Targeted assessment program

Revegetation to achieve sustainable rehabilitation outcomes

January 2024 – December 2024

March 2025

Amendment schedule		
Date	Version	Amendment
March 2025	1.0	First published

Executive summary

This report summarises assessment findings from a targeted assessment program (TAP) across 44 mines focussing on how the mine operators were preparing for, and implementing, revegetation activities to achieve sustainable rehabilitation outcomes. Assessments were conducted between January and December 2024. The threats and critical controls assessed are shown in Appendix A. Figures 1-3 present the compliance findings for each de-identified mine and critical control. Explanatory notes on the assessment system are in Appendix B.

Assessment finding letters were issued to each mine in the program, which included a summary of key observations made by the Resources Regulator during the assessment, as well as recommendations for improvement in the medium to longer term. Statutory notices pursuant to section 240 of the *Mining Act 1992* were issued to 4 mines, directing them to take specific actions relating to preparing and implementing revegetation measures to achieve sustainable rehabilitation outcomes that will support achievement of the final land use.

The key TAP findings and recommendations to continually improve the implementation of the critical controls required to mitigate risks to revegetation include:

Rehabilitation risk assessments – Generally across industry there has been an improvement in the scope and quality of risks assessments pertaining to mine rehabilitation. The TAP identified further improvement at certain sites to specifically address revegetation risks and ensure controls were appropriately prioritised. Furthermore, where a mine had multiple risk assessments, there should be a centralised register/system that identifies all the risks and controls measures as a means to ensure the appropriate controls are captured in the rehabilitation management plan.

Revegetation methodology – geochemical/soil biota constraints – While several mines had a level of understanding of the geochemical quality of substrates (e.g. soils), further characterisation analysis, in particular soil biota conditions, was recommended to understand potential constraints and amelioration requirements for revegetation campaigns, as well as to determine the effectiveness of ameliorants applied. Quality assurance processes (such as inspection test plans) should be implemented that trigger and record characterisation analysis of topsoil and substrates and specialists should be used to provide advice on soil ameliorants.

Revegetation methodology – physical/structural properties of the substrate – While various techniques were implemented across some mines to address physical constraints (e.g. compaction), more formalised assessments of the physical and structural properties of the substrate was recommended to be undertaken before revegetation campaigns. Quality assurance processes (such as inspection test plans) should be implemented that trigger and record the assessment.

Revegetation strategy – unseasonal/adverse weather conditions – Preparing, implementing and documenting processes of how forecast weather reports were used to plan when substrate preparation and seeding activities occurred. Seasonal and weather conditions that were present at each revegetation campaign should be recorded for future analysis when evaluating causal factors that led to either the success and or failure/delay of revegetation areas.

Revegetation methodology – revegetation in optimal seasonal conditions – Preparing, implementing and documenting management actions that avoided and/or minimised impacts of adverse seasonal conditions to ensure that revegetation was established effectively.

Revegetation methodology – availability and integrity of seed resource - There were some mines that implemented robust seed collection and handling processes, which validated the type, source

and viability of seed used in revegetation programs. Noting where there was a concentration of mines (e.g. Hunter Valley) where the demand for similar native seed would be increasing, the TAP has recommended more widespread adoption of methodologies to address this issue. This included:

- implementing a program of periodic independent testing to validate seed viability results and to confirm the appropriate seed mix for the target rehabilitation areas to be established across the mine site

- ensuring the seed collection program targets species found to be deficient in the revegetation areas from the findings of rehabilitation monitoring programs.

Revegetation methodology – protection of substrates and revegetation from damage - There were some mines that implemented measures to:

- prevent unauthorised access

- protect plant and soil from damage relating to predatory species (e.g. native fauna, rabbits, goats, pigs, etc) such as barriers (e.g. fencing, tree guards, etc) or control programs like culling, baiting, etc.

Revegetation methodology – landform aspect or unit - Consideration of the landform aspect and/or unit in the selection of appropriate seed mixes when planning and implementing the final landform design. Particularly where different native vegetation communities that were sensitive to landform aspect or landform units (e.g. higher elevation vs lower elevation or creek zones) were required to be established across the mine.

Rehabilitation monitoring program - Improvements to existing monitoring programs that were in place for mining operations, including:

- implementing a quality assurance process (such as an inspection test plan) for each rehabilitation area/campaign that covered all the phases of rehabilitation to ensure that all risks were addressed before progressing to the next phase

- undertaking a gap analysis of monitoring programs against performance indices associated with rehabilitation completion criteria to ensure that rehabilitation trajectory and success of achieving the final land use(s) could be validated

- ensuring future monitoring reports were used to assist addressing knowledge gaps to finalise rehabilitation completion criteria for approval by the Regulator

- reviewing the appropriateness of reference sites used to compare against rehabilitation to ensure they were a good representation of the range of conditions

- expanding the number of reference sites and/or sharing relevant reference site data collected by other mining operations (e.g. sharing by mines situated across the Hunter Valley)

- reviewing the rehabilitation key performance indicators presented in the annual rehabilitation report to ensure they reflected the correct status/phase of rehabilitation on site.

Rehabilitation maintenance program/adaptive management program - Based on good practices identified at some sites, the TAP recommended more widespread adoption of measures such as:

- developing trigger action response plans (TARPs) to address the outcomes of rehabilitation monitoring programs to ensure recommendations are budgeted, assigned to responsible positions and implemented

- developing and maintaining rehabilitation methodology record forms (captured in a GIS system) for each rehabilitation area/campaign to assist knowledge retention to evaluate the methods that led to successful and/or failed rehabilitation

- geospatial records management tools to record when and where maintenance actions were conducted as well as a rehabilitation performance scorecard system to target maintenance actions to priority areas to ensure revegetation achieves the final land use as soon as reasonably practicable

- adopting a rehabilitation scorecard system to track performance of rehabilitation for each rehabilitation campaign across the mine site, which included the results of the rehabilitation monitoring program to validate the nominated phase of rehabilitation as well as detailing further works required (if any) to further progress rehabilitation maturity.

