



**NSW
Resources
Regulator**

CAUSAL INVESTIGATION REPORT

COLLAPSE OF SHAFT COLLAR

North Wambo Underground Mine



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Executive summary

A catastrophic failure of an underground bulkhead seal occurred at North Wambo Underground Coal Mine on 3 May 2020 at 8.15am. This caused a rapid loss of drilling mud from a blind bore drilling shaft. An engineered underground bulkhead seal was installed directly beneath the blind bore drilling project, where the shaft was to intersect the roadway underground. The purpose of this bulkhead seal was to confine the drilling mud to within the shaft column for the duration of the drilling project, and to prevent interaction with the underground workings.

Within minutes of the drilling mud escaping from the shaft, the alluvial materials close to the surface began to collapse into the shaft void, due to the rapid loss of confinement pressure. A sinkhole rapidly developed and the drill rig personnel moved to a place of safety, before both the drilling rig and constructed drilling pad partially descended into the sinkhole.

Subsequently, an underground inspection was undertaken by mining supervisors, who confirmed that there was clear evidence the bulkhead had catastrophically failed, and that no further source of ground instability was identified.

The mine had foreseen the risk of inrush and had documented this in its risk assessment. The risk control measure introduced to eliminate or minimise the risk was an inrush control zone underground while work was being undertaken to sink the shaft. The inrush control zone prevented workers from being exposed to the fatal hazard that ultimately occurred.

Investigation findings

The key findings from the investigation were:

- The incident occurred because of the catastrophic failure of the bulkhead seal.
- The bulkhead seal had not attained design strength at the time of the failure. This was determined by a sampling program coordinated by the mine.
- The risk assessments that were conducted for the project had not considered the impact of the rapid loss of confinement pressure created by the rapid loss of drilling mud on the stability of the upper section of the shaft being drilled.
- The mine had deviated from its original plan of blind boring the shaft into solid coal, and had relocated the planned position of the shaft due to both underground and surface considerations.

- Inadequate change management procedures were implemented when it was identified that the bulkhead had not attained its designed strength.

Recommendations

Mine operators and persons conducting a business or undertaking (PCBUs) have a duty to identify hazards and manage risks to health and safety associated with the operation of plant and equipment in accordance with the *Work Health and Safety Act 2011* and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations.

It is recommended that mine operators, contract service providers and equipment suppliers implement strategies to:

- eliminate or minimise risks associated with the rapid loss of drilling mud during blind boring activities
- identify all foreseeable risks and nominate adequate controls during the planning phase of engineering projects
- ensure that when deficiencies are identified mid-project, robust change management procedures are activated and additional controls implemented as appropriate.

Mine operators should also read the *Post incident actions* section in this report as it provides additional detail about what the mine has done, and intends to do in response to this incident.

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1. Causal investigation

A preliminary investigation and assessment of the incident was carried out by the NSW Resources Regulator. It did not identify any material breaches of the work health and safety laws. Following this assessment, we determined that an investigation under the *Causal investigation policy* would be appropriate.

A causal investigation is an investigation into a safety incident that has been notified to the Regulator under work health and safety laws. It is not to obtain evidence for a prosecution, but to identify the causal factors of safety incidents, the effectiveness of the controls used and the factors that may have contributed to the failure of these controls. Timely communication helps to ensure that duty holders, under the work health and safety laws, can better understand the risks they must manage and the necessary controls needed to prevent reoccurrences of similar incidents.

We invited relevant stakeholders to participate in the causal investigation process and an investigation team comprising representatives from Wambo Underground Mine, Mastermyne Pty Ltd, Australian Shaft Drilling Pty Ltd, the Construction Forestry Maritime Mining Energy Union (CFMMEU), and the Regulator was established.

1.1. Purpose

This report has been published under section 70(1)(b) of the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* to share safety lessons about the incident and prevent similar incidents from reoccurring.

1.2. The mine

Wambo Coal Pty Ltd is the appointed mine operator of the Wambo Underground Mine. It is a thermal coal operation mining the Middle Whybrow seam, about 20 kilometres west of Singleton in NSW.

1.3. Parties involved

1.3.1. Mine operator

Wambo Coal Pty Ltd is the appointed mine operator of the Wambo Underground Mine.

1.3.2. Bulkhead/plug seal material supplier and construction contractor

The cementitious materials and labour and equipment used to construct the UG bulkhead/plug seal arrangement were provided by Mastermyne Pty Ltd.

1.3.3. Drilling contractor

The drilling rig and associated equipment, and the labour to operate it were provided by Australian Shaft Drilling Pty Ltd.

2. The incident

A surface drill rig was in the process of drilling a three-metre diameter blind bore hole into underground workings. At 8.15am on 3 May 2020, the drillers reported losing drilling fluid. This resulted in the rapid undermining of the surface rig pad leading to the rig sinking approximately two metres (as seen in Figure 3). An inspection underground identified that a bulkhead had failed catastrophically allowing the drilling fluid to be rapidly lost from the shaft being drilled. Figures 1 and 2 depict the bulkhead seal location and environs after the catastrophic failure.

Figure 1 The bulkhead seal location after the catastrophic failure



Figure 2 Looking inbye from the bulkhead seal site following the catastrophic failure



The original intention was to carry out a blind sink into virgin coal and develop the mains roadways into the completed shaft. This is the typical method implemented for a blind bore shaft. Due to a number of delays in the project timeline, alternative engineering solutions were considered for providing an adequate barrier between the bore hole being drilled and the underground workings.

Due to identification of weathered and alluvial material to a depth of 13.5 metres, the collar design recommended reinforcement of this zone.

Resin injection was the selected method because of time constraints.

Consolidation of material between the 7.5 metre collar sink and the 13.5 metre depth of alluvial materials was by resin injection method.

Figure 3 The blind boring drill rig operated by Australian Shaft Drilling Pty Ltd partially sunk in the collapsed shaft



Analysis of this indicated a less than favourable result. Subsequent injecting of grout using 6 by 16 metre holes with inch line hoses set at a depth of six metres below the surface was undertaken to further consolidate the alluvial material.

3. Investigation

Following the incident, inspectors conducted an initial site assessment with an Industry Safety and Health Representative and mine representatives.

The initial investigation established the basic timeline and parties involved. The assessment found:

- The drilling proceeded without problems until the rapid loss of drilling mud, due to the catastrophic failure of the underground bulkhead/plug seal arrangement. There appeared to be no engineering deficiencies with the rig or associated equipment that may have contributed to the incident.
- Communication between the drilling contractors and the underground mine control room operator had confirmed that the underground inrush control zone had been established and no underground workers were at risk before the drilling resumed on the morning of the incident.
- The mine had established a perimeter around the destabilised ground on the surface to prevent further exposure to risk.

- The drillers were not injured and had removed themselves from the drilling platform before the partial collapse into the shaft collar. An aerial photo depicting the collar collapse can be seen in Figure 4.

Figure 4 An aerial view of the shaft collar collapse



Following the site assessment, inspectors issued a prohibition order, due to the uncertainty of the stability of the strata beneath the drilling pad and equipment, and the significant risks associated with the recovery of the drilling equipment from the shaft collar. The order prevented any activity until a formal risk assessment was completed and a recovery plan formulated.

At this stage of the investigation, the likely cause was considered to be the catastrophic failure of the underground bulkhead/plug seal arrangement, resulting in a rapid loss of drilling mud/confinement pressure within the shaft. This allowed the ingress of alluvial material from the upper section of the shaft surrounds into the shaft, resulting in partial collapse of the drill rig platform into the shaft collar.

The consideration of the potential severity and the unusual nature of the incident prompted the recommendation for a causal investigation.

4. Post incident actions

The mine responded to the incident with the following actions:

- The incident was communicated to the mine workforce.
- The mine accepted an invitation to participate in a causal investigation.
- The mine conducted a formal risk assessment and formulated a recovery plan that was submitted to the Regulator prior to commencing recovery work at the incident site.
- The mine implemented its recovery plan and retrieved the drill rig and associated surface equipment without further incident.
- An incident cause analysis method (ICAM) investigation was conducted including a 5-whys analysis

4.1. Engineering assessment

Mastermyne Pty Ltd conducted a series of tests on the placer pump and the cementitious materials used to construct the bulkheads/plug seal to determine the reasons for the structure failing to attain its design strength. These tests failed to identify any deficiency with the operation of the pump or the individual constituents of the cementitious product.

Figure 5 Failed cementitious product recovered from the failed bulkhead



4.2. ICAM

An ICAM investigation was held at North Wambo Mine on 20 May 2020.

The ICAM concluded the incident was caused by the catastrophic failure of the underground bulkhead/plug seal arrangement, resulting in the release of drilling mud into the underground workings and the subsequent movement of alluvial material into the shaft void resulting in the partial collapse of the drilling rig and pad into the shaft collar.

The ICAM recognised a number of contributing factors, which are summarised below:

Direct causes

- Basic cause - The basic cause of this event is the failure of the bulkhead and plug arrangement, of which its purpose is to prevent the loss of drilling fluids from the drill shaft.
- Root cause - The cementitious material used to construct the bulkhead and plug arrangement did not perform to specification. The samples recovered from underground were of varying hardness and strength. This suggests that the material pumped into the void has not cured to the required strength to form a homogenous unit and therefore failed to meet the intended purpose.

The design of the bulkhead and plug arrangement failed to consider the effect and action of the drilling process. There was no peer review of the design and a design risk assessment was not undertaken to identify adverse conditions to base a factor of safety on.

Contributing factors

- The original strategy of drilling into virgin coal was not undertaken.
- The relocation of the shaft occurred on multiple occasions. This was a consequence of mine scheduling and financial pressures and limited locations due to underground fault systems and surface disturbance limitations.

Figure 6 A mine plan of the proposed seam intersection by the blind borehole and the inrush control zone



- The risk management process relied on the engineer’s certification. As a result, it did not consider the possibility of sudden and catastrophic failure of the bulkhead resulting in the loss of drilling fluids.
- There was inadequate change management and review of the original risk assessment when it was identified that the void had not cured to the required strength. While the engineer revised the certification, it was not peer reviewed and another design risk assessment was not undertaken.

5. Further actions

Recommendations from the ICAM are as follows:

- An investigation is required to understand the circumstances/factors that led to the cementitious product not curing to the intended strength.
- The design of the bulkhead and plug is to be independently reviewed by a suitable engineer experienced in the intended application.
- Review the Wambo risk management standard to develop controls that align with requirements of Peabody risk management standards.
- Peabody will undertake a review of the WRAC template to improve the notification level function and alignment to legislative requirements including the consideration for hierarchy of controls.
- Review the compliance certification for the other seal/bulkhead installations at Wambo Mine constructed from the same materials.

Figure 7 The incident scene

