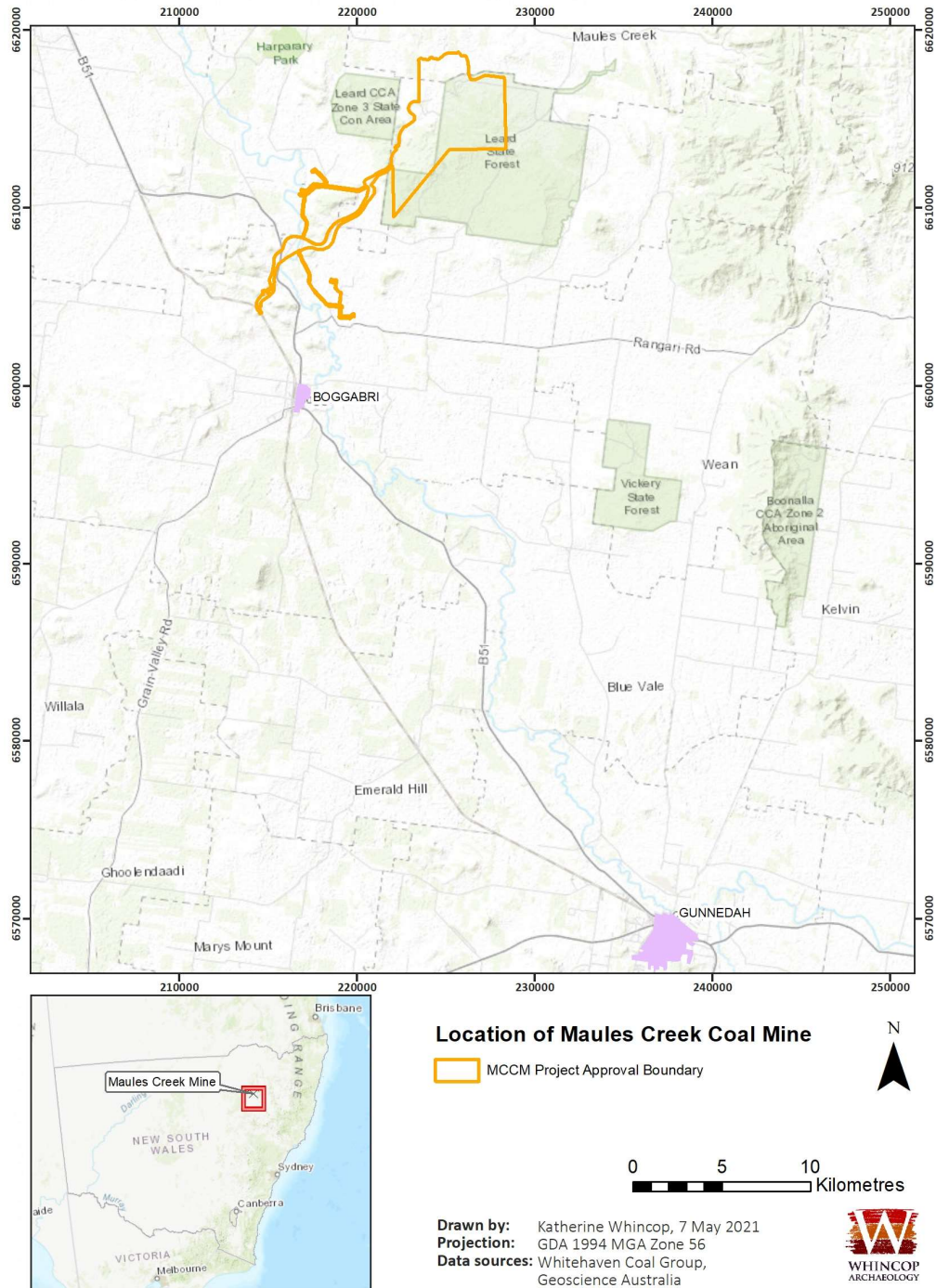



Figure 1 Project Locality Plan

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2.0 STATUTORY REQUIREMENTS AND COMMITMENTS

This BLMP has been prepared to fulfil the requirements of relevant legislation, approval conditions, EPL conditions, EA commitments, relevant standards and guidelines.

2.1 Relevant Legislation

The *Protection of the Environment Operations Act 1997* (POEO Act) is the principal piece of legislation governing blast emissions in NSW. The POEO Act requires an EPL be held for mining operations such as the MCCM. Please refer to **Section 2.3**.


2.2 Project Approval Conditions

2.2.1 PA10_0138 – Blast Management Plan

This Blast Management Plan (BLMP) follows the management plan requirements specified in Schedule 3 Condition 25 of PA10_0138.

Table 1 Blast Management Plan Requirements

Condition	Requirement	Where addressed
Sch 3, Cn 25	<i>The proponent shall prepare and implement a Blast Management Plan for the project to the satisfaction of the Secretary. This Plan must:</i>	This document
Sch 3, Cn 25 (a)	<i>be submitted to the secretary for approval prior to undertaking any blasting activities on the site;</i>	Section Error! Reference source not found.
Sch 3, Cn 25 (b)	<i>be prepared in consultation with the EPA and interested members of the local community potentially affected by blasting operations;</i>	Section 4.3
Sch 3, Cn 25 (c)	<i>propose and justify any alternative ground vibration limits for public infrastructure in the vicinity of the site;</i>	Section 3.2.
Sch 3, Cn 25 (d)	<i>describe the measures that would be implemented to ensure:</i>	Sections 3.0, 4.0, 6.0

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	<ul style="list-style-type: none"> <i>best management practice is being employed; and</i> <i>compliance with the relevant conditions of this approval</i> 	
Sch 3, Cn 25 €	<i>include a road closure management plan for blasting within 500 metres of a public road, that has been prepared in consultation with Council;</i>	Section 5.4
Sch 3, Cn 25 (f)	<i>include a specific blast fume management protocol to demonstrate how emissions will be minimised including risk management strategies if blast fumes are generated;</i>	Sections 3.4, 4.2 and 6.0
Sch 3, Cn 25 (g)	<i>include a monitoring program for evaluating the performance of the project including:</i> <ul style="list-style-type: none"> <i>compliance with the applicable criteria; and</i> <i>minimising fume emissions from the site; and</i> 	Section 4.0
Sch 3, Cn 25 (h)	<i>include a Leard State Forest Mining Precinct Blast Management Strategy that has been prepared in consultation with the other mines within the Leard Forest Mining Precinct to minimise the cumulative blasting impacts of all the mines within the precinct</i>	Section 3.5

2.2.2 Blast Conditions

Schedule 3, Conditions 18 to 20 of PA 10_0138 provide the relevant blast criteria and other restrictions for the MCCM. The blast criteria are reproduced in **Table 2**



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Table 2 Blasting Criteria

Approval Condition				BLMP Reference
Schedule 3				
Blasting				
Blasting Criteria				
18. The proponent shall ensure that the blasting on site does not cause exceedances of the criteria in Table 7. Table 7: Blasting criteria				Section 3.4.2
Location	Airblast overpressure (dB (Lin Peak))	Ground Vibration (mm/s)	Allowable exceedance	
Residence on privately owned land	120	10	0%	
	115	5	5% of the total number of blasts over a period of 12 months	
All public infrastructure	-	50 (or alternatively a specific limit determined to the satisfaction of the Planning Secretary by the structural design methodology in AS 2187.2-2006, or its latest version)	0%	
However, these criteria do not apply if the Proponent has a written agreement with the relevant owner or infrastructure provider / owner, and the Proponent has advised the Department in writing of the terms of this agreement.				
Blasting Hours				
19. The Proponent shall only carry out blasting on the site between 9am and 5pm Monday to Saturday inclusive. No blasting is allowed on Sundays, public holidays, or at any other time without the written approval of the Planning Secretary .				Section 3.2
Blasting Frequency				
20. The Proponent may carry out a maximum of: (a) 1 blast a day; unless an additional blast is required following a blast misfire; and (b) 4 blasts a week, averaged over a calendar year; for the Project. This condition does not apply to blasts that generate ground vibration of 0.5mm/s or less at any residence on privately-owned land, or to blasts required to ensure the safety of the mine or its workers. <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>				Section 3 0


2.2.3 Blast Control and Management

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Schedule 3, Conditions 21 to 25 of PA 10_0138 describe the various blast management measures required; these are reproduced in **Table 3**

Table 3 Blast Management Measures

Approval Condition	BLMP Reference
Schedule 3	
Property Inspections	
<p>21. If the Proponent receives a written request from the owner of any privately-owned land within 2 kilometres of the approved open cut mining pit on site, for a property inspection to establish the baseline condition of any buildings and / or structures on his / her 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 is acceptable to both parties, to;</p> <ul style="list-style-type: none"> establish the baseline condition of any 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 project on these buildings and / or structures; and <p>(b) give the landowner a copy of the new or updated property inspection report.</p> <p>If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Planning Secretary for resolution.</p>	Section 6.3
Property investigations	
<p>22. If the owner of any privately-owned land claims that the buildings and / or structures on his / her land have been damaged as a result of blasting on site, then within 2 months of receiving this claim in writing from the landowner the Proponent shall:</p> <p>(a) commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties, to investigate the claim; and</p> <p>(b) give the landowner a copy of the property investigation report.</p> <p>If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damages to the satisfaction of the Planning Secretary.</p> <p>If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Planning Secretary for resolution.</p>	Section 6.3
Operating Conditions	
<p>23. During mining operations on site, the Proponent shall:</p> <p>(a) implement best management practice to:</p> <ul style="list-style-type: none"> protect the safety of people and livestock in the surrounding area; 	Section 3.4.2

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Approval Condition	BLMP Reference
<ul style="list-style-type: none"> protect public or private infrastructure/property in the surrounding area from any damage; and minimise the dust and fume emissions of any blasting; and minimise blasting impacts on heritage items in the vicinity of the site. <p>(b) coordinate the timing of blasting on site with the timing of blasting at other mines within the Leard Forest Mining Precinct to minimise the cumulative blasting impacts of these mines; and</p> <p>(c) operate a suitable system to enable the public to get up-to-date information on the proposed blasting schedule on site, to the satisfaction of the Planning Secretary.</p>	
<p>24. The Proponent shall not undertake blasting on-site within 500 metres of:</p> <p>(a) any public road without the approval of Council; or</p> <p>(b) any land outside the site that is not owned by the Proponent, unless:</p> <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 Department in writing of the terms of this agreement, or the Proponent has: <ul style="list-style-type: none"> demonstrated to the satisfaction of the Planning Secretary that the blasting can be carried out closer to the land without compromising the safety of the 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. 	Section 4.3
Blast Management Plan	
<p>25. The Proponent shall prepare and implement a Blast Management Plan for the project to the satisfaction of the Planning Secretary. This plan must:</p> <p>(a) be submitted to the Planning Secretary for approval prior to undertaking any blasting activities on the site;</p> <p>(b) be prepared in consultation with the EPA and interested members of the local community potentially affected by blasting operations;</p> <p>(c) propose and justify any alternative ground vibration limits for public infrastructure in the vicinity of the site;</p> <p>(d) describe the measures that would be implemented to ensure</p> <ul style="list-style-type: none"> best management practice is being employed; and compliance with the relevant conditions of this approval; <p>(e) include a road closure management plan for blasting within 500 meters of a public road, that has been prepared in consultation with Council;</p> <p>(f) include a specific blast fume management protocol to demonstrate how emissions will be minimised including risk management strategies if blast fumes are generated;</p> <p>(g) include a monitoring program for evaluating the performance of the project including:</p> <ul style="list-style-type: none"> compliance with the applicable criteria; and 	This document

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Approval Condition	BLMP Reference
<ul style="list-style-type: none"> minimising fume emissions from the site; and <p>(h) include a Leard Forest Mining Precinct Blast Management Strategy that has been prepared in consultation with the other mines within the Leard Forest Mining Precinct to minimise the cumulative blasting impacts of all the mines within the precinct.</p> <p><i>Note: The Leard Forest Mining Precinct Blast Management Strategy can be developed in stages and will need to be subject to ongoing review dependent upon the determination of and commencement of other mining projects in the area.</i></p>	<p>See separate document "BTM Complex Blast Management Strategy"</p>

2.2.4 Statement of Commitments

Appendix 5 of PA 10_0138 provides a consolidated Statement of Commitments, which summarises the key management and mitigation measures for the MCCM. The commitment relevant to blasting is presented in **Table 4**

Table 4 Statement of Commitments


PA 10_0138 Appendix 5 Statement of Commitments	
<p>4. The proponent will develop a staged EMS in consultation with relevant regulators (and the Aboriginal community where relevant) to the approval of DP&I [now DP&E] which shall comprise...</p> <p>...Environmental Monitoring Program (incorporating air quality, noise, blasting, ecology, Aboriginal heritage, surface water and groundwater)...</p>	<p>Section 3.4.2</p>

2.3 Environment Protection Licence

MCC is the licence holder of EPL 20221 for the MCCM premises. The EPL 20221 conditions relevant to blasting are presented below.

L5 Blasting

- L5.1 *The airblast overpressure level from blasting operations in or on the premises must not exceed 120dB (Lin Peak) at any time at monitoring points 31, 32, 33, or 34 as defined in Condition P1.4 of this licence.*
- L5.2 *The airblast overpressure level from blasting operations in or on the premises must not exceed 115dB (Lin Peak) for more than five per cent of the total number of blasts over each reporting period at any time and at monitoring points 31, 32, 33, or 34 as defined in Condition P1.4 of this licence.*
- L5.3 *The ground vibration peak particle velocity from the blasting operations carried out in or on the premises must not exceed 10mm/sec at any time at monitoring points 31, 32, 33, or 34 as defined in Condition P1.4 of this licence.*
- L5.4 *The ground vibration peak particle velocity from the blasting operations carried out in or on the premises must not exceed 5mm/sec for more than five per cent of the total number of blasts over each reporting period at monitoring points 31, 32, 33, or 34 as defined in Condition P1.4 of this licence.*

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L5.5 *Blasting operations on the premises must only be carried out between the hours 9am to 5pm, Monday to Saturday, inclusive.*

L5.6 *The hours of operation for blasting operations specified in condition L4.5 may be varied if 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.*

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 it is demonstrated to be necessary for safety reasons and the EPA and neighbours have been notified of the intended blast prior to the additional blast being fired.*

Note: *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.*

Note: *For the purpose 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.*

L5.8 *Condition L4.7 does not apply to blasts that generate ground vibration of 0.5 mm/s or less at any residence on privately- owned land, or to blasts required to ensure the safety of the mine or its workers.*

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.*

O4 Other operating conditions

Blast Fume


O5.1 *Offensive blast fume must not be emitted from the premises.*

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:

- (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.*

M7.1 To determine compliance with conditions L4.1 to L4.4 inclusive: a) Airblast overpressure and ground vibration levels must be measured and electronically recorded for monitoring points 31, 32, 33 and 34 for the parameters specified in Column 1 of the table below and b) The licensee must use the units of measure, sampling method and sample at the frequency specified opposite in the other columns.

Parameter	Units of measure	Frequency	Sample Method
Airblast overpressure	DB (Linear Peak)	All Blasts	Australian Standard AS 2187.2-2006

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Ground vibration peak particle velocity	millimeters/second	All Blasts	Australian Standard AS 2187.2-2006.
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- R4.3 The licensee must report any exceedence of the licence blasting limits to the regional office of the EPA as soon as practicable after the exceedence becomes known to the licensee or to one of the licensee's employees or agents.

2.4 Relevant Standards and Guidelines


Guidelines and standards applying to blasting for the MCCM include:

- ANZECC (1990) '*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*';
- Australian Standard AS 2187.2 2006 '*Storage and Use of Explosives*'; and
- AEISG (2011) '*Code of Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting*' (Code of Practice).Blast Management Measures

Best practice blast management procedures will be implemented at the MCCM to achieve acceptable outcomes (in terms of rock fragmentation, ground vibration, overpressure, flyrock, dust and blast fume). The Maules Creek Coal Project Environmental Assessment (Maules Creek EA) (Hansen Bailey, 2011) predicted that blast ground vibration is likely to remain well below the criteria for all privately owned residences. Similarly, airblast overpressure is likely to be less than criteria for all privately owned residences.

Notwithstanding, best practice control of ground vibration, airblast overpressure, flyrock, dust and blast fume will be achieved through procedures and safeguards including:

- Comply with the relevant internal procedural documents prior to the commencement of any blast;
- Best practice blast design and drill and blast practice in accordance with Australian Standard AS 2187.2 2006 '*Storage and Use of Explosives*';
- Pre-blast assessment for each blast and review of blast exclusion zones (generally 500m or as required) and fume management zone at a separate distance, if required, past the blast exclusion zone based on risk and pre-blast assessment (referred to in section 3.3);
- Use of a predictive air quality management system;
- Management of blast fume in accordance with the *Code of Good Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011); and
- Boggabri Coal, Tarrawonga Coal and Maules Creek Coal (BTM Complex) Blast Management Strategy (BMS) which addresses management of the cumulative blasting impacts of the adjacent mines.

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3.0 BLAST MANAGEMENT MEASURES

3.1 Blast Design

Blasts will be designed to meet best management practices (including the Australian Explosives Industry Safety Groups (AEISG) codes of practice) to ensure the blasting requirements in Schedule 3, Condition 18 and 23 of PA 10_0138 are met. A suitably qualified drill and blast engineer will consider the relevant MCC procedures, external guidelines and standards when developing and implementing blast designs.


To ensure compliance with regulatory limits, and to minimise the likelihood of significant blast impacts to neighbouring receivers, all blast designs will consider:

- The suitability of the planned blast location regarding proximity to roads and infrastructure, heritage items and adjoining non-mine owned land;
- Expected offsite ground vibration levels calculated based on a model, which utilises data from previous blasts;
- Expected offsite airblast overpressure levels calculated based on a model, which utilises data from previous blasts;
- Limiting the maximum instantaneous charge (MIC) as appropriate to minimise ground whilst ensuring the required rock breakage;
- The adequacy of stemming and suitability of material used;
- Appropriate initiation delays and detonation system;
- Dewatering requirements and selection of appropriate explosives types with regard to water resistance where dynamic or static water is present;
- Use of Blast hole liners where considered appropriate to mitigate ground conditions;
- Sleep time of the product to be loaded;
- Drilling accuracy and that adequate front row burden remains;
- Use of appropriate explosives considering ground conditions and potential fume risks;
- Reduction of powder factor or modification of the timing, size or depth of the blast if ground conditions require;
- Blasthole loading procedures; and

3.1.1 Drill and Blast Practices

To ensure blasts are carried out as designed, MCC employ appropriately qualified, licenced (where required) and experienced drill and blast personnel. Personnel receive adequate training to ensure their understanding of the following MCC drill and blast practices and associated issues that are implemented at MCCM.

- Drill report assessment;

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- Preparation and management of blasting work areas including drainage, grading, barricading, isolation and exclusion of non-authorised personnel from blasting work areas;
- Safe transport and handling of explosives and blasting accessories;
- Security requirements in relation to explosives, blasting work areas and explosives magazines;
- Blasthole monitoring prior to loading;
- Explosive selection;
- Explosive loading procedures, including primer placement;
- Blasthole loading sequence;
- Recognition and management of critical risks such as hot blastholes ;
- Blasthole dewatering requirements;
- Detection, prevention and management of water inflow to blastholes ;
- Management of blastholes that may have slumped after being loaded;


Blasthole stemming; Sleep time;

- Blast exclusion zone determination and management, including searching and clearance procedures;
- Fume management zone determination;
- Blast guard posting;
- PPE - including personnel gas monitors;
- Changes to conditions after explosives loading;
- Blast initiation warning system;
- Blast initiation system and procedures;
- Post blast gases identification, rating and reporting;
- Detection and management of misfired explosives;
- Meteorological influences including rainfall predictions;
- Dispersion model of potential fume and dust generation;
- Emergency response and other safety considerations (refer 3.3.8);
- Modelling of each blast for ground vibration, airblast overpressure and potential for fume using check sheets; and
- Review blast designs to manage ground vibration and airblast overpressure wave front.

3.2 Blast Scheduling

Blasting activities for the MCCM are permitted to occur within the hours described in Schedule 3, Condition 19 of PA 10_0138.

Following an independent blast fume modelling assessment which identified that during the cooler months in Autumn and Winter in the late afternoon, there is a slightly higher potential under highly unfavourable weather conditions for blast fume to migrate off the mine site dependent on wind direction, MCC has implemented additional restrictions on blast scheduling. As such, during these months (March to August), where possible

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MCC will schedule blasting to occur prior to 4pm. During Summer and Spring blasts will be scheduled to occur up until 5pm. Should a blast be required in the Autumn and Winter months after 4 pm MCC will:

- Assess the potential for fume generation with consideration to key items listed in 3.1.1. If it is considered likely that a level 3C (or higher) fume event could potentially leave the premises in the direction of a private receiver location, the blast will not be undertaken unless required for safety purposes;

If it is considered likely that a level 3C (or higher) fume could potentially leave the premises and a blast is required for safety purposes then MCC will:

- Notify potentially affected neighbouring residents regarding the potential of the level 3 event prior to blasting in accordance with Section 5.2; and
- Notify the DP&E and the EPA prior to blasting.

A blast schedule will be prepared to ensure:

- Cumulative impacts are minimised;
- Public notification is able to be achieved in a timely and efficient manner;
- Notification to site personnel is able to be achieved in a timely and efficient manner;
- Blasts are planned to occur in allowable hours; and
- No more than the weekly allowable number of blasts as described in Schedule 3, Condition 20 of PA 10_0138 are carried out (subject to the exception where blasts resulting in <0.5 mm/sec are not included in the total).

Variations to the planned schedule may be required in the event of unplanned factors such as, but not limited to, weather conditions (including approaching storms) and the need to load and/or fire at other times to avoid wet blast product and associated fume risk and misfires.


Blast scheduling will be informed by a predictive air quality management system, used to predict the optimum periods for blasting based on favourable weather conditions. This is aimed at preventing airblast overpressure greater than the relevant criteria at offsite receptor locations and directing any potential dust or fume away from neighbouring receptors.

Where a planned blast event is either 30 minutes prior or 60 minutes after the planned event, a new notification will be issued to local residents by Short Message Service (SMS) or phone call. Please refer to Section 5.2.

Further details of the predictive and real-time air quality management system are outlined in the BTM Complex Air Quality Management Strategy (AQMS).

3.2.1 Cumulative Blast Scheduling

Cumulative operational blasting will be monitored and managed using the communication protocol between the BTM Complex operations outlined in the BTM Complex BLMS. The BLMS satisfies the requirement for the Leard Forest Mining Precinct Blast Management Strategy which is required by Schedule 3, Condition 25 (h) of PA 10_013. The BLMS details the relevant cumulative blasting impact assessment criteria for each mine and outlines the management protocols that will be implemented within the BTM Complex to manage cumulative blast impacts.

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Protocols described in the BLMS will be used with the BLMP to ensure that blasting is coordinated to avoid cumulative impacts on sensitive receivers.

The key management measure for the mitigation of cumulative blast impacts will be the scheduling of blasts to prevent overlap between blast timing on adjacent mines. The schedule will be developed to ensure blasts are fired with a minimum 15 minute time gap between them to reduce any potential cumulative impacts.

3.3 Pre-Blast Assessment

Prior to each blast, a pre-blast assessment, including a risk and level for fume production, will be undertaken to ensure meteorological conditions are suitable and to determine the blast exclusion zone and fume management zone, if required. This pre-blast assessment will include consideration of the outputs of the predictive air dispersion modelling system (**Section 3.4**). Records of each pre-blast assessment will be retained. Meteorological conditions will be reviewed (wind speed, wind direction, cloud cover and possible temperature inversion conditions) to ensure the forecast model is accurate and meteorological conditions are suitable before approval to blast. An internal checklist has been designed to facilitate this process which is included in Appendix B of the Blast Fume Management Procedure.

3.3.1 Unfavourable Weather Conditions

The following outlines unfavourable/adverse weather conditions and the site response to those conditions.


When the site automatic weather station (AWS) records wind direction from the north (270° through to 90°) and wind speed greater than 8 m/s over successive readings, blasting will not occur unless required for safety reasons. Blasting will not occur when the AWS records wind direction from the south (90° through to 270°) and wind speed greater than 6 m/s over successive readings, unless required for safety reasons. If prior to the blast, a very low wind speed (< 1.5 m/s) is detected, further consideration will be given to other meteorological factors including the presence of inversions. If it is considered likely that a level 3C (or higher) fume event could potentially leave site in the direction of a private receiver, then blasting will be rescheduled unless required for safety reasons. If blasting is required due to safety reasons MCC will notify potentially affected neighbouring residents (Section 5.2), DP&E and the EPA (see *Regulator Consultation*). Review of weather records during blasts has occurred in developing the specific conditions outlined above. MCC will review blast performance, and associated weather conditions, following blasts and generation of fume rated level 3, or higher.

3.3.2 Management of Flyrock

Management of flyrock is achieved by appropriate controls at the blast design stage, including adequate stemming, suitability of material used and adequate front row burden. Prior to each blast, a blast exclusion zone will be determined to ensure protection to people and livestock, with an appropriate margin of safety added to the anticipated flyrock range.

3.3.3 Public Safety

A blast exclusion zone and sentry procedure will take into account the location of mine personnel on the lease at the time of detonation. Sentries, warning signs and warning barriers will be utilised on access roadways to address public safety when conducting blasts in proximity to forest areas.

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Additional information concerning blast fume safety management is provided in **Section 3.4.2** and detail of the road closure practice is provided in **Section 5.3**.

3.3.4 Blast Impact on Heritage Features

Sites at MCCM include aboriginal heritage sites and historic (non-aboriginal) heritage sites. Several measures will be implemented for the management of the protected sensitive Aboriginal archaeological and historical sites including identification during blast planning, consideration to flyrock, predictive ground vibration modelling and visual monitoring of significant sites within close proximity. Annual inspections are also undertaken of heritage sites in accordance with relevant management plans and monitoring of any grinding groove site or rock shelters that are identified within 500 metres of proposed blasting. Management measures are described in the MCC Aboriginal Archaeology and Cultural Heritage Management Plan and Historic Heritage Management Plan.

3.3.5 Air Vibrations (Overpressure) Management

Noise (the audible part of the air vibration spectrum) and airblast (the remaining sub-audible part of the air vibration spectrum) generation can be controlled by ensuring that all, or nearly all, of the explosion energy is consumed in fragmenting and displacing the overburden by the time the gases vent (via the broken burden rock and/or ejected stemming material) into the atmosphere. Blast events are designed to meet the relevant airblast overpressure and ground vibration criteria.

This objective will be met by ensuring that:

- Where practicable, the blast face is orientated away from or at an oblique angle to nearby residences;
- Blasthole spacing is implemented in accordance with blast design;
- The burden distance and stemming length are carefully selected and then implemented precisely;
- Appropriate materials (e.g. 20 mm aggregate) are used for stemming;
- Charges are initiated in the correct sequence and with inter-row delays that provide good progressive release of burden;
- The maximum weight of explosive detonated in a given delay period (the Maximum Instantaneous Charge - MIC) is limited to conservative and proven levels; and
- Conducting blasting during suitable meteorological conditions as described in **Sections 3.2 and 3.3.1**


3.3.6 Ground Vibration Management

When a confined explosive charge detonates, some of the liberated energy is manifested as seismic energy (i.e. as ground vibrations). The magnitude of ground vibrations depends upon:

- The MIC for the blast;
- The distance between the blast and a residence or sensitive structure; and
- The characteristics of the intervening material (rock, soils, geological structures, etc.) through which the ground vibration wave propagates.

Ground vibration is managed by ensuring:

- The minimum practicable weight of explosive detonates at an instant (i.e. minimising the MIC) by using the appropriate delay periods between blastholes; and

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- Most of the energy liberated by the charge(s) on a given delay number is consumed in providing good fragmentation, adequate displacement and/or a loose, easily excavated material, rather than in creating ground vibrations (i.e. by ensuring that the effective burden distance and sub-drill are not too large).

3.3.7 Dust Management

The application of best practice control measures to reduce particulate matter emissions from blasting at MCCM are described in further detail in this management plan and are summarised below:

- No blasting during adverse weather condition, unless for safety reasons;
- Blasts conducted during the day;
- Advising local residents of blasting times;
- Gravel stemming blastholes;
- A defined blast protocol in operation; and
- Coordination with surrounding mines.

The pre-blast assessment includes considerations of meteorological conditions to ensure suitability for blasting to occur and to minimise the potential for offsite dust impacts. Consideration is also provided to the blast size and location during the planning process.

Potential dust impacts from blasting will be managed through implementing the pre-blast assessment process outlined in **Section 3.3**.


3.3.8 Safety Management

The MCCM's project approval and EPL recognises additional blasts may be necessary to ensure the safety of the mine or its workers. Blasting may also be necessary during unfavourable weather conditions to ensure the safety of the mine or its workers.

Where blasting is required on a given day in addition to that allowed by the project approval and EPL, or during unfavourable weather conditions, MCC will utilise the Whitehaven risk management system to document and assess the level of risk of undertaking the blast. The risk assessment includes consideration to environmental impacts, health exposure and potential consequence to community stakeholders.

Following this assessment approval will be gained from the General Manager or delegate on the site at the time.

Notification will be provided to DP&E and EPA prior to the intended blast, MCC will notify potentially affected neighbouring residents in accordance with Section 5.2.

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3.4 Blast Fume Management

To ensure compliance with Condition O5.1 of EPL 20221, as detailed in **Section 2.3**, the blast fume management procedures outlined in **Sections 3.4.1 and 3.4.2** have been implemented at MCCM.

An assessment of the potential air quality impacts of blast fume from MCCM operations was undertaken by Todoroski Air Sciences (2015). This assessment reviewed local topography, prevailing meteorological conditions and conservatively modelled potential blast fume emissions from site over a one year period. The results of the Todoroski assessment indicated that there were no impacts to private residences or offsite exceedances of NO_x criteria, with the exception of potential risks for blasts occurring after 4:00pm (particularly in the autumn and winter months during poor inversion conditions). MCCM has implemented additional restrictions as outlined in Section 3.2 and also described in the BFMP Appendix A to minimise any potential risk for significant offsite blast fume impacts at private residential locations.


While the potential for offsite fume has been assessed as low, the following sections have been prepared to provide a protocol for the mitigation and management of post-blast fumes from blasting operations and are based on the AEISG (2011) Code of Practice. This provides the basis on which to make blasting decisions to minimise the incidence and severity of post-blast fume events at the MCCM.

3.4.1 Blast Fume Prevention

Blast fume generation is the result of a less than optimal chemical reaction of ammonium nitrate explosives during the blasting process. This results in the release of a mixture of gases, the primary gases of concern being nitric oxide (NO) and nitrogen dioxide (NO₂), collectively known as oxides of nitrogen (NO_x). Excessive fume generation can be the result of water and explosive mixing in the blasthole (geological and/or meteorological influences), the quality of explosive product supplied, appropriateness of the explosives for the ground conditions or contamination of the explosive product during loading and/or on bench.

Blast fume prevention measures that will be implemented are:

- Formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fume generation. MCC will work with the manufacturer and/or supplier to ensure products are authorised and come with appropriate quality control systems to ensure specifications are met;
- Geology: Where clay or other unfavourable geological conditions are identified, explosive product selection will be modified to suit conditions. When blasting in soft ground, or areas with a history of producing blast fume, increased blast clearance may also be required to ensure the safety of personnel;
- Inspecting the holes prior to loading to ensure that mitigation measures are implemented where there is:
 - Dynamic water or wet holes, and/or
 - Broken or cracked ground;
- Sleep Time: All blasts will be designed and planned to be fired within 7 days of first being loaded. Approval from the Operations Manager is needed for shots requiring longer sleep times. The prevailing and forecast weather conditions as well as the Fume Risk rating and manufacturers recommendations will be taken into account when considering blast sleep time; and
- Consideration of meteorological conditions in blast scheduling. For example a water resistant product would be considered if significant rainfall was forecast between the commencement of loading and the firing of the shot.

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Additionally, to minimise the likelihood of post-blast fume, the following measures will be undertaken:

- Blast sequences will be designed to minimise blasting without a free face;
- Using hole liners when the Drill and Blast Engineer and Shotfirer consider it appropriate to mitigate ground conditions and/or wet holes;
- Explosive product will be selected with consideration of the likelihood of moisture in the blasthole (including the presence of clay strata); and
- Shotfirer procedures will include QAQC measures to avoid product contamination during blasthole loading, this may include blastholes being “dipped” for depth and to detect the presence or absence of water, all results will be recorded.

The predictive and real-time air quality management system described in the BTM AQMS will be used to assist in predicting any blast plume path and possible dispersion of potential blast fume using inputs from the sites meteorological station. The drill and blast engineer will consider the predictive outputs of the system when scheduling blasting to minimise, where practicable, the risk of offsite impacts if a fume event were to occur.


3.4.2 Blast Fume Management Procedure

The Blast Fume Management Procedure (BFMP), attached as **Appendix A**, will be used to determine how fume emissions from blasting will be minimised and to outline how issues of public safety will be managed. Additional information on monitoring and reporting of blast fume impact is described in the BFMP.

The health and safety risks from blast fumes and information for treatment by medical staff are outlined within BFMP.

3.5 Cumulative Blast Management Strategy

MCCM along with Boggabri Coal Mine and Tarawonga Coal Mine have developed the BTM Complex Blast Management Strategy in order to minimise cumulative blasting impacts. The Blast Strategy forms part of this management plan as required by PA10_0138 Sch 3, Cn 25(h). The most recent version of this strategy is available on the Maules Creek Coal Mine website.

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4.0 MONITORING AND REPORTING

Monitoring of airblast overpressure, ground vibration and blast fume is required under Schedule 3, Condition 25 (g) of PA 10_0138. Blast fume monitoring undertaken at the MCCM is described in the BFMP (**Appendix A**).

4.1 Monitoring of Blast Ground Vibration and Airblast Overpressure

Blasting generates noise (i.e. overpressure or airblast) and ground vibration, which may be detectable at residential receptor locations. Ground vibration levels also have the potential to impact infrastructure and heritage features in proximity to the site.

Blast monitoring units capable of recording airblast overpressure and ground vibration in accordance with the requirements of *Australian Standard AS 2187.2-2006 'Explosives—Storage and use Part 2: Use of explosives'* will be used at the locations listed in Table 5 below and shown on MCC Blast Monitoring Locations. The location numbers are as identified in **Figure 2** of the MCCM Environmental Assessment.

Table 5 **Blast Monitoring Unit Locations**

Location ID	Location No
BM1	80
BM2	115
BM3	108
BM4	236

In accordance with Schedule 3, Condition 18 of PA 10_0138, blasting must not exceed the relevant criteria for airblast overpressure (dB (Lin Peak)) and Ground Vibration (mm/s) at any residence on privately owned land. The blast monitoring locations above are representative of residences on privately owned land and as such, will be used to assess compliance with blasting criteria. The permanent blast monitor locations may be reviewed and relocated based on community complaints or following landownership changes.


Temporary blast monitors will be used to record ground vibration at any non-mine owned infrastructure where blast design indicates 50 mm/second, or an otherwise agreed criterion, might be approached.

Similarly, temporary blast monitoring locations, if required for complaint monitoring, may be utilised at or near residences. These temporary locations will be positioned as near to the identified location, on the mine side of the property, to accurately reflect the blast impacts at the location of concern.

4.2 Blast Fume Monitoring and Reporting

Blast fume monitoring will be undertaken for every blast. The results of the blast will be recorded and any incident of fume will be ranked. Reporting will comply with Part 5.7 of the *Protection of the Environment Operations Act 1997* (NSW) where fume could cause or threaten material harm to the environment outside of the premise boundary.

Additionally the Department of Planning and Environment and the NSW EPA will be notified of any level 3C or higher fume event leaving the premises. Fume is rated on the scale contained in the Australian Explosives

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Industry and Safety Group Inc. – *Code of Good Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting.*

4.3 Reporting

4.3.1 Scheduled Reporting

MCC's environmental performance is reported a number of ways. External reporting includes:

- An Annual Review (AR);
- Monthly updates of monitoring results on the Whitehaven website; and
- Community Consultative Committee (CCC) meetings.

4.3.2 Exceedance Reporting

In the event it is determined that an exceedance of a blast criterion has occurred, at the earliest opportunity (as soon as practicable) MCC will notify to DP&E and the EPA. In accordance with Schedule 4, Condition 3 (a) of PA 10_0138, affected landowners will also be notified (in writing) of the exceedance.

An exceedance occurs when the criteria in Error! Reference source not found. are exceeded.


Table 6 PA 10_0138 Blasting Criteria

Location	Airblast (dB(Lin peak))	Ground Vibration (mm/s)	Allowable Exceedance
Residence on privately owned land	120	10	0 %
	115	5	5% of the total number of blasts over a period of 12 months
All public infrastructure	-	50 (or alternatively a specific limit determined to the satisfaction of the DG & relevant guidelines)	0 %

However, these criteria do not apply if the Proponent has a written agreement with the relevant owner or infrastructure provider/owner, and the Proponent has advised DP&E in writing of the terms of this agreement.

In accordance with Schedule 5, Condition 8 of PA 10_0138, MCC will, within seven days of exceedance date, notify DP&E and other relevant agencies. MCC will submit a written report that:

- Describes the date, time, and nature of the exceedance;
- Identifies the cause (or likely cause) of the exceedance;
- Describes what action has been taken to date; and
- Describes the proposed measures to address the exceedance.

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5.0 CONSULTATION

5.1 Neighbouring Mines

Coordination of blast schedules with other mines will be as per procedures in the BTM Complex Blast Management Strategy.

The key management measure for the mitigation of cumulative blast impacts will be scheduling of blasts to ensure each mine fires their blast at separate times. MCC will send notification of scheduled blasts to the neighbouring mines the day prior to the scheduled time. If there is no conflict regarding the scheduled blast times, there will be no further correspondence. If there are conflicting blast times between the mines, a revised schedule for firing the blasts will be agreed upon. The schedule will be developed to ensure blasts are fired with a minimum of 15 minute time gap between them to reduce any potential cumulative impacts.

If a late change to the blasting schedule is required, consultation will occur with other mines to confirm no overlap with the new blasting schedule prior to notification of new blast time.


5.2 Community Consultation

Community consultation has occurred during the development of this BLMP, including the original version of this document. In accordance with the requirements of Schedule 3 Condition 25 of PA_0138, this included consultation with '*interested members of the local community potentially affected by blasting operations*'. Consultation methods included presentation to the Community Consultative Committee by MCC personnel. Review comments and input from stakeholders have been considered within the development of this plan.

Notification to the general public of blasting activities will occur via the company website (www.whitehavencoal.com.au). Additionally, the schedule blast may be distributed via e-mail to organisations and individuals if this is their preference. It should be noted that the scheduled blasts may be varied depending on external factors including variable weather, which may require a blast to be delayed or brought forward.

Further to this, MCC has set up an SMS system to contact local residents the day prior to the planned blast event. On the day of a blast event, where a planned blast event is either 30 minutes prior or 60 minutes after the planned event, a new notification will be issued to local residents by SMS or phone call to enable notification of the rescheduled blast time. If required relevant residents as requested can be contacted by telephone prior to each blast in order to provide notification and to maintain good working relationships. A list of residents to be notified has been determined through consultation with the relevant residents and the MCC Community Consultative Committee. The list will be maintained and updated following a request by relevant stakeholders with any change of contact details or additional relevant residents.

SMS notifications are also sent to selected MCC staff for the purpose of verifying that the SMS messages have been sent out to residents and that there has not been any faults in the delivery of the SMS. In the event a SMS is not delivered a second SMS is sent to that resident. If the second SMS is unable to be delivered a phone call will be made in an attempt to contact the resident to advise of an upcoming blast event. The Whitehaven Coal company website also displays the timing of blast events occurring at Maules Creek Coal.

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If MCC expect a fume event or offsite dust impacts to occur and are required to blast due to safety reasons, positive communication with potentially affected receivers will take place prior to blasting. MCC will identify the potential path of the plume and contact those people that could be affected. Further detail is provided in the BFMP (**Appendix A**).

Notification of blasting events that require road closures will be via the above channels (part of the weekly schedule information), and in accordance with the Road Closure Management Plan.

5.3 Regulator Consultation

In accordance with the requirements of Schedule 3, Condition 25 of PA_0138 the BLMP has been prepared in consultation with DP&E and the EPA. Engagement has also occurred with local landholders.

Notification and consultation with DP&E and EPA when:

- Blasting after 3pm (**Section 3.2**)
- Blasting is required in unfavourable conditions (**Section 3.3.1**)
- Blasting if predicted Level 3C fume will leave the premises (**Section 3.3.1**)
- Blasting in addition to approval requirements (**Section 3.3.8**)
- Exceedance of criteria or licence (**Section Error! Reference source not found.**)


5.4 Road Closure

Schedule 3, Condition 25 (e) of PA 10_0138 requires this BLMP include '*a road closure management plan for blasting within 500 metres of a public road*'. This aims to ensure public safety, primarily as protection against flyrock , but also to prevent exposure to fume and dust.

No blasting activities are planned to occur within 500 m of a public road for the initial years of the MCCM. The most eastern part of the approved open cut mining area is anticipated to encroach within 500 m of the Leard Forest Road, which is currently a public road. The southern section of the Leard Forest Road has been closed to the public by Boggabri Coal and is no longer a through road.

As such, the measures described below will not be required for the term of this plan. However in the instance that blasting activities may be required within 500 m of a public road, the following requirements will be addressed.

If any blast is planned to be within 500 m of a public road, then a road closure is required in accordance with a Road Closure Management Plan that is to be developed in consultation with Narrabri Shire Council.

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Road closure will only be performed by personnel trained and qualified in traffic control. These people will wear appropriate high visibility clothing and have direct communication with the shotfirers to minimise delay and, to advise of any blast exclusion zone breach.

All signage placement and associated traffic control procedures will be in accordance with a plan approved by Narrabri Shire Council for that section of road.

A safety check will be made to ensure the road is clear of debris after blasting and prior to road re-opening. If required, a grader will be on standby to remove any larger debris and small debris will be removed by hand.


5.5 Non MCC Owned Land

In accordance with Schedule 3, Condition 24 of PA 10_0138, as outlined in **Section 2.2.3**, prior to undertaking blasting on-site within 500 m of any land outside the site that is not owned by MCC, MCC must:

- Receive a written agreement from the relevant landowner to allow blasting to be carried out closer to the land and advise the DP&E in writing of the terms of this agreement;
- Demonstrate to the satisfaction of the Secretary that the blasting can be carried out closer to the land without compromising the safety of the people or livestock on the land, or damaging the buildings and/or structures on the land; and
- Include in the Blast Management Plan specific measures (detailed below) to be implemented while blasting is being carried out within 500 m of land.

Blasting activities are planned to occur within 500 m of land outside the site that is not owned by MCC, notably this will be limited to land owned by an adjacent coal mine and the Forestry Corporation of NSW. As required by PA 10_0138 MCC will seek written agreements from the relevant landowner to commencing blasting operations within 500 m of their land and notify the DP&E of these agreements. Given that the affected lands are not residential sites, the additional impacts of blasting within 500 m of these lands is expected to be negligible, when compared with blasting at other areas within the MCCM.

The standard management measures for mitigating blasting impacts outlined in **Section 3.0** will continue to be implemented for blasts within 500 m of land outside the site that is not owned by MCC. The 500 m exclusion zone will be extended into the adjacent land. In situations where the 500 m exclusion zone extends into an adjacent mining lease the establishment of an exclusion zone in that area will be managed by the mining operator of the lease. MCC will provide notification of planned blasts to the affected landowner/s on the day prior to the blast and will provide the adjacent landowners with a site contact to enable prompt communication of activities on their land that could potentially be impacted by MCC blasting. This communication will enable blasting to be proactively planned for times when there is no or limited activity occurring on the adjacent land, limiting any potential disruption to the adjacent landowner/s.

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6.0 RESPONSE PROCEDURES

6.1 Complaint Response Protocol

MCC maintains a 24-hour complaints hotline (1800 WHAVEN, 1800 942 836) to respond to any complaints from neighbouring residents or interested stakeholders. The complaints hotline is advertised in the local media and is available on the Whitehaven website and in community newsletters. Complainants will be contacted as soon as possible to gather additional information and respond to community concerns.

Records of complaints will be maintained in the complaints register database and kept on file for a period of no less than five years.

In the event of a community complaint about blasting, all relevant information pertaining to the time of alleged blast nuisance is to be gathered as follows:

- Blast location and details;
- Meteorological conditions at the time of the blast; and
- Data from nearest blast monitors.

Using the above data, an assessment is to be made as to the validity of the complaint.

If there is any claim that property has been damaged then, as per Schedule 3, Condition 22 of PA 10_0138, an inspection is required as follows:

"...within 2 months of receiving this claim in writing from the landowner the Proponent shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties, to investigate the claim; and


(b) give the landowner a copy of the property investigation report."

Disputes regarding the selection of a suitably qualified inspector, or the inspection findings, will be referred to the Planning Secretary of DP&E for resolution.

6.2 Emergency Response

In the event that a significant blast fume event of Level 3C or higher classification is observed or predicted, using the rating scale from the AEISG (2011) Code of Practice, to leave the site, a response will be triggered, in accordance with MCC Pollution Incident Response Management Plan (PIRMP). Attempts will be made to contact neighbouring residents in the predicted path of the plume. Communication to relevant stakeholder and regulatory agencies will be conducted in accordance with the PIRMP.

Should an individual be exposed to blast fume, that individual should seek immediate medical advice and treatment (refer to the Blast Fume Management Procedure (**Appendix A**)).

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6.3 Property Inspections


In accordance with Schedule 3, Condition 21 of PA 10_0138, MCC will, upon written request from the owner of any privately-owned land within 2 km of the approved open cut mining pit on site, complete a property inspection to establish baseline conditions for all buildings and structures or to have a previous property inspection report updated, then within 2 months of receiving this request, MCC shall commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties, to:

- establish the baseline condition of any 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 MCCM on these buildings and/or structures.

MCCM will provide the landowner a copy of the new or updated property inspection report. In accordance with Schedule 3, Condition 21 of PA 10_0138, if the owner of any privately-owned land claims that the buildings and/or structures on his/her land have been damaged as a result of blasting on site, then within 2 months of receiving this claim in writing from the landholder, MCC shall commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties, to investigate the claim, and provide the landowner with a copy of the property investigation report.

If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damages to the satisfaction of the Secretary.

If there is a dispute over the selection of the suitably qualified, experienced and independent person, or MCCM or the landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution.


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7.0 DOCUMENT REVIEW AND CONTINUOUS IMPROVEMENT

In accordance with Schedule 5, Condition 5 of PA 10_0138, this BLMP will be reviewed within 3 months of any AR, incident report, audit or modification of the conditions of the approval. Should this review identify any requirement to change the BLMP, this document will be updated in accordance with the approval.


Additionally, this BLMP will be reviewed and revised in accordance with a requirement issued under Schedule 2, Condition 4 of PA 10_0138.

Edition	Rev.	Comments	Author	Authorised By	Date
1	0	Issued to DPI for Approval	Manaia Rehu	Craig Simmons	May 2013
1	1	Issued for DPI Approval	PEL	Daniel Martin	Nov 2013
1	2	Issued for Consultation	Daniel Martin	Daniel Martin	Jun 2014
1	3	Issued for DPI Approval	Daniel Martin	Daniel Martin	July 2014
1	4	2015 Revision	Gary Gray	Craig Simmons	August 2015
2	0	Incorporate fume management, and regulatory comments	Craig Simmons	Matthew Sparkes	September 2015
2	1	Incorporate EPA & DP&E	MCC	MCC	March 2016 & February 2017
2	2	Address DP&E comments	MCC	MCC	September 2017
2	3	Address DP&E comments	MCC	MCC	2018
3	1	MOD 8 & IEA	Terrock	MCC	May 2022
3	2	Incorporation of Consultation	Terrock	MCC	December 2022

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8.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of MCC staff in respect of this BLMP are presented in the Blast Fume Management Plan Appendix F.

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9.0 REFERENCES

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10.0 GLOSSARY

Blast fume – a mixture of gases generated as a result of a less than optimal chemical reaction of ammonium nitrate explosives during the blasting process. The critical gases of concern in blast fume are the oxides of nitrogen (NO_x), being nitric oxide (NO) and nitrogen dioxide (NO_2). Blast fume gases will present as yellow to orange to dark red (depending on concentration) due to the presence of NO_2 in the post-blast gases.


Blast ground vibration – The transfer of energy through the ground measurable as acceleration, velocity and displacement. Particle velocity has been found to correlate best to structural damage resulting from blasting whereas human response is best quantified by acceleration. However, particle velocity is commonly measured during blasting and is the relevant measure for this project.

Blast exclusion zone - a distance of generally 500m, or as required, around the blast to ensure safety of equipment and operational personnel.

Post-blast fume management zone - an exclusion zone that may be pre-determined if required, which is generally outside the blast exclusion zone, to ensure adequate distance for dispersion of post-blast gases.

Overpressure (airblast) – noise from a blast, containing mostly low frequency energy and typically has a very distinct pressure change pattern (n-wave).

dB (Lin) – Unweighted noise level in decibels (dB); used to quantify airblast overpressure.

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APPENDIX A **BLAST FUME MANAGEMENT** **PROCEDURE**


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1. SCOPE

This procedure outlines the specific management actions to be implemented at Maules Creek Coal Mine (MCCM) in line with the strategies outlined in the Australian Explosives Industry and Safety Group (AEISG) Code of Practice – Prevention and Management of Blast Generated NO_x Gases in Surface Blasting (2011) (AEISG Code of Practice). The strategies apply to all personnel involved in purchasing explosives, blast design, drilling, loading and firing of explosives.

2. BACKGROUND & DESCRIPTION OF BLAST FUMES

Blasting fumes are comprised of a group of gases; these include nitrogen dioxide, nitrous oxide, nitric oxide, carbon monoxide and carbon dioxide. The two main gases, nitric oxide (NO) and nitrogen dioxide (NO₂) may be found as by-products in the post-blast gases of ammonium nitrate-based explosives, and are generated in greater quantities where incomplete or low-order detonation occurs. Nitric oxide is colourless, but nitrogen dioxide ranges from yellow to dark red / purple depending on the concentration and size of the gas cloud. These gases are harmful to humans if inhaled in large quantities. Blasting fumes can be harmful to humans if inhaled in sufficient quantities and/or over a prolonged period of time. These fumes can pose a risk to members of the blast crew and sentries in close proximity, or other mine workers exposed in the event that fumes travel outside the immediate blast clearance area without dispersing. Risks to persons outside the mining area are low however also need to be addressed in the event that large fume clouds travel outside the mine lease on to private or public land.

3. CAUSES OF BLAST FUME

Fume generation can be attributed to a number of circumstances that, either singularly or combined, can be managed to minimise or mitigate the production of NO_x:

- Explosive formulation and quality assurance;
- Geological conditions;
- Blast design;
- Explosive column disruptions during the shot sequence;
- Explosive product selection;
- Explosives desensitisation;
- On bench practices;
- Contamination of explosive in the blast hole; and
- Weather conditions.

These are discussed in detail in the AEISG Code of Practice, and summarised below in Appendix C.

4. PROCEDURE

4.1 BLAST DESIGN & PLANNING

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; and
- Control of potential blast impacts including flyrock, fume, airblast overpressure and ground vibration and dust.

Blast fume prevention measures that will be implemented include:

- Formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fume. Maules Creek Coal (MCC) will work with the manufacturer and/or supplier to ensure products are authorised and come with appropriate quality control systems to ensure specifications are met;

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- Reviewing geological conditions in the formulation of blast designs;
- Reviewing ground conditions (e.g. presence of clay or loose/broken ground);
- Minimising the time between drilling and loading, and loading and shooting of the blast; and
- Consideration of meteorological conditions in blast scheduling.

Additionally, to minimise the likelihood of post-blast fume, the following measures will be undertaken:

- Blast sequences will be designed to blast from a free face where possible;
- Explosive product will be selected with consideration of the likelihood of moisture in blastholes in blastholes (including the presence of clay strata); and
- Shotfirer procedures will include measures to avoid product contamination during hole loading.

Checklists have been developed to assist the planning and design of each blast. More specific fume mitigation measures are described below in **Sections 4.2 and 4.3** and summarised in the Cause and Control Matrix (**Appendix C**) for each likely scenario.

4.2 GEOLOGY

Geotechnical investigations will be undertaken as required if areas of geological variation or instability are identified and it is suspected that they will contribute to an increase in the generation of blast fume. Where clay or other unfavourable geological conditions are identified, explosive product selection will be modified. If there is a risk of blast fume, the Shotfirer must extend the blast exclusion zone to ensure the safety of all personnel. This is particularly important if a blast has had an extended sleep time, where water intrusion may have affected the bulk explosive or, when firing misfires. When blasting in soft ground, or areas with a history of producing blast fume, increased blast exclusion zones may also be required to ensure the safety of personnel.

When blasting within 20 meters of the natural pre-mining surface, consider using a water resistant explosive product. Also consider mitigation techniques such as reducing pattern size, with intention of reducing sleep time. (larger patterns will allow the equivalent volume of material to be blasted using less blastholes reducing sleep time). Additional considerations include:

- Topography - creek lines and shallow groundwater flow will have to be assessed in the planning of natural surface blasts.
- Faulted or Fractured Ground - use appropriate explosive products in areas of known faults or fractured ground. Develop a case history of rock type and apply learnings to future designs
- High Clay Content - use appropriate water resistant explosive products in areas of known high clay content.
- Consider potential ground movement/product desensitisation/mud/sediment in the base of blastholes

In all of the above situations, aim to reduce the time between drilling, loading and firing, particularly in areas when past experiences or geological knowledge indicate increased risk of water and blasthole collapse.

Figure 1 illustrates a stratigraphic column of the indicative geology of the MCCM. **Table 1** presents a matrix of the risk rating for each of the blast horizons based on experience to date.

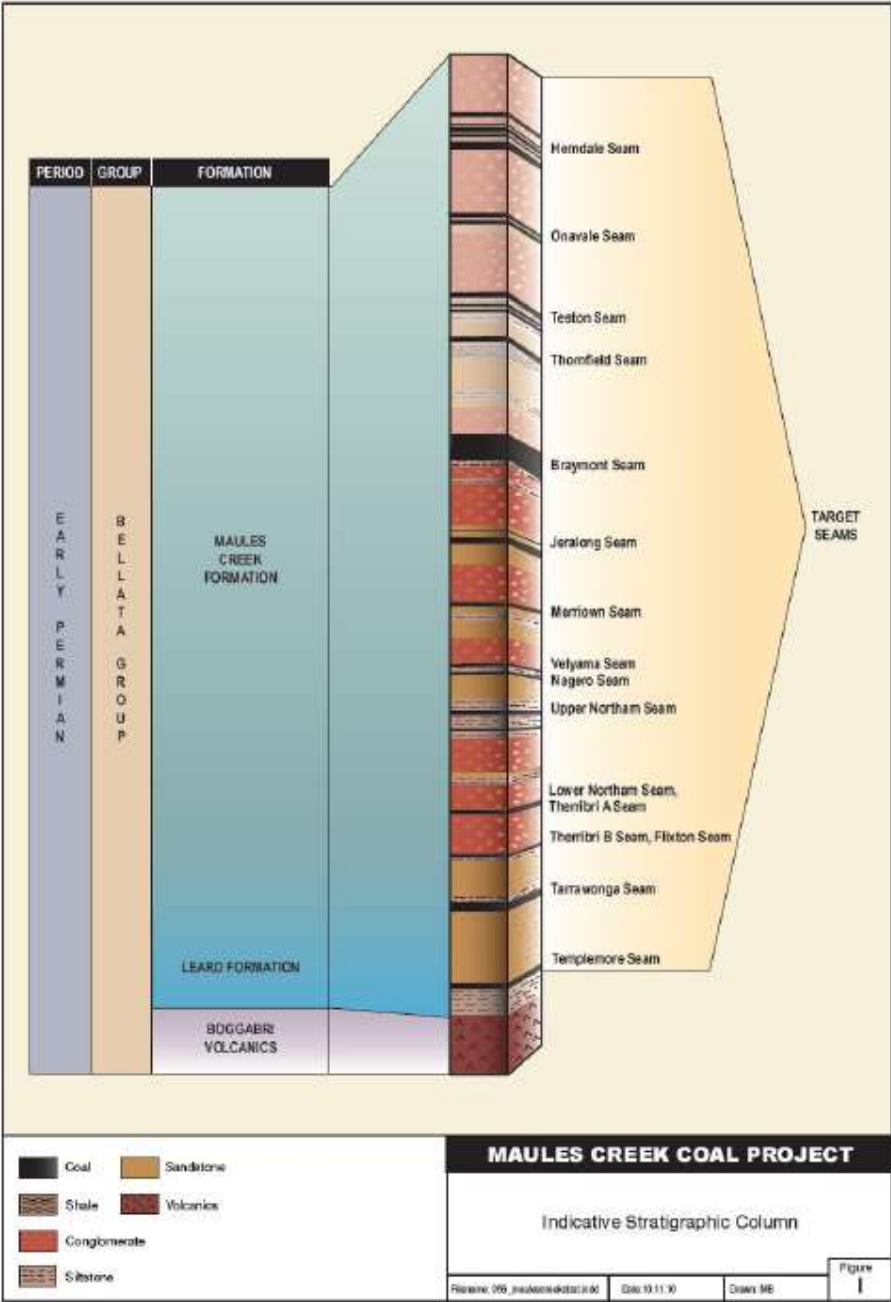


Figure 1 Stratigraphic Column


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Table 1 Blast Horizon Matrix

Blasting Horizon	Fume Risk Rating
Blasting to the first seam/sub crop	Evidence of fume coming from the sub crop area, use of appropriate explosive product as required
Herndale	Medium
Onavale	Low
Teston Upper	Low
Teston Middle	Low
Teston Lower	Low
Thornfield	Low
Braymont	Medium
Jeralong	Medium
Merriown	Low
Velyama	Low
Nagero	Medium
Upper Northern	Low
Lower Northern	Not blasted yet
Therribri	Not blasted yet
Flixton	Not blasted yet
Tarrawonga	Not blasted yet
Templemore	Not blasted yet

4.3 METEOROLOGICAL CONDITIONS

Throughout the loading process of a blast, the weather conditions are considered prior to performing each step from priming blastholes through to stemming them.

Dust and fume impacts from blast events will be informed by using the predictive and real-time air quality management system described in the Boggabri Coal, Tarrawonga Coal and Maules Creek Coal (BTM Complex) Air Quality Management Strategy (AQMS). Prior to the scheduled blast, continued use is made of real time measurements from the on-site Automated Weather Station (AWS), together with daily weather predictions and observations in the immediate pit area. Consideration is provided to the safety of operations and neighbouring properties, weather conditions including wind speed and direction, and the presence of inversions and low continuous cloud cover.

When the site AWS records wind direction from the north (270° through to 90°) and wind speed greater than 8 m/s, blasting will not occur unless required for safety reasons. When wind speed is recorded from the south (90° through to 270°) and wind speed is above 6 m/s, blasting will not occur unless required for safety reasons. If blasting is required due to safety reasons MCC will notify potentially affected neighbouring residents, DPIE and EPA in accordance with the Blast Management Plan (BLMP).

Potentially adverse weather conditions exist for post blast fume at very low wind speeds (< 1.5 m/s). In these conditions further consideration will be given to other factors such as wind direction, cloud cover and temperature inversions, unstable conditions e.g. storms, and the risk level for fume production. If it is considered likely that a Level 3C fume or higher event will be produced and could potentially leave site in the

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direction of a possible receiver, then blasting will be rescheduled unless required for safety reasons. If blasting is required due to safety concerns, communication will be made with neighbours, the EPA and DPE prior to initiating the blast.

If there is an increased risk of blast fume generation identified in the design stages, the drill and blast engineer must review the blast and fume management exclusion zones to allow for the safety of all personnel.

4.4 SENSITIVE RECEIVERS

The following will be considered during the planning stages of any proposed blast:

- If blasting is to be carried out within 500 m of a public road, the road will be closed for the duration of the blast as described in the BLMP. Sensitive receivers identified in the planning stages as being in proximity to the blast area (or in the location predicted for potential blast fume to travel) will be notified of the proposed blasting date and time. Details of updating sensitive receiver contact details progressively occur as part of land ownership reviews for project related modifications, review of mine property tenancies and access to other publically available information or communication received from residents regarding pre-blast notification list contact details.
- The date, time and location of the blast/s will be posted on appropriate signs, located on the mine site access roads.
- The procedure for notifying neighbouring properties, in the event of an unexpected release of blast fume off site for a Level 3C or higher event, is outlined below in **Section 4.9**.

4.5 BLAST EXCLUSION ZONES & TIMING

Blast exclusion zones and sentry locations are determined and communicated prior to blasting.

In accordance with Project Approval 10_0138, blasting will only be carried out between 9:00 am and 5:00 pm Monday to Saturday, inclusive. No blasting is allowed on Sundays or Public Holidays, or at any other time without the written approval of the Secretary of the Department of Planning, Industry and Environment (DPIE).

Following an independent blast fume modelling assessment, MCCM has implemented additional restrictions on blast scheduling. The independent blast fume modelling assessment has indicated that should a level 5 blast fume event occur during the winter months in the late afternoon, there is a slightly higher potential for blast fume to migrate off the mine site. As such, during Autumn and Winter months (March to August), MCCM will schedule blasting to occur prior to 4:00 pm during these months. Should a blast be required after 4:00 pm during the Autumn and Winter periods, MCCM will:

- Assess the potential for fume generation. If there is potential for a Level 4 or 5 fume event to occur, or if it is considered likely that a Level 3C or higher fume event will be produced that could potentially leave site in the direction of a private receiver location, the blast will not be undertaken unless required for safety reasons and there are no feasible alternative measures that can be implemented. A fume management zone will also be determined and communicated to site personnel;
- Notify potentially impacted residents prior to blasting in accordance with the BLMP if a level 3C or greater fume event is predicted; and
- Notify the DPIE and EPA prior to blasting in accordance with the BLMP.

4.6 TECHNICAL & SAFETY DATA SHEETS

Copies of all relevant Technical and Safety Data sheets for the explosive products shall be supplied to the Drill and Blast Engineer and Shotfirer's by the Explosives manufacturer. Copies will be kept on site for reference. Safety Data Sheets provide guidance on the use and precautions when handling and using these products.

4.7 BLAST FUME MONITORING

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The pre blast checklist (refer **Appendix B**) will assist in determining the potential fume risk for each blast. This includes a notification checklist; pre-blast weather conditions assessment prior to and at the time of the blast; and a post-blast assessment which includes fume rating.

Visual observation of the blast and any fume produced will be recorded. Video record of the blast event will be taken, extending to at least one minute after the blast and should be allowed to capture any post blast fume until the fume dissipates. This video footage will also be later examined to improve future blasting performance and to further minimise blast fumes and/or vibrations. The video footage is to be kept for at least two years. Portable fume monitors are used to monitor and measure CO, NO, and NO₂. Postblast gas monitoring will continue near the northern boundary of the project for blasts when predicted wind direction is from the south (90° through to 270°) towards neighbouring north-west private properties. The location of the portable monitors can vary from blast to blast as it is guided by variables including logistics and predicted wind direction. In the unlikely event a reading is recorded on the fume monitors as a result of blasting from Maules Creek Coal, a third party will be engaged to extrapolate the results to determine any offsite fume levels. Results will be provided to the regulatory agency upon request.

4.8 RATING BLAST FUME

All blasts will be rated for fume level, colour and extent on a scale between 0 - 5, based on the AEISG Code of Practice (refer **Appendix A**).

The rating will be undertaken by the Shotfirer(or delegate), following assessment of available evidence and observations from other blast team members, from videos and photographs of the blast where available. A target to minimise fume shots to 0-2 rating for 98% of total shots within a calendar year, as per recommendation from DPIE, is to be implemented.

Records of post-blast fume ratings will be kept on site for a minimum of two (2) years.

4.9 NOTIFICATION

In the unlikely event that a blast produces a fume event that rates at Level 3C or higher and migrates off site, notification will be provided to relevant agencies, emergency and community contacts in accordance with the PIRMP.

For the purposes of assessing blast fume migration, the "Site" comprises the land bound within the "Maules Creek Project Boundary" identified in the map attached to the Project Approval (PA 10_0138) as modified from time to time. The Lot and DP details of the shared rail-spur have been excluded as they are not covered by MCCM EPL 20221.


Following the identification of visual NO_x, the extent and direction of travel will be observed. The movement of visual NO_x outside the blast exclusion zone will be communicated to site personnel, and where necessary, personnel will be moved away from the direction of the fume.

4.10 MANAGEMENT OF FUME EXPOSURE

The Queensland Government Guidance Note covering the management of NO_x in open cut blasting provides first aid advice for people exposed to blast fume.

4.10.1 INITIAL FIRST AID

Initial first aid includes moving out of the fume cloud, seeking fresh air and using water to reduce the amount of exposure to wash out eyes and clear nose and throat. Any person exposed to fumes should be sent to be checked by medical staff as a precautionary measure. 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.

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Relevant guidance is provided in **Appendix D** (Health and Safety Risks of Blast Fumes) and **Appendix E** (Information for Medical Staff).

4.11 INCIDENT & HAZARD MANAGEMENT

Post-blast fume incidents will be managed in accordance with internal Whitehaven Coal hazard management procedures that is to be followed for all health, environment and safety incidents that may occur on Whitehaven Coal sites.

The basic precautions relevant to blast fume incidents on site are:

- Managing personnel from entering the fume or path of the fume;
- Notifying site personnel located indoors at the site offices that the fume is heading towards them and to close all windows and doors and stay inside;
- Wind up windows, close doors, stay inside vehicles, move away from the area and use recirculated air conditioning if possible; and
- Activating reporting procedures and response protocol.

For situations where blast fume is observed as having the potential to travel beyond the MCCM Project Boundary, the Environmental Superintendent (or delegate) will be contacted and the site's PIRMP will be activated to notify off site receivers as per the Blast Fume Management Procedure and BLMP.

4.12 INVESTIGATION – POST FUME INCIDENT

Should excessive blast fume (Level 3C or higher that is not localised as defined in Appendix A) be generated from a blast, an incident investigation will be undertaken. A fault tree (refer to **Figure 2**) will be used during the incident investigation to identify contributing factors and appropriate action plans to be developed and implemented.

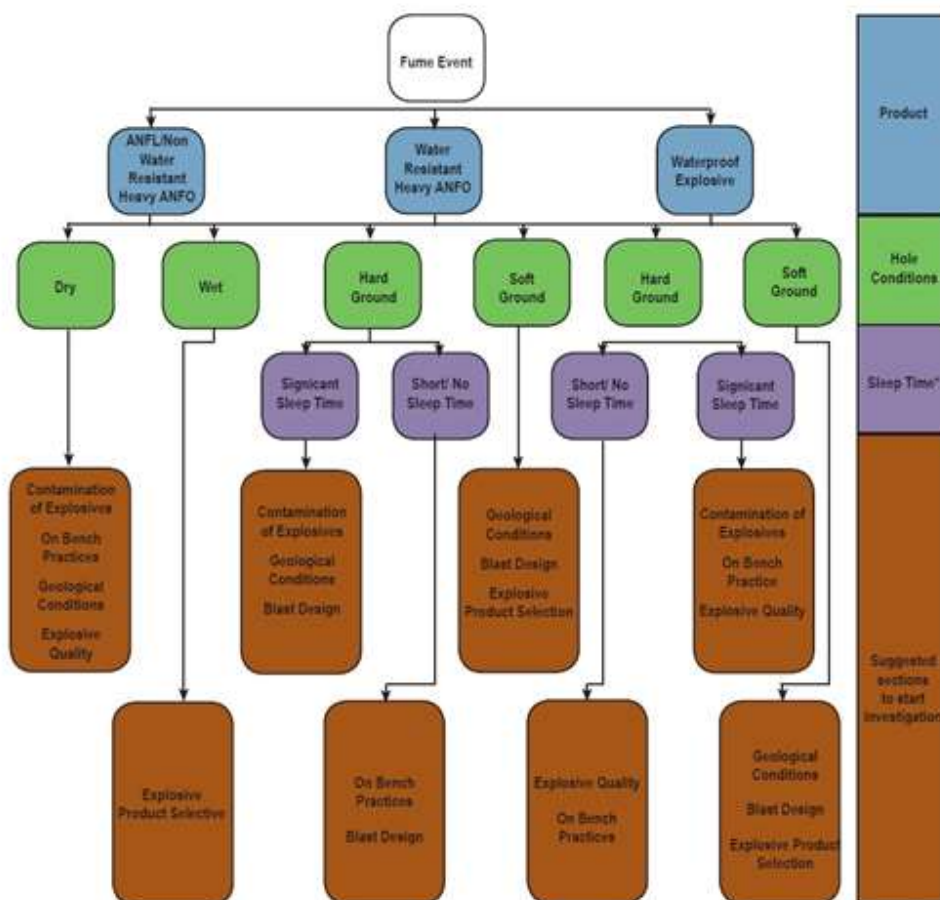


Figure 2 Blast Fume Fault Tree (Source: AEISG, 2001)

4.13 REPORTING & REVIEW

Blast fume reporting includes a range of internal reporting such as load sheets, blast design and environmental checks, shotfirer records, relevant registers and video footage. Reporting also includes requirements under the PIRMP and Annual Review including management and improvement measures such as post blast fume monitoring classification. Review of this procedure will occur as part of the review of the BLMP.

Review of this procedure will occur as part of the review of the BLMP.

4.14 EDUCATION & TRAINING


Training for relevant personnel (Drill and Blast Engineer, Shotfirers, Drillers, OCEs) will be undertaken with reference to identification of post-blast fume, potential health impacts, reporting process and emergency response protocol.

5. RESPONSIBILITIES

Role	Accountabilities for Fume Management
Drill and Blast Engineer	Ensure designs take into account the potential for fume by assessing (inter alia) the following:

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	<ul style="list-style-type: none"> - Horizon risk level; - Expected hole conditions for the blasting material type; - Correct energy match for material type; - Designed powder factor; - Product selection; - Expected sleep time; - Bench topography; <p>Ensure D&B design are signed off by the D&B Superintendent; Ensure the charge sheets are developed using measured data; Ensure charge sheets are approved by D&B Superintendent; Ensure any alterations to previously approved charging plans are re-approved by the D&B Superintendent; Ensure the reporting protocol is followed. Ensure pre and post blast checklists completed and actions undertaken</p>
Drill and Blast Superintendent	<p>Ensure this management plan is communicated to all personnel involved in the blasting process; Ensure D&B Engineers are taking into account the potential for fume generation for all D&B designs and that these design are signed off by an experienced D&B engineering person (Superintendent or Senior Engineer); Ensure the shotfirer in charge of the blast has a charge plan prior to loading; Approve all charge plans; Approve all alterations to previously approved charging plans; Ensure the reporting protocol is maintained; Ensure this plan is audited every two years; Report and track fume ratings including resources for monitoring; Escalate fume events to the appropriate areas in accordance to the NSWEC Escalation Process; Maintain horizon risk matrix; Ensure all blasts are scheduled to reasonably expected weather windows; Conduct a pre-scheduling risk assessment for all high risk blasts; Monitor sleep time of all blasts; Ensure the explosive supplier(s) meets the required standard for their explosives, as the contract owner; Ensure relevant approvals are in place prior to initiating a blast; Ensure hazards related to blast fume are incorporated in operating standards and procedures for drilling, charging; Ensure that all personnel working on the shot are trained and competent; Sign off of all blasting schedules.</p>
Drill Supervisor	<p>Coordinate drill activities in consultation with the D&B engineers; Coordinate drill bench preparation prior to drilling and where possible minimise the potential for water pooling on the pattern; Ensure drillers are fulfilling their responsibilities; Coordinate water management activities on the pattern from the bench preparation stage through the completion of drilling.</p>
Driller	<p>Drill the drill pattern to plan; Notify the Drill Supervisor when conditions cause a change to the design, which include:</p> <ul style="list-style-type: none"> - Strata hardness; - Depth to coal seam; - Moisture conditions; <p>Ensure adequate hole protection is in place (eg. Use of hole savers for holes greater than 15m).</p>

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Blast Supervisor	<p>Ensure adequate resources are assigned to blasting activities;</p> <p>Ensure the charge plan is followed;</p> <p>Ensure any changes to the charge plan are approved by the D&B Superintendent;</p> <p>Ensure shotfirers are fulfilling the shotfirer's responsibility;</p> <p>Report all fume events to D&B Superintendent;</p> <p>Ensure approvals for blasting are in place before initiating a shot;</p> <p>Ensure the sentries are placed at the appropriate locations to reduce the risk of fume exposure for personnel on site;</p> <p>Ensure blasting activities follow blasting standards and procedures for shot prep, charging, stemming, blast guarding and post blast inspections.</p>
Shotfirer	<p>Ensure the charging plan is followed;</p> <p>Ensure that any changes to the charging plan are discussed with the D&B technical service department prior to their implementation and an alteration to design form is completed and signed off by the D&B Superintendent;</p> <p>Supervise trainee shotfirers;</p> <p>Ensure explosive supplier(s) are recording hole by hole loading;</p> <p>Monitor product usage during loading; Ensure blasting activities are completed in accordance with the drill and blast standards and procedures, in particular:</p> <ul style="list-style-type: none"> - Managing loading activities to prevent contamination of explosives; - Appropriate stemming practices are employed; - Accurate placement of gas bags; - Ensure adequate hose handling techniques are employed; - Cup density checks are conducted to ensure correct densities are met; - Identify and record any hole slumping; <p>Ensure all reporting is completed to requirements.</p>
Environmental Superintendent & Officer	<p>Ensure weather monitoring site data is accessible;</p> <p>Ensure blast fume event responses are followed & PIRMP activated where necessary.</p> <p>Regulatory engagement support</p> <p>Reporting blast monitoring results</p>
Community Relations Manager	Respond to community complaints
Operations Manager	<p>Enabling adequate resources to implement BLMP</p> <p>Ensuring implementation and accountability by relevant personnel</p>

APPENDICES

A FUME RATING SYSTEM

Level	Typical Appearance
Level 0 No NOx gas	
Level 1 Slight NOx gas	
1A Localised	
1B Medium	
1C Extensive	
Level 2 Minor yellow/orange gas	
2A Localised	
2B Medium	
2C Extensive	
Level 3 Orange gas	
3A Localised	
3B Medium	
3C Extensive	
Level 4 Orange/red gas	
4A Localised	
4B Medium	
4C Extensive	
Level 5 Red/purple gas	
5A Localised	
5B Medium	
5C Extensive	

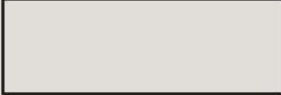





(Source: AEISG, 2011)


Assessing the amount of NOx gases produced from a blast will depend on the distance the observer is from the blast and the prevailing weather conditions. The intensity of the NOx gases produced in a blast should be measured on a simple scale from 0 to 5 based on the table above. The extent of the NOx gases also needs to be assessed and this should be done on a simple scale from A to C where:

A = Localised (i.e. NOx gases localised across only a few blast holes)


B = Medium (i.e. NOx gases from up to 50% of blast holes in the shot)


C = Extensive (i.e. extensive generation of NOx gases across the whole blast).

Level	Colour	Pantone Number
Level 0 No NOx gas		Warm Grey 1C (RGB 244, 222, 217)
Level 1 Slight NOx gas		Pantone 155C (RGB 244, 219, 170)
Level 2 Minor yellow/orange gas		Pantone 157C (RGB 237, 160, 79)
Level 3 Orange gas		Pantone 158C (RGB 232, 117, 17)
Level 4 Orange/red gas		Pantone 1525C (RGB 181, 84, 0)
Level 5 Red/purple gases		Pantone 161C (RGB 99, 58, 17)


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<h2>WHC_PRO_MC_BLAST FUME MANAGEMENT</h2>			

B ENVIRONMNETAL BLAST HAZARD ANALYSIS

		MAULES CREEK ENVIRONMENTAL MANAGEMENT SYSTEM				Revision Period: 3 Years Issue: 4 Last Revision Date: 15/12/2021			
		WHC_CHK_OC_MC_ENVIRONMENTAL BLAST HAZARD ANALYSIS							
SHOT 2022#		SHOT LOCATION/ID		PLANNED BLAST		Date:		Time:	
HAZARD ANALYSIS REVISION #									
PRE BLAST ACTIONS	HAZARD ANALYSIS (Initial)	WEATHER FORECAST		BLAST NOTIFICATION	SMS (24 hours)	BLAST MONITORS (Overpressure/Vibration/Gas)	Checks completed	WEATHER CHECK (Initial)	
		DISPERSION MODELLING			Website (ASAP)		In Place		
POST BLAST	DATE:	TIME:	PHOTOS & VIDEO TAKEN?						
			PREDICTED WIND SPEED and DIRECTION						
BLAST HAZARD ANALYSIS – PAGE 1		GREEN		ORANGE		RED		ADDITIONAL CONTROLS TO CONSIDER	
Vibration Hazard	BCM	<2000kBCM	>2000kBCM			<input type="checkbox"/> Notify Operations Manager <input type="checkbox"/> Fire blast earlier or later than lunch time <input type="checkbox"/> Operations Manager signoff required for vibration > 4mm/s <input type="checkbox"/> Fire only 1 blast <input type="checkbox"/> Other:		Vibration Results (mm/s) BM1: BM2: BM3: BM4: Vibration Complaints:	
	Explosive Tonnage	<1500t	>1500t						
	Powder Factor	<1.0	>1.0						
	Duration	<10 sec	>10sec						
	Holes	<3000	>3000						
	MIC	<5000kg	>5000kg						
	Predicted Vibration	<4 mm/sec	4-5 mm/sec	>5mm/sec					
	Presplit Direction	Away from monitors/no PS	Towards Monitors						
Ave Relief Rate (OB only)	>8 ms/m	6-8 ms/m	<6 ms/m						
OVERALL VIBRATION HAZARD		HAZARD SCORE: > 4 ORANGE = Ops Manager Sign Off + additional controls; RED = Postpone blast				Additional Controls: YES NO			
Overpressure Hazard	Meteorological conditions	Wind Speed <4 m/s	Wind Speed 4-6 m/s	Wind Speed >6 m/s		<input type="checkbox"/> Notify Operations Manager <input type="checkbox"/> Fire blast earlier or later in blast window to suit met conditions <input type="checkbox"/> Check wind speed hourly prior to blast <input type="checkbox"/> Impose additional wind restrictions: Direction: _____ Speed: _____ <input type="checkbox"/> Other:		Overpressure Results (dB) BM1: BM2: BM3: BM4: Vibration Complaints:	
	Ground Type	Normal	Highly weathered, Weak						
	Face Burden	Interburden	Thin/Cracked/Broken						
	Weather Reinforce	None	Thick Low Cloud/Inversion						
	Powder Factor	<1.0	>1.0						
	Free Face Direction	Not North	North						
	Face height	<20m	>20m						
	Predicted Overpressure	<110 dBL	110-112 dBL	>112dBL					
Time	11am - 3pm	<11am, >3pm							
Elevation In Pit	Lower than 20m bgl*	Surface to 20m bgl*							
OVERALL OVERPRESSURE HAZARD		HAZARD SCORE: > 4 ORANGE = Ops Manager Sign Off + additional controls; RED = Postpone blast				Additional Controls: YES NO			
Dust Hazard	Meteorological conditions	Wind Speed <4 m/s	Wind Speed 4-6 m/s	Wind Speed >6 m/s		<input type="checkbox"/> Notify Operations Manager <input type="checkbox"/> Delay loading/firing until favourable weather conditions <input type="checkbox"/> Observer near boundary or drone <input type="checkbox"/> Fire blast earlier or later in blast window to suit met conditions <input type="checkbox"/> Check wind speed hourly prior to blast		Dust Complaints:	
	BCM	<2000kBCM	>2000kBCM						
	Surface Area	<700m x 100m	>700m x 100m						
	Elevation In Pit	Lower than 20m bgl*	Surface to 20m bgl*						
	Distance to Boundary	>1000m	<1000m						
	Ground Moisture	Wet	Dry						
	Rain within 2 days	Any rain	None						
	OVERALL DUST HAZARD		HAZARD SCORE: > 4 ORANGE = Ops Manager Sign Off + additional controls; RED = Postpone blast				Additional Controls: YES NO		

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WHC_PRO_MC_BLAST FUME MANAGEMENT

	MAULES CREEK ENVIRONMENTAL MANAGEMENT SYSTEM		Revision Period:	3 Years
			Issue:	4
			Last Revision Date:	15/12/2021

WHC_CHK_OC_MC_ENVIRONMENTAL BLAST HAZARD ANALYSIS

BLAST HAZARD ANALYSIS – PAGE 2		GREEN	ORANGE	RED	ADDITIONAL CONTROLS TO CONSIDER	POST BLAST
Fume Hazard	Meteorological conditions	Wind Speed <4 m/s	Wind Speed 4-6 m/s	Wind Speed >6 m/s	<input type="checkbox"/> Impose additional wind restrictions: Direction: _____ Speed: _____ <input type="checkbox"/> Check wind speed hourly prior to blast <input type="checkbox"/> Observer near boundary or drone <input type="checkbox"/> Fume Management Zone established <input type="checkbox"/> Communication with Neighbours and On-site departments (circle): Residents: Boggabri Coal Tarravonga Coal: MCC CHPP MCC Maintenance: Railway Public Roads Contractors: Other: _____ <input type="checkbox"/> Notify EPA and DP&E	Actual Weather at Blast Wind Direction: Wind Speed:
	Ground Type	Normal Interburden	Wet/Weathered/Weak OB Cracked/Broken/LOX			Fume Rating Intensity: 1 2 3 4 5
	Sleep Time	AM range <14 days	>14 days			Extent: A B C
	ANFO	<6 days	>6 days			Did 3C Level or Greater Fume Leave Site Premises? Yes No
	Dewatered	No / minimal	Extensive / Dynamic recharge			PIRMP triggered?
	Cracked Ground	None	Throughout pattern			Fume Complaints?
	Loading Method	Augured	Pumped/augured into wet			
	Settling	<10% Holes	>10% Holes			
	Slump height	<1m	>1m			
	Explosives Product	Heavy ANFO	Gassed ANE			
Rain within 14 days	None / Little	Heavy				
Elevation in Pit	Lower than 20m bgl*	Surface to 20m bgl*				
Distance to Boundary	>1000m	<1000m				
OVERALL FUME HAZARD		HAZARD SCORE: > 4 ORANGE – Ops Manager Sign Off + additional controls; RED – Postpone blast			Additional Controls: YES NO	

Hours Prior to blast	Time	Wind Speed (km/h)	Wind Direction (°)	Clear/Cloudy/Overcast/Raining	Is blast OK to proceed?
1 hour	:				Y / N
0.5 hours	:				Y / N
15 minutes	:				Y / N
10 minutes	:				Y / N
5 minutes	:				Y / N

SIGNOFF			
Position	Name	Signature	Date
Blast Controller			

OPERATIONS MANAGER SIGNOFF – REQUIRED FOR ORANGE TARP			
Position	Name	Signature	Date
Operations Manager			

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C CAUSE & CONTROL MATRIX

The following matrix covers each potential cause and situation that may contribute to fume generation. For each potential cause, a likely indicator and control measure is outlined.

Primary Cause 1: Explosive Formulation and Quality Assurance

Potential Cause	Likely indicators	Possible Control Measures
Explosive product incorrectly formulated	<ul style="list-style-type: none"> Product appearance from auger / discharge point on truck abnormal; All blasts in a specific location utilising a specific explosive product creating fume. 	<ul style="list-style-type: none"> Track explosive mix back with supplier; Visual check at discharge point; Explosives supplier to test formulations on the bench as per the Contract; Quarterly check of suppliers QA system; Remove truck from loading operation if unable to rectify.
Inadequate mixing of raw materials	<ul style="list-style-type: none"> Product appearance from auger / discharge point on truck abnormal; All blasts in a specific location utilising a specific explosive product creating fume. 	<ul style="list-style-type: none"> Visual check at discharge point; MMU calibration every 6 months; Weekly MMU mass balance checks; On bench cup density checks ; Remove truck from loading operation if unable to rectify.
Delivery system metering incorrectly	<ul style="list-style-type: none"> All blasts in a specific location utilising a specific explosive product creating fume; Not achieving collar height during loading process. 	<ul style="list-style-type: none"> MMU calibration every 6 months; Weekly MMU mass balance checks; On bench cup density checks; Remove truck from loading operation if unable to rectify.
Initiating explosives not manufactured to specification or degraded during transport storage	<ul style="list-style-type: none"> Damaged IE; Out of date stock; Misfires. 	<ul style="list-style-type: none"> Magazine management rules; Visual inspection of the IE and, if damaged, destroyed.
Product degradation in hole	<ul style="list-style-type: none"> Slumping. 	<ul style="list-style-type: none"> Shotfirers perform daily inspection of all sleeping shots; All slumped are recorded by the shotfirer and reported back to the Drill and Blast Production Planning Department; Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows.


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Primary Cause 2: Geological Conditions

Potential Cause	Likely Indicators	Possible Control Measures
Blasting in weak / soft strata	<ul style="list-style-type: none"> Specific areas known to contain weak/soft strata only; Excessive powder factor. 	<ul style="list-style-type: none"> Understand geology of each shot and design blast (timing and explosive product) to ensure adequate relief in weak/soft strata; Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level.
Inadequate confinement in soft ground	<ul style="list-style-type: none"> Specific areas known to contain weak/soft strata only; Excessive powder factor. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Appropriate explosives product selection; Change design to suit conditions; Increase stemming length.
Explosive product seeping into cracks	<ul style="list-style-type: none"> Slumping; Not achieving collar height during loading process; Inconsistencies in explosive reconciliation. 	<ul style="list-style-type: none"> Maintenance of accurate drill records e.g. loss of cuttings / air; Capture hole by hole charging data; Incrementally charge the holes and monitor charging on areas where product loss occurs in dry holes to identify cracked areas. Do not overload holes; Bag off the hole above known cracking to avoid excessive seepage of product; Shotfirers perform daily inspection of all sleeping shots; All slumped are recorded by the shotfirer and reported back to the Drill and Blast Production Planning Department; Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows.
Dynamic water in holes	<ul style="list-style-type: none"> Slumping; Not achieving collar height during loading process. 	<ul style="list-style-type: none"> Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows; Follow manufacturer's recommendations on explosive product selection; Understand hydrology of pit and plan blasting to avoid interaction between explosives and dynamic water (either natural or from other pit operations); Load blast holes in a sequence that ensure the wet holes are loaded first to allow for re-assessment of what impacts the water displaced in the wet holes has on surrounding dry holes; Load a buffer zone surrounding the wet holes with wet product to prevent water ingress into holes loaded with dry product.
Moisture in clay	<ul style="list-style-type: none"> Base of weathering shots; Excessive rainfall. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Water resistant explosive products when the hole is classified as wet or wet walled; Load a buffer zone surrounding the wet holes with wet product to prevent water ingress into holes loaded with dry product; Design blast to have correct explosive energy match to material type to ensure adequate confinement of explosives; Ensure all loaded dry holes are stemmed prior to predicted wet weather and that these holes are capped with drill cuttings instead of gravel, as drill cuttings offer a better water seal over the holes than gravel. Finish with gravel.


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Potential Cause	Likely indicators	Possible Control Measures
Blast hole wall deterioration between drilling and loading e.g. cracks, voids, hole contraction	<ul style="list-style-type: none"> Traceable to specific geological areas usually clay zones; Old drill holes; Holes drilled too close to adjacent shot. 	<ul style="list-style-type: none"> Minimise time between drilling and loading; Drillers are to use hole savers for holes >15m to prevent fall back from drill cuttings; Blast boundaries are surveyed prior to initiating every blast to help prevent drilling into shot ground; Effects from surrounding patterns are assessed in the pre-loading assessment prior to loading every shot; Leave an infill between adjacent shots.
Ground movement	<ul style="list-style-type: none"> Horizon offset; Area previously known for misfires. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Design timing to prevent hole movement and explosive column dislocation.

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Primary Cause 3: Blast Design

Potential Cause	Likely Indicators	Possible Control Measures
Explosive desensitisation due to the blast hole depth	<ul style="list-style-type: none"> In deep holes only. 	<ul style="list-style-type: none"> Reduce bench height; Follow manufacturer's recommendations on explosive product selection and blast design for deep holes, for example decking where appropriate; Ensure explosives product are not outside the critical depth stated on manufacturer's technical data sheets.
Failure to identify potential causes of fume generation	<ul style="list-style-type: none"> Inexperienced D&B Engineer; Inadequate analysis. 	<ul style="list-style-type: none"> D&B design checklist is completed for all designs; Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; All D&B designs are signed off by the D&B Superintendent or D&B Senior Engineer.
Inappropriate priming and/or placement	<ul style="list-style-type: none"> Misfires / product discovered during mining. 	<ul style="list-style-type: none"> Follow manufacturer's recommendations on placement on initiating explosives; Ensure the bottom primer is located 1m above the bottom of the hole.
Inter-hole explosive desensitisation	<ul style="list-style-type: none"> Blast holes drilled too close together. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Review drill pattern prior to drill leaving pattern to ensure the bench is drilled to design; Reduce charge per hole; Increased control on drilling in complex bench areas; Develop the timing design to the as-drilled pattern instead of the designed pattern.
Intra-hole explosive desensitisation in decked blast holes	<ul style="list-style-type: none"> When using decks only. 	<ul style="list-style-type: none"> Appropriate separation of explosive decks.
Initiation of significant explosive quantities in a single blast event	<ul style="list-style-type: none"> Intensity of post-blast gases proportional to explosives quantity used. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Design blast to have correct explosive energy match to material type to ensure adequate confinement of explosives; Reduce powder factor.

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Primary Cause 4: Explosives Product Selection

Potential Cause	Likely Indicators	Possible Control Measures
Non water-resistant explosive products loaded into wet or dewatered holes	<ul style="list-style-type: none"> Blasts containing wet / dewatered blast holes only. 	<ul style="list-style-type: none"> Follow manufacturer's recommendations on explosive product selection; Measure all holes in shots that have holes >8m and conduct a sample measurement of shots with holes <8m to understand the hole conditions throughout the pattern; Weather forecasts are reviewed prior to loading to assess the expected sleep time and rainfall impacts prior to loading; Bench topography is assessed prior to loading to understand holes that will be susceptible to water pooling in the event of rain and/or dewatering activities; Water resistant explosive products when the hole is classified as wet or wet walled; Load blast holes in a sequence that ensure the wet holes are loaded first to allow for re-assessment of what impacts the water displaced in the wet holes has on surrounding dry holes; Load a buffer zone surrounding the wet holes with wet product to prevent water ingress into holes loaded with dry product; Design blast to have correct explosive energy match to material type to ensure adequate confinement of explosives; Ensure all loaded dry holes are stemmed prior to predicted wet weather and that these holes are capped with drill cuttings instead of gravel, as drill cuttings offer a better water seal over the holes than gravel; Regular education of shot crew on explosive product recommendations from current supplier; Provision of load sheets detailing explosive type.
Excessive energy in weak/ soft strata desensitising adjacent explosive product columns	<ul style="list-style-type: none"> In specific areas known to contain weak/soft strata only. 	<ul style="list-style-type: none"> Understand geology of each shot and design blast (timing and explosive product) to match; Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level.
Desensitisation of explosive column from in-hole cord initiation	<ul style="list-style-type: none"> Only in areas where in-hole cord initiation is used. 	<ul style="list-style-type: none"> Follow manufacturer's recommendations on compatibility of initiating systems with explosives; Minimise use of detonating cord for down the hole initiation.

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Primary Cause 5: On Bench Practices

Potential Cause	Likely Indicators	Possible Control Measures
Hole condition incorrectly identified	<ul style="list-style-type: none"> Only when using non water-resistant explosive products; Slumping. 	<ul style="list-style-type: none"> Measure all holes in shots that have holes >8m and conduct a sample measurement of shots with holes <8m to understand the hole conditions throughout the pattern; Record wet, dewatered and dry holes on dip sheets and use this information as a basis for explosive product selection; Capture hole by hole charging data; Minimise time between dipping and loading, especially in soft and clay strata; Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows; Training/competence of blast crew.
Blast not drilled to plan	<ul style="list-style-type: none"> Inaccurately drilled patterns; 	<ul style="list-style-type: none"> Maintenance of accurate drilling records; Review drill pattern prior to drill leaving pattern to ensure the bench is drilled to design; Review of blast design if required to compensate for inaccuracies.
Dewatering of holes diverts water into holes previously loaded with dry hole explosive products	<ul style="list-style-type: none"> Poor charging practices; Cross grade of bench. 	<ul style="list-style-type: none"> Assess the bench topography to understand where pumped water runoff will pool and which holes will be effected by dewatering activities; Load dewatered holes in a sequence that allows for re-assessment of what impacts the pumped water runoff has on surrounding dry holes; Load dry holes after dewatering activities are completed; Training/competence of blast crew.
Blast not loaded as per blast plan	<ul style="list-style-type: none"> Incorrect tonnages / types of explosives used on shot. 	<ul style="list-style-type: none"> Training/competence of blast crew; Effective supervision; Communication of loading requirements; Alteration to the design sign off is completed to provide a documentation trail of the revision and sign off of any alteration to the charge plan issued to the shotfirers from the Drill and Blast Production Planning Department; Capture hole by hole charging data; Perform on bench cup density checks to ensure correct explosive density is reached.
Low lying areas susceptible to water pooling	<ul style="list-style-type: none"> Pooled water on bench; Low spots in bench. 	<ul style="list-style-type: none"> Load low lying areas last to allow for re-assessment of hole conditions once the surrounding holes have been loaded and water impacts has been realised; In cases when wet weather is predicted load these low lying holes with wet product prior to the arrival of the rainfall; Load a buffer zone surrounding the low lying area in cases where the holes are identified as wet holes to prevent water ingress into holes loaded with dry product.

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Primary Cause 6: Contamination of Explosives in the Blasthole

Potential Cause	Likely indicators	Possible Control Measures
Explosive product mixes with mud/ sediment at bottom of hole.	<ul style="list-style-type: none"> Blasts containing wet/dewatered blast holes. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Use correct hose handling practices (no top loading of wet product), if required; Insert gas bag to separate mud/ sediment from explosive product; if required; Ensure appropriate loading practices are followed during charging; Ensure primer is positioned in undiluted explosive product; Use blast hole savers after drilling; Training/competence of blast crew.
Penetration of stemming material into top of explosive column (fluid/ pumpable explosive products only)	<ul style="list-style-type: none"> Blasts charged with pumpable explosive products only. 	<ul style="list-style-type: none"> Use appropriate stemming material; Ensure explosive product is gassed to manufacturer's specification before stemming.
Water entrainment in explosive product	<ul style="list-style-type: none"> Intermittent NOx gases; Blasts containing wet/dewatered blast holes only. 	<ul style="list-style-type: none"> Use correct hose handling practices (no top loading of wet product), if required; Ensure all primers are positioned correctly: <ul style="list-style-type: none"> Bottom primer 1m above the base of the hole in explosive product; Use a second booster for hole >15m; Use of gas bags in dewatered holes, as required; Ensure all loaded dry holes are stemmed prior to predicted wet weather and that these holes are capped with drill cuttings instead of gravel, as drill cuttings offer a better water seal over the holes than gravel; Measure water recharge rate after dewatering and adjust explosive product selection to suit hole condition; Load holes identified as wet with wet product only; Load low lying areas last to allow for re-assessment of hole conditions once the surrounding holes have been loaded and water impacts has been realised; Load dewatered holes in a sequence that allows for re-assessment of what impacts the pumped water runoff has on surrounding dry holes; Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows.
Moisture in ground damaging explosive product	<ul style="list-style-type: none"> Frequent fume events in blasting horizon; Wet ground. 	<ul style="list-style-type: none"> Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level; Explosives product selection; Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows; Load blast holes in a sequence that ensure the wet holes are loaded first to allow for re-assessment of what impacts the water displaced in the wet holes has on surrounding dry holes; Load a buffer zone surrounding the wet holes with wet product to prevent water ingress into holes loaded with dry product.
Contamination of explosives column by drill cuttings during loading	<ul style="list-style-type: none"> Poor loading practices. 	<ul style="list-style-type: none"> Drillers are to use hole savers for holes >15m to prevent fall back from drill cuttings; Verify correct hose handling practices are in place (eg. operator competence, procedures), use explosives supplier's personnel; Training/competence of blast crew.

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Primary Cause 7: Weather

Potential Cause	Likely indicators	Possible Control Measures
Rainfall on a sleeping shot.	<ul style="list-style-type: none"> • Rainfall • Ponding on the shot • Stumping 	<ul style="list-style-type: none"> • Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows • Drillers are to use hole savers for holes >15m to prevent fall back from drill cuttings • In cases when wet weather is predicted load these low lying holes with wet product prior to the arrival of the rainfall. • Ensure all loaded dry holes are stemmed prior to predicted wet weather and that these holes are stemmed with drill cutters instead of gravel, as drill cuttings offer a better water seal over the holes than gravel. • Assess the bench topography to understand where pumped water runoff will pool and which holes will be effected by rainfall runoff • Load a buffer zone surrounding the wet holes with wet product to prevent water ingress into holes loaded with dry product • Consider squaring off the pattern and firing prior to the arrival of the rain event
Wind conditions preventing blasts from firing and causing long sleep time	<ul style="list-style-type: none"> • Seasonal Conditions • Horizon risk matrix 	<ul style="list-style-type: none"> • Minimise sleep time of shot with the use of the uninterrupted load tie and fire approach and scheduling blasts to achievable firing windows • Utilise horizon risk matrix and implement adequate controls relevant to the determined fume risk level

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D HEALTH AND SAFETY RISKS OF BLAST FUME

NIOSH Pocket Guides

The US National Institute for Occupational Safety and Health (NIOSH) produces the NIOSH Pocket Guide to Chemical Hazards (NPG)... "intended as a source of general industrial hygiene information on several hundred chemicals/classes for workers, employers, and occupational health professionals. The NPG does not contain an analysis of all pertinent data, rather it presents key information and data in abbreviated or tabular form for chemicals or substance groupings (e.g. cyanides, fluorides, manganese compounds) that are found in the work environment. The information found in the NPG should help users recognize and control occupational chemical hazards."

The NIOSH Pocket Guides for NO, NO₂ and CO are reproduced with authority of the US Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333, USA.

The guides can be accessed through the NIOSH Pocket Guide to Chemical Hazards homepage:
<http://www.cdc.gov/niosh/npg/default.html>

Note that the exposure limits do not necessarily match the Australian short-term exposure limit (STEL) and time-weighted average (TWA).

Health and Safety Risks of Blast Fumes

Nitrogen Dioxide (NO₂)

NO₂ is a toxic gas that irritates the eyes and mucous membranes, primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. Inhalation can result in respiratory tract irritation and pulmonary oedema. Onset of pulmonary oedema can be delayed and can cause death, so personnel who have been exposed to NO₂ must be observed in hospital for at least 12 hours. Changes in pulmonary function are evident at exposures levels of 2 to 3 ppm NO₂; asthmatics are particularly sensitive, potentially suffering significant broncho-spasm at very low concentrations.

NO₂ varies in colour from light orange through to reddish-brown, depending on the concentration and the light conditions. NO₂ is visible in concentrations above 2.5 ppm, although from a distance (such as viewing a blast) the concentrations may need to be above 30 ppm to be observed.

NO₂ has a sharp, biting odour and can be detected by smell at low concentrations (< 0.5 ppm), but the sense of smell can be subdued above 4 ppm. It has a higher molar mass than air and consequently tends to travel across the ground, dispersing over distance.

The STEL for NO₂ is 5 ppm (9.4 mg/m³), TWA is 3 ppm (5.6 mg/m³), and 20 ppm is considered immediately dangerous to life or health (IDLH). The US National Institute for Occupational Safety and Health (NIOSH) recommended short-term exposure limit is 1 ppm.

Concentration	Symptoms
~ 800 ppm	15 seconds exposure lethal by reflex choking if not rescued. Extremely irritating to the eyes, nose and throat.
~ 350 ppm	5 minutes exposure lethal by reflex choking if not rescued. Extremely irritating to the eyes, nose and throat
~ 250 ppm	Lethal to man 15 minutes by reflex choking. Airway reactivity and resistance makes breathing more difficult with time. Less than 5 minutes exposure causes potentially fatal pulmonary oedema
~ 200 ppm	Lethal to man in 30 minutes by reflex choking. Airway reactivity and resistance makes breathing difficult.
~ 150 ppm	For 10 minutes or less causes coughing; eye, nose and throat irritation; headache; nausea and vomiting. Longer exposure can cause permanent eye damage and potentially fatal delayed pulmonary oedema
~ 90 ppm	For 40 minutes has caused moderate irritation to the eyes and mucous membranes and potentially fatal delayed pulmonary oedema. The delay may be up to 70 hours when symptoms of cyanosis (turning blue), shortness of breath, restlessness, headache and frothy yellow or brown sputum appear. If untreated, fluids or froth can flood the lungs (i.e.drowning) or can be infected by viruses or bacteria resulting in bronchitis or pneumonia which may be fatal to a weakened patient.
~ 50 ppm	Moderately irritating to the eyes and mucous membranes within 10 minutes and long exposure can cause permanent eye damage.
4-5 ppm:	For 15 minutes will cause increased airway reactivity (constriction of airways), airway resistance (more effort needed to breathe), and decreased diffusion of gases in the lungs
4 ppm	For 10 minutes anaesthetises the nose so it can no longer smell
0.1 ppm	For 2 hours can result in increased airway reactivity for asthmatics or people with chronic bronchitis.

Symptoms of nitrogen dioxide exposure

Nitric Oxide (NO)

NO is a colourless gas, with a slightly irritating odour. It is slightly soluble in water and forms nitrous and nitric acid. Mild exposure can cause shortness of breath, coughing and chest pains, but more severe exposure (above 100 ppm) can lead to pulmonary oedema, cyanosis, or respiratory failure.

The TWA is 25 ppm (31 mg/m³), and 100 ppm is IDLH.

Concentration	Symptoms
~ 8,000 ppm (0.8%)	Sudden unconsciousness followed by death in 1 minute by chemical asphyxiation. Higher concentrations may be fatal in less time
~ 3,000 ppm (0.3%)	Dizziness or drowsiness in minutes quickly followed by unconsciousness and death in 5 Minutes
~ 1,600 ppm	Muscular tremors, loss of coordination, faster breathing, faster heart rate, drowsiness, dizziness, excess salivation and vomiting may occur in 5 minutes with unconsciousness in 10 minutes and death in 15 minutes
~ 400 ppm	First symptoms, similar to 1,600 ppm above, appear within 2 hours when Methemoglobin concentration reaches 30-40%. Vomiting may cease and unconsciousness may occur within 3 hours. Still has the potential to be fatal if Methemoglobin concentration of blood reaches 70- 90%
0.3 – 0.9 ppm	Pungent odour

Symptoms of nitric oxide exposure

Carbon Monoxide (CO)

CO is a colourless, odourless and tasteless gas. It is readily absorbed through the lungs, where it displaces oxygen in blood through the formation of CO-haemoglobin, leading to headache, fatigue, dizziness, drowsiness and nausea. Large amounts of CO can lead to rapid loss of consciousness and death.

Atmospheric CO ppm	CO-Hb in blood %	Symptoms
1950	80	Rapidly fatal.
800-1220	60-70	Unconsciousness; intermittent convulsions; respiratory failure; death if exposure is prolonged.
350-520	40-50	Headache; confusion; collapse; fainting upon exertion
220	30	Decided headache; irritability; easy fatigability; disturbed judgment; possible dizziness; dimness of vision.
120	20	Shortness of breath with moderate exertion; occasional headache with throbbing in the temples.
70	10	Shortness of breath upon vigorous exertion; possible tightness across the forehead.

Symptoms of carbon monoxide exposure. The table gives the levels of COHb in the blood which tend to form at equilibrium with various concentrations of CO in the air and the clinical effects observed.

The TWA is 30 ppm (34 mg/m³). Short-term excursions should never exceed 400 ppm.

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Sulphur Dioxide (SO₂)

SO₂ is a colourless gas with a characteristic pungent and irritating odour. It is a severe irritant of the eyes, mucous membranes and skin, due to the rapid formation of sulphurous acid on contact with moist membranes. High concentrations can cause respiratory paralysis or pulmonary oedema.

Concentration	Symptoms
80 – 100 ppm	May cause an increased incidence of nasopharyngitis, shortness of breath on exertion (dyspnea), and chronic fatigue
10 – 50 ppm	For 5 to 15 minutes: irritation of the eyes, nose and throat; rhinorrhea (discharge of thin nasal mucus), choking, cough, and in some instances reflex bronchoconstriction with increase pulmonary resistance
10 ppm	Upper respiratory irritation; nose bleeds
5 ppm	Coughing after 5 minutes
3 ppm	Odour threshold
0.3 – 1 ppm	Detectable by taste

Symptoms of sulphur dioxide exposure

The STEL for SO₂ is 5 ppm (13 mg/m³), TWA is 2 ppm (5.2 mg/m³), and 100 ppm is considered IDLH.


Hydrogen Sulphide (H₂S)

H₂S is a colourless gas with a strong 'rotten egg' odour. It is irritating to the eyes and the respiratory tract, and may cause effects on the central nervous system. Inhalation may lead to pulmonary oedema, and as with NO₂, the effects may be delayed by several hours

Concentration	Symptoms
400 – 700 ppm	Loss of consciousness and possible death after 30 – 60 minutes
50 – 200 ppm	Severe respiratory tract irritation; eye irritation
100 ppm	Loss of sense of smell due to olfactory fatigue
20 ppm	Neurological effects including memory loss and dizziness
5 – 10 ppm	Minor metabolic effects
2 ppm	Bronchial restriction in some asthmatics
0.008 ppm	Odour threshold

Symptoms of hydrogen sulphide exposure [Ref 16, 17]

The STEL for H₂S is 15 ppm (21 mg/m³), TWA is 10 ppm (14 mg/m³), and 100 ppm is considered IDLH.

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E. INFORMATION FOR MEDICAL STAFF

Those exposed to NOx 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 NOx Gases.

The patient may have been exposed to NOx. This is a gas usually produced on mines after the use of explosives. NOx consists of multiple combinations of nitrogen and oxygen (N₂O, NO, NO₂, N₂O₄, N₂O₃, N₂O₅). Nitrogen dioxide (NO₂) is the principle hazardous nitrous gas. NOx irritates the eyes and mucous membranes primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. However, 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 NOx 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 NOx may cause pulmonary oedema. Symptoms of pulmonary oedema often do not 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 NOx exists, symptoms will have to be treated on their merits.

APPENDIX B BLAST MONITORING LOCATIONS

