Resources Regulator
Department of Regional NSW

NSW GOVERNMENT

Consolidated report

Ground or strata failure – slope stability – tier 1 quarries and surface metalliferous mines

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Table of Contents

Executive summary

A crucial part of the NSW Resources Regulator's Incident Prevention Strategy involves targeted assessment and planned inspection programs for mines and petroleum sites. This is a focus on assessing an operation's control of critical risks through evaluating the effectiveness of control measures in the mine's safety management system.

The Regulator has developed a bowtie hazard management framework and standardised assessment checklist for each program plan. Under each program plan, the effectiveness of the safety management system at each mine site is assessed against a standard set of control supports and critical controls.

This report summarises the assessment findings from 26 mines in relation to assessments for the hazard of ground or strata failure – slope stability, conducted between April 2021 and January 2023.

The threats and critical controls assessed for the material unwanted event (ground or strata failure – slope stability) are shown in Table 1.

Table 1: Threats and critical controls for the material unwanted event (Ground or strata failure – slope stability – tier 1 quarries and surface metalliferous mines)

THREAT	CRITICAL CONTROL
▪ Ground conditions ▪ Natural or induced seismic event	PC 1.4 – Drilling and blasting practices
▪ Unconsolidated material ▪ Natural or induced seismic event	PC 3.4 – Dump to design

Legislative requirements and published guidance relating to the principal hazard of ground or strata failure is listed in Appendix A. Figure 1 presents safety compliance findings for each deidentified mine and critical control assessed for the material unwanted event of ground or strata failure. Explanatory notes on the assessment system are also listed in Appendix B.

Key findings

Resources Regulator inspectors were able to share information from other mine sites about what was done well to manage the hazards associated with surface ground or strata failure, as well as any incidents that occurred within the mining industry and what controls were applied to prevent a similar type of incident from reoccurring.

Some general findings from the inspection program are listed below, as well as some specific findings for each of the focus areas assessed.

General findings:

- A few sites assessed did not undertake drilling and blasting activities. e.g. sand mines.
- The majority of larger sites used specialist blasting contractors to conduct the blasting activities at the mine. This was also the case with drilling activities where contractors were used predominately to conduct the blasthole drilling activities. In some cases, the contractor conducted both the drilling and blasting activities at the mine.
- The drilling and blasting contractors had experienced, competent shotfirers and drillers undertaking the activities. When inexperienced personnel were involved in those activities, experienced workers directly supervised the activities.

- Maintenance issues were identified with a few of the contractors' drills rigs and associated equipment. This included drill rig pre-starts being completed incorrectly and unqualified drillers doing maintenance work. Some contractor's mobile equipment such as drill rigs and light vehicles were not formally inspected when introduced to site.
- At 2 sites, drilling contractors brought petrol-operated equipment and petrol containers onto the mine site in breach of the mine's hazardous chemical procedures.
- Not all sites had dumps. At a couple of the mines, all extracted material was used to make quarry products, eliminating the need to form and maintain dumps.
- A few sites had 2 shift operations. At one site, the shift supervisor's statutory shift changeover report did not always have both the outgoing and incoming supervisors signatures.
- Seismicity was mentioned in 2 of the mines' risk assessments but no controls were documented or implemented at either site.
- Positive communications were the primary control used to manage traffic on dumps with the dozer operator controlling/coordinating the dumping activities.
- Issues were identified at a few sites where bench edge protection, berms and windrows were not installed to the required documented standard.

Critical control: PC1.4 – Drilling and blasting practices

- All drilling activities were undertaken to a plan that had detailed information on the hole location, depth, diameter, angle, shot burden and spacing etc.
- Drill operators were experienced and were able to explain the key features of the drill plan. This included explaining the type of shot being drilled and key drill pattern requirements such as hole location, number, depth, diameter, and angle.
- Drill operators were able to explain the hole mark-up process and how they drilled the blast holes in the correct location. Some modern drill rigs had GPS capabilities where the blast hole files were uploaded to the drill rig to confirm/record hole locations and associated drilling data.
- Drill operators were able to confirm and explain how they ensured that drill patterns were drilled to the drill plan/design requirements. This included recording the drill hole details on a drill log.
- Drillers maintained and recorded detailed drill hole and associated information on a drill hole log. Drill log details included recording deviations from the planned requirements such as short holes, broken ground, water in hole/s, redrilled holes, voids encountered etc. Some drill logs did not record all applicable details such as shot location, drilling date, site contact details, hole diameter/angle/length or have the supervisor sign them off as completed.
- Drillers were able to explain their actions when they experienced difficulties in achieving the drill plan. This included using collar pipes, redrilling holes, discussing drilling difficulties with shotfirers/site supervisors and blast/design engineers.
- At several sites, shotfirers were not on site at the time of the inspection. Several smaller mines only conduct blasting activities infrequently when required.
- Shotfirers said they reviewed drillers' drill hole logs and also dipped holes before charging the holes to confirm the holes met design requirements. This included bore tracking face holes and inspecting face and bench conditions before charging activities began.
- Shotfirers had blast information packs that included bench location and condition/blast details including number of holes, hole lengths, hole diameter, types of explosives to be used in the blasts – such as ANFO or emulsion, type and size of primers, detonator types such as nonel/ electronic, MIC, timing sequence, stemming height etc.
- At a couple of mines there was a lack of demarcation, bunding, signs or other controls in place to identify and prevent unauthorised access to active drill/charging benches.
- A few mines lacked formal procedures for stand-off distances from high walls.

Critical control: PC 3.4 – Dump to design

- Supervisors responsible for managing dumps had appropriate skills and knowledge of dump designs limits and associated hazards.
- Supervisors provided guidance to equipment operators on dump limits and associated hazards controls. This occurred during morning tool box meetings and in the field when conducting dump inspections.
- Supervisors conducted regular inspections of dumps to ensure they met design requirements. At times supervisors conducted several dump inspections during their shifts such as during heavy rainfall. At a couple of sites, the supervisor's dump inspections were not formally recorded or actioned.
- At a few sites, the dump safe work procedures and associated dump inspection sheets lacked details on what areas where inspected and if the required standards were implemented.
- Only a few mines had onsite geotechnical engineers. Not all mines had third party geotechnical inspections or reviews conducted on dump and high wall stability.
- Dump operators, especially dozer drivers who controlled the dumping activities, were very experienced operators. They had appropriate knowledge of dump standards and hazards and were able to explain how to repair or recover the dump when not to standard, such as removing/ controlling water or low spots.
- Dump delineation markers, signs and barriers were not always installed as specified in site procedures.

Recommendations

The planned inspection program identified appropriate levels of control implementation and effectiveness across all sites assessed. Practices that could be improved are:

- Mine operators must ensure formal inspections of bench conditions and high walls are conducted by competent persons and any identified hazards are actioned before drilling and charging activities commence on the bench. This includes ensuring bench edge protection, demarcation of charging and drilling activities, and high wall stand-off distances are implemented to site standards.
- Mine operators must ensure risk-based safe work procedures are in place for conducting inspections and the procedures contain sufficient detail on what needs to be inspected and the frequency of inspections. Any hazards identified during the inspection process need to be actioned appropriately.
- Procedures must be developed and implemented to ensure that contractors' mobile plant and associated equipment/consumables brought to site go through an introduction-to-site process to ensure they are fit-for-purpose and meet site standards.
- Mine operators must ensure site supervisors regularly check contractors' mobile equipment at pre-start inspections. This must include checking that competent workers conduct safety critical maintenance activities on contractors' mobile equipment.
- Mine operators should ensure that regular third-party geotechnical inspections are conducted at the mine.
- Mine operators must ensure that when 2 shift operations are conducted that both the outgoing and incoming shift supervisors sign the statutory shift report. Refer Work Health & Safety (Mines & Petroleum Sites) Regulation Section 31 - Communication between outgoing and incoming shifts.

Findings by mine

Figure 1 presents aggregate assessment findings by threat and critical control, providing a summary view of the status of each mine's hazard management processes. Importantly, the system recognises the value of fully implemented and documented controls by awarding an additional point if both elements were assessed as present. More details explaining the assessment system are at Appendix B.

Figure 1: Assessment findings for the planned inspection program – Ground or strata failure – slope stability – tier 1 quarries and surface metalliferous mines

	Threat	
	1. Ground conditions 5. Natural or induced seismic event	3. Unconsolidated material 5. Natural or induced seismic event
	PC1.4	PC3.4
Mine	Drilling & blasting practices	Dump to design
Mine A	Not applicable	Orange
Mine B	Not applicable	Orange
Mine C	Green	Red
Mine D	Yellow	Orange
Mine E	Yellow	Yellow
Mine F	Yellow	Yellow
Mine G	Green	Yellow
Mine H	Yellow	Green
Mine I	Green	Yellow
Mine J	Green	Yellow
Mine K	Green	Yellow
Mine L	Green	Yellow
Mine M	Green	Green
Mine N	Green	Green
Mine O	Green	Green
Mine P	Not applicable	Green
Mine Q	Not applicable	Green
Mine R	Green	Green
Mine S	Green	Green
Mine T	Green	Green
Mine U	Green	Green
Mine V	Not applicable	Green
Mine W	Not applicable	Green
Mine X	Green	Green
Mine Y	Green	Green
Mine Z	Green	Green

Green (=100%)
Yellow (>= 80% and <100%)
Orange (>= 65% and <80%)
Red (<65%)
Not applicable

Notices issued

Of the 26 sites assessed under the inspection program, 21 separate mines were given notices relating to the principal hazard of ground or strata failure, while some mines were given notices in relation to other matters. For the purposes of this report, contraventions related to other matters were removed from the analysis. The notices issued for ground or strata failure were examined in detail and Table 2 below lists the notices issued by type and details.