Rehabilitation management plan – Reviewing and amending the rehabilitation management plan to ensure the relevant recommendations of this report were documented and implemented.

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Introduction

The Resources Regulator undertakes TAPs at mines in New South Wales, assessing critical rehabilitation risks and the critical controls required to mitigate these risks.

We developed a bowtie risk management framework and standardised assessment checklists for a range of TAPs. Each TAP focuses on implementing identified critical controls (categorised in accordance with the ICMM handbook[1]) to determine whether measures have been identified and implemented to ensure sustainable rehabilitation outcomes.

Further details regarding our TAP programs, including the bowtie risk assessments, are available on our website.

A summary of the TAP assessment set-up, including objectives and assessment criteria for each critical control is in Appendix A.

The TAP applies the following principles:

- Consideration of the mine's risks to achieve effective rehabilitation.
- A focus on the implementation of the identified critical controls.
- Evaluation of the effectiveness of the control measures implemented.

The revegetation TAP was undertaken between January 2024 and December 2024. The revegetation TAP assessed the critical controls associated with preparing and implementing revegetation activities to achieve sustainable rehabilitation outcomes that will support the final land use.

The program included site inspections at 44 mines.

Scope

The TAP incorporated:

- a desktop assessment of documents and records to identify the control measures the mine used to prevent and mitigate the risks to achieving sustainable rehabilitation outcomes
- a site inspection of the mine to assess the implementation of those controls.

The process

The process for undertaking a TAP generally involves the following stages:

Written notification to the mine providing details of the proposed TAP. This includes:

- the focus areas of the assessment
- assessment timing and assessment team composition
- a list of the likely documents and records that should be made available for assessment
- the resources that should be made available by the mine, including site personnel that may be required to participate.

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

- a site visit to the mine (normally one day) to undertake both the desktop assessment and site inspection

- verbal discussion and feedback to the mine management team on the findings and likely actions that need to be taken by the miner operators in response

- written feedback to the mine, which may include an assessment finding letter and/or a direction to address certain matters pursuant to section 240 of the *Mining Act 1992*.

Assessment findings

Controls assessed

MRP1.1 – Rehabilitation risk assessment

The risk

A standard condition of mining leases[2] requires preparing a rehabilitation risk assessment that:

- identified, assessed and evaluated the risks that need to be addressed to achieve the final land use

- identified the measures that need to be implemented to eliminate, minimise or mitigate the risks.

The measures identified in the rehabilitation risk assessment were required to be implemented, and mine operators must identify and record any reasonably foreseeable hazard that presented a risk to rehabilitation being able to achieve the final land use.

Rehabilitation risk assessments are required for each mine to identify the risks to be addressed for revegetation relevant to their site and circumstances. The rehabilitation risk assessment will identify the appropriate risk control measures that must be implemented, and identify how risk control effectiveness will be assessed.

A deficient rehabilitation risk assessment will result in appropriate control measures not being identified and implemented to manage revegetation planning and implementation risks to ensure rehabilitation achieves the final land use.

What was assessed

A rehabilitation risk assessment should identify, assess and evaluate the risks that need to be addressed when preparing and implementing revegetation activities to achieve sustainable rehabilitation outcomes that will support the final land use.

Site-specific rehabilitation risk assessments should have been conducted that:

- identified, assessed and evaluated the risks that need to be addressed to achieve the rehabilitation outcome documents (being the rehabilitation objectives statement, rehabilitation completion criteria statement and final landform and rehabilitation plan)

- identified site-specific risks associated with revegetation

- identified suitable controls and strategies to treat the identified risks

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[2] Refer to clauses 6(3) and 7 in Schedule 8A Mining Regulation 2016

- were relevant to active mining operations.
- was produced by a team of appropriately skilled and experienced people from the workforce with responsibilities for mine rehabilitation.
- results in the identified controls being assigned to a responsible and suitably qualified position.

Where multiple risks assessments were conducted, there should be a centralised document (e.g. risk register) that links all assessments to the requirements set out in Schedule 8A of Mining Regulation 2016.

What we found

We found that since the introduction of Schedule 8A of Mining Regulation 2016 in July 2021, the standard of rehabilitation risk assessments had improved in both scope and quality across the mining industry. However, although we observed some mine operators had risk assessments that would be considered satisfactory, some mines had risk assessments we considered 'broad-brush'. For instance, for these mines we found risk assessments tended to refer to the management plan as a control, instead of nominating specific controls.

We noted some risk assessments had revegetation risks and controls missing. We also noted a portion of these assessments were outdated (in some cases several years) and/or not reflective of the existing operations and risk controls used at the mine.

We also observed uncertainty about how risk control effectiveness was assessed. In instances where failed controls were observed during the TAP inspection (for example spread of invasive species into rehabilitation areas), we found that reviews of the risk assessment and effectiveness of risk controls was ad-hoc, with limited formal records available to validate the review had taken place.

In the majority of cases, the risk assessment was prepared by a range of suitably qualified people.

We also noted some larger mines used the services of revegetation experts as part of the risk assessment process (i.e. attendance at the risk assessment workshops).

RP1.2 – Tailored revegetation methodology – geochemical/soil biota constraints

The risk

Revegetation methodologies that were not tailored to address any geochemical and/or soil biota constraints of the substrate, presented a risk to achieving and sustaining the target revegetation outcomes.

What was assessed

Characterisation analysis was conducted and geochemical and soil biota (micro-organisms, soil animals and plants) constraints/opportunