Bengalla Mining Company Pty Limited

Post Blast Fume Generation Mitigation and Management Plan

Revision	Date	Description	Author	Reviewer	Approved
0	30/01/12	Update for Section 96(2) Modification	P Neely Bengalla Mine	C Kent Bengalla Mine	J Davison Bengalla Mine
1	14/12/17	Updated following the Y1 Independent Environment Audit.	L McGinnity Bengalla Mine	C White Bengalla Mine	J Campbell Bengalla Mine

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1.0 INTRODUCTION

1.1 Background

Bengalla Mining Company Pty Limited (BMC) operates the Bengalla Mine (Bengalla), which is located approximately 4 km west of Muswellbrook in the Upper Hunter Valley, New South Wales (NSW). BMC was granted Development Consent for State Significant Development (SSD) 5170 on 3 March 2015 by the Secretary of the Department of Planning and Environment (DP&E) for the Continuation of Bengalla. As per SSD-5170 (as modified), BMC must implement measures to minimise the fume emissions of any blasting at Bengalla. Environmental Protection Licence (EPL) 6538 also requires BMC to manage blast fume so that offensive blast fume is not emitted from Bengalla.

Blast fumes, some of which are toxic, are the gases that may be generated during blasting. In terms of health impacts, the critical gases generated are oxides of nitrogen (NOx) - nitrogen dioxide (NO2) and nitric oxide (NO). NO2 gives blast gas plumes their characteristic reddish orange colour and pungent odour.

Fume produced during blasting usually disperses rapidly and poses no acute health risk. However, under certain conditions the fume may persist and can affect nearby people or residents who are downwind of the blast site.

1.2 Plan Objectives

This document provides a protocol for the mitigation and management of post blast NOx fumes from blasting operations at Bengalla. The aim of this strategy is to address known factors that can affect the generation of fume and provide information on how post blast fume is rated and reported.

2.0 CAUSES AND CONTROLS

The conditions leading to post-blast NOx are varied, but can be seen as cases of either fuel deficiencies or incomplete detonation of the explosive. In practical terms, NOx-generating conditions might be the result of:

- Explosive formulation and quality assurance.
- Geological conditions.
- Blast design.
- Explosive product selection.
- On-bench practices.
- Contamination of explosive in the blast-hole.

The following tables provide more details relating to the primary causes of NOx generation in surface blasting. The tables also include likely indicators and possible control measures that can be taken in managing surface blasts to prevent or mitigate the generation and effects of NOx.

Primary Cause 1: Geological conditions		
Potential Cause	**Likely Indicators**	**Control Measures**
Blasting in weak/soft strata (incorrect timing and pattern size)	• Specific areas known to contain weak / soft strata only • Excessive powder factor	Understand geology of each blast and design blast (timing and explosive product) to ensure adequate relief in weak / soft strata, for example incorporation of a free face, reduction of powder factor, modified timing and increased stemming.
Explosive product seeping into cracks.	• Slumping • Specific areas known to contain a high incidence of faulted fractured ground. • Not achieving designed collar height when loading as per load sheet.	Consider manufacturer's recommendations on explosive product selection. Consider use of blast hole liners. Record and monitor blast holes which have slumped or require excessive explosive product to reach stemming height, but where water is not present.
Dynamic water in holes	• Slumped blast holes • Usually when using non water resistant explosive products.	Minimise sleep time of blast. 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.
Moisture in clay	• When clay or clay rich strata present.	If the drill holes are defined as wet, then water resistant explosive products with appropriate energy will be used in the loading of these holes.
Blast hole deterioration between drilling and loading.	• Traceable to specific geological areas. • Dipped depth inconsistent with drilled depth indicating hole collapse.	Minimise time between drilling and loading. Use hole savers. Mine planning to ensure benches are unaffected by backbreak from earlier blasts, for example presplits, buffers etc. Optimise drilling practices to minimise hole damage.
Ground movement	• Horizon offset (bench, etc) • Area previously known for misfires.	Design sequence timing to prevent hole movement and dislocation of explosives columns.

Primary Cause 2: Climate/Seasonality		
Potential Cause	**Likely Indicators**	**Control Measures**
Rainfall on a sleeping shot.	• Excessive rainfall. • Slumping of holes. • Ponding of water on pattern.	Review rainfall forecasts for planned sleep time of shot and select explosive products according to manufacturer's recommendations. Minimise sleep time for dry blast hole explosive products if rain is predicted. Consider early firing of blast. Bench design for water runoff with appropriate bunding and drainage. If a large amount of rain is predicted to impact on a live shot, then the top of the blast holes will be protected to prevent water ingress by constructing contour drains to divert water away from hole collars. Consider removing water affected product.

Primary Cause 3: Blast Design		
Potential Cause	**Likely Indicators**	**Control Measures**
Explosive desensitisation due to the blast hole depth.	• In deep holes only	Reduce bench height. Ensure adequate relief in deep holes. Follow manufacturer's recommendations on explosive product selection and blast design for deep holes.
Inappropriate priming and /or placement.	• Residue product.	Follow manufacturers recommendations on explosive product initiation.
Inter-hole explosive desensitisation.	• Blast holes drilled closer together than planned. • Blast hole deviations differ greatly from planned.	Review the design and adjust for actual drilling. Review product selection and adjust for new design. Increased control on drilling with deeper designs.
Inter-hole explosive desensitisation in decked blast holes.	• When using decks only.	Appropriate separation of explosive decks. Initiation timing.
Excessive confinement	• Specific to blasts known to be confined. • No free face present. • Excessive powder factor.	Understand geology of each shot and design blast (timing and explosive product) to ensure adequate relief in all strata. Consider incorporation of a free face, reduction of powder factor, modified timing, depth of blast, etc.

Primary Cause 4: Explosive Product selection.		
Potential Cause	**Likely Indicators**	**Control Measures**
Non water resistant explosives loaded into wet or dewatered holes.	• Blasts containing wet / dewatered blast holes.	Follow manufacturer's recommendations on explosive product selection. Regular education of bench crew on explosive product recommendations from current supplier. Discipline in on bench practices.
Excessive energy in strata desensitising adjacent explosive product columns.	• Specific to areas known to contain weak / soft strata only.	Understand geology of each shot and design blast (timing and explosive product) to match, for example reduction in powder factor. Follow manufacturer's recommendations on explosive product selection. Obtain appropriate technical assistance if required to ensure optimal result.
Primer of insufficient strength to initiate explosive column.	• For blasts using a particular primer type / size.	Follow manufacturer's recommendations on compatibility of initiating systems with explosives.
Desensitisation of explosive column from in-hole detonating cord initiation.	• In areas where in-hole cord initiation is used.	Follow manufacturer's recommendations on compatibility of initiating systems with explosives.

Primary Cause 5: Explosive Quality.		
Potential Cause	**Likely Indicators**	**Control Measures**
Explosive product incorrectly formulated.	• All areas associated with loading from a specific delivery system. • Product appearance abnormal	Explosives formulated by supplier to an appropriate oxygen balance to minimise the likelihood of post blast fume.
Inadequate mixing of raw materials.	• In all areas associated with loading from a specific loading system. • Product appearance abnormal.	Visual check. Density check. MMU calibration check.
Delivery system metering incorrectly (on bench incorrect manufacture of product).	• All blasts and all locations utilising explosive product(s) that incorporate a specific precursor.	Regular calibration of MMU. Quality control of explosive products conducted in accordance with manufacturers recommendations.
Explosive precursors not manufactured or supplied to specification or degradation during transport and storage.	• Traceable to a precursor which has degraded between manufacture and use.	Contractor Management System-regular Audits of supplier to ensure compliance with QA/QC systems.
Initiation explosives not manufactured to specification or degradation during transport and storage.	• Damaged packing or out of date stock • Misfire	Rotating Stock in Explosives Magazine
Raw materials changes	• All areas associated with loading from a specific delivery system. • Product appearance changed.	Change management procedures in place by suppliers. Prior notification to suppliers from site change management systems where other raw materials are supplied by the customer, for example diesel fuels.
Product Degradation.	• Slumping of holes.	Sleep times of 4 days maximum for all shots. Sleeping a blast more than 4 days requires Mine Managers approval. Any sleeping shot is inspected daily by the Shotfirer.

Primary Cause 6: Contamination of explosives in the blast hole.		
Potential Cause	**Likely Indicators**	**Control Measures**
Explosive product mixes with mud/sediment at bottom of hole.	• Blasts containing wet/dewatered blast holes only. • Dipped depth inconsistent with drilled depth indicating hole collapse.	Optimise drilling practices to minimise blast hole damage. Ensure appropriate loading practices are followed during charging. Ensure primer is positioned in undamaged explosives product. Where mud or sediment is identified in a hole from dipping, a gas bag will be used to separate mud/sediment from explosive product. Use blast hole savers.
Penetration of stemming material into top of explosive column (fluid /pumpable explosive products only)	• Blasts charged with fluid /pumpable explosive products only	Use appropriate stemming material. Ensure explosive product is gassed to manufacturer's specification before stemming.
Water entrainment in explosive product	• Blasts containing wet/dewatered blast holes only. • Dynamic water present. • Historical groundwater information.	Load wet blast holes first and check remaining holes prior to loading. Adjust explosive product selection according to manufacturer's recommendations depending on changing conditions. Ensure appropriate loading practices are followed during charging. Eliminate top loading into wet or dewatered blast holes. Ensure all primers are positioned in undamaged explosive product. Use of gas bags in dewatered blast holes. Protect top of explosives column to prevent water ingress. Reduce excessive hose lubrication during charging. Adjust explosive product selection according to manufacturer's recommendations for wet environment. Verify correct hose handling practices are in place. Load low blast hole last where practical.

Primary Cause 7: On bench practices.		
Potential Cause	**Likely Indicators**	**Control Measures**
Hole condition incorrectly identified	• Slumping of holes. • Unexpected material in drill cuttings.	Assess all holes prior to loading. Use number and location of wet holes as a basis for explosives product selection. Minimise time between drilling and loading, especially in soft and clay strata. Note: Enough time should be allowed for any dynamic water in the hole to be identified. Minimise sleep time.
Blast not drilled as per plan	• Can be correlated with incorrectly drilled patterns.	Maintenance of accurate drilling records and review of blast design if required to compensate for inaccuracies.
Dewatering of holes diverts water into holes previously loaded with dry hole explosive product.	• Visual inspections of water on bench. • Bench setup, understanding gradient of bench for water runoff.	Load wet holes first and dip remaining holes prior to loading. Adjust explosive product selection according to manufacturer's recommendations.

3.0 BLAST FUME RATING

The Shotfirer will rate and record the fume characteristics of each blasts using the Australian Explosives Industry and Safety Group (AESIG) fume rating system (see **Figure 1**). The intensity of the NOx gases produced in a blast should be measured on a simple scale from 0 to 5 based on **Figure 1** below. 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	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	

Figure 1. Visual NOx gases rating scale

4.0 RESPONSIBILITIES

Table 1 summarises the key responsibilities of site personnel relating to the implementation of the BFMP.

Table 1. BRMS Responsibilities

Position	Role	Responsibilities/Remarks
Mine Planning Engineer	Plan the mine operations to extract coal	Design extraction plan to minimise those blasting activities such as box cuts or blast areas that do not have a free face.
Geologist	Provide data on ground conditions to assist Drill and Blast Engineer with blast design.	Accurate provision of ground data across the proposed blast. Provide geology and rock mass conditions.
Drill and Blast Engineer	Design a blast to provide good extraction of materials while managing blast hazards.	Blast Design to consider: Geology and rock mass conditions. Explosive product selection appropriate to ground and water conditions. Historical blast performance for the current area. Weather conditions during loading and firing.
Environment & Approvals Superintendent	Check environmental conditions.	Complete Blast Risk Assessment and Recording form and obtain appropriate sign-off. Check blasting permissions page for favourable weather conditions prior to firing the blast. External incident reporting.
Drill and Blast Superintendent	Manage drill and blast operations for the site	Incorporate process steps and hazards related to blasting into Standard Operating Procedures for drilling, charging stemming, blast guarding and post blast inspection. Competence of blast team. Adequate resourcing of blasting activities. Escalate all fume events to Mining Manager / Statutory manager.
Drill and Blast Supervisor	Supervise drill activities on the bench. Manage day to day blasting operations.	Conduit between drill activities and blast designer. On bench water management. Bench preparation prior to drilling. Review the use of products appropriate to conditions. Review actual loaded condition of blast prior to shot being fired. Compliance check of on bench activity. Report all fume events to Drill and Blast Superintendent.
Driller	To provide drilled holes for the loading of explosives for a blast.	Accurately drill the shot plan and report variations. Report anomalous ground conditions to drill supervisor. Place collar protection for blast holes.
Shotfirer	Manage all explosives activities on bench.	Compliance with design. Notify any variance from design. Record explosive use data. Supervision of loading technique; Preventing contamination of the explosives column.

		Accurate and adequate placement of Stemming Accurate placement of gas bags. Manage MMU's on bench operations; Ensure QC density checks completed Hose handling for pumped products. Conduit between on bench and Drill and Blast Supervisor. Identify and report hole slumping. Rate and record the fume characteristics of all blasts using AESIG fume rating system. Share Best Practice for learning relating to fume management.
MMU operator	Manufacture blasting explosives. On bench activities as directed by the Shotfirer	Compliance with Shotfirer loading instructions. MMU calibration. Adequate and correct process chemicals. Manufacture QC checks. Generate delivery / production records.
Explosives Manufacturer / Supplier	Provide explosives fit for purpose.	Manufacturing equipment compliance. Provision of precursors and formulation to ensure minimum amount of fume. Change management of formulation to ensure fumes are minimised in product. Design, calibration and operation of explosives manufacturing equipment to deliver consistent explosives within specification. Provide recommendations for product use and training as required.

5.0 DOCUMENTATION AND RECORDS

The documentation and records used for the preparation and firing of a blast are identified in **Table 2**.

Table 2. Documentation for the preparation and firing of a blast

Position	Record	Documentation
Drill and Blast Engineer	Blast design and performance.	• Drill pattern plans. • Load sheet. • Location of blast. • Type of blast. • Pattern size. • Hole diameter. • Video of blast. • Air blast and vibration results. • Monthly reconciliation of blasted volumes.
Shotfirer	Explosive stock control	• Quantity (weight/numbers of units) of explosives delivered. • Quantity (weight/numbers of units) of explosives used on a shot by shot and day by day basis.
Shotfirer in charge	Shotfiring report	• Date/time of firing. • Name, type and location of shot. • Explosives type, tonnages delivered of explosives used. • Number of holes charged (for day/total). • Average hole depth. • Numbers of holes fired. • General comment on blast loading progress or results. • Fume category.
Drill operator	Drill shift report	• Drill number. • Location pattern no. • Burden and spacing. • Operator name. • Bit size. • Date /time/shift. • Drilling task by the hour. • Hole number and depth. • Comments and/or defects. • Total summary for shift. • Coal seam horizons as requested • Geological anomalies/conditions encountered
Environment and Approvals Superintendent	Environment records	• Forecast and actual meteorological conditions. • Blast vibration and overpressure.

6.0 INCIDENT REPORTING

6.1. Incident Criteria

SSD-5170 defines an incident is a set of circumstances that:

- Causes or threatens to cause material harm to the environment; and/or
- Breaches or exceeds the limits or performance measures/criteria in SSD-5170 (as modified).

EPL 6538 and the *Protection of the Environment Operations Act 1997* (PoEO Act) define an incident as a situation where, in the course of an activity, material harm to the environment is caused or threatened. EPL 6538 further defines an incident if blast fume emitted from the premises is:

1. Harmful to (or likely to be harmful to) a person that is outside the EPL premises area (see **Appendix A**), or
2. Interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside of the EPL premises area (see **Appendix A**).

6.2. Internal Reporting

Actual or potential environmental incidents, as per **Section 6.1**, will be reported to the Environment and Approvals Superintendent. The Environment and Approvals Superintendent will determine if the incident is to be reported externally.

6.3. External Reporting

If the Environment and Approvals Superintendent determines that an incident is required to be reported externally, BMC will immediately notify the relevant authorities. BMC must provide written details of the incident to the EPA, DP&E and/or any other relevant agencies within 7 days of the date on which the incident occurred.

Notifications to the EPA must be made by telephoning the EPA Environment Line service on 131 555.