Table 2: Notices issued for the planned inspection program – Ground or strata failure – slope stability – tier 1 quarries & surface metalliferous mines

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES
s.195 prohibition notice	-	-
s.191 improvement notice	9	8
s.23 notice of concerns	19	19
Total	**28**	**21**

Of the combined 28 notices issued, there were some common themes that were apparent throughout the program plan. Table 3 summarises the type of contraventions. These themes can be related to the critical controls outlined earlier and identify some trends that are of concern.

Table 3: Notices issued - prevalence of categories of concern

IDENTIFIED CONCERN CATEGORY
Lack of risk-based inspection procedures that detail the frequency and competencies for undertaking inspections of high walls, dumps, and drilling and blasting activities. Supervisors not conducting formal (recorded) inspections.
Introduction to site inspections of contractor's mobile plant and associated equipment/consumables were often inadequate.
Prestart documentation on contractors' mobile plant was not always completed to an acceptable standard.
Instances where bunding of exposed edges was not in place or ineffective.
Supervisors of a mine with 2 shift operations had not formally signed the shift change over acknowledgements.
Drillers and shotfirers not recording all required details on drill logs and blast plans.

Further information

For more information on safety assessment programs, the findings outlined in this report, or other mine safety information, please contact the NSW Resources Regulator:

CONTACT TYPE	CONTACT DETAILS
Email	cau@regional.nsw.gov.au
Incident reporting	To report an incident or injury call 1300 814 609 or log in to the Regulator Portal
Website	www.resourcesregulator.nsw.gov.au
Address	NSW Resources Regulator 516 High Street Maitland NSW 2320

Appendix A. Legislative requirements and published guidance relating to the principal hazard ground or strata failure

The following is a list of certain legislative requirements for the management of ground or strata failure risks referred to in this report, as provided by the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 and Work Health and Safety Regulation 2017.

- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Section 14 Management of risks to health and safety
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Division 2 Principal hazard management plans and principal control plans
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Section 31 Communication between outgoing and incoming shifts
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Section 33 Explosives and explosive precursors
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Section 39 Inspections
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Division 8 Information, training and instruction
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Part 5 Consultation and workers' safety role
- Work Health and Safety (Mines & Petroleum Sites) Regulation 2022 - Schedule 1 Principal hazard management plans - 1 Ground or strata failure
- Safety Bulletin SB17-03 - Rocks breach catch bund
- Safety Bulletin SB18-11 - Windrow management and demarcation
- Safety Bulletin SB19-07 - Lack of bunding on accessible edges
- Safety Bulletin SB20-01 - Failure of highwalls, low walls and dumps
- Safety Bulletin SB21-02 – Flyrock from blasting activities
- Safety Bulletin SB22-03 – Impacts of severe weather on slope stability

Appendix B. Assessment system explained

The NSW Resources Regulator uses a bowtie framework to proactively assess how mine sites manage their principal hazards. Bowties are a widely used risk management tool that integrates preventative and mitigating controls onto threat lines that relate to a material unwanted event.

As part of program planning, controls were categorised by the NSW Resources Regulator's mine safety inspectorate in accordance with the ICMM handbook. Only controls deemed critical[1] are assessed under a planned inspection program. For a control to be assessed as effective, each of its control supports must be in place and operational.

Assessment findings results calculation

During the program, each control support assessed at each mine was rated and the findings recorded. Points were awarded depending on whether there was evidence that the control support had been documented and/or implemented. Importantly, the system recognises the value of fully implemented and documented controls by allocating four points if both these elements were present.

For finding outcomes, points were awarded for each control support identified within a critical control. An overall assessment result for the critical control was then calculated as a proportion of the maximum possible points for that critical control. For example, if a critical control comprises ten control supports and five were assessed as fully implemented ('documented and implemented') and five were found to be 'not documented and not implemented' then the overall assessment result for that critical control would be 50%.

Table 3: Finding outcome and points

FINDING OUTCOME	POINTS
Documented and implemented	4
Implemented but not documented	2
Documented but not implemented	1
Not documented and not implemented	0

Critical control calculations also took into account instances where control supports were not applicable to the mine being assessed or when control supports were not able to be assessed during a site visit.

The overall assessment result for each critical control has been assigned a colour based on the assessment bands presented in the table below. The colour band results are then used to identify industry focus areas requiring improvement.

Table 4: Assessment results and colour code

CRITERIA	COLOUR
An assessment result of 100% of possible points	Green
An assessment result of ≥ 80% but < 100% of possible points	Yellow
An assessment result of ≥ 65% but < 80% of possible points	Orange
An assessment result of < 65% of possible points	Red

[1] Critical Control Management Implementation Guide, International Council on Mining and Metals (ICMM), 2015.