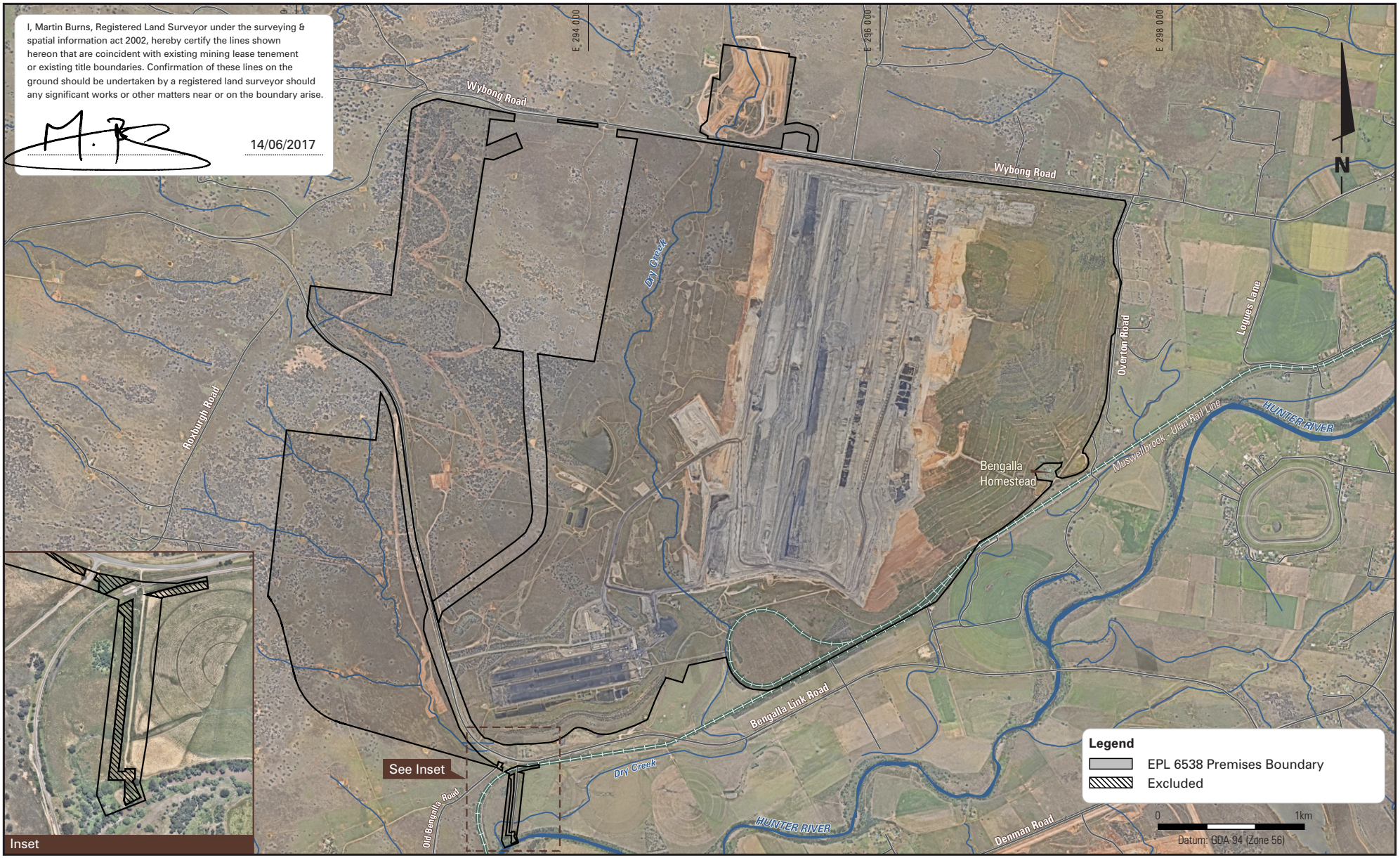
Notifications to the DP&E is by telephone and/or email to DP&E compliance.

7.0 REFERENCES

- SSD-5170
- EPL 6538
- PRO-0650 Blast Management Plan
- Australian Explosives Industry and Safety Group Inc (AEISG). 2011. Code of Practice for Management of post blast NOx fume in surface blasting.

APPENDIX A

EPL 6538 Premises Area



HB BENGALLA EPL Boundary Revisions 1649 F1 BMC Premises Boundary - Option 2 - With MTP EPL Components Removed 21 06 2017 Rev C

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BMC Premises Boundary

14 June 2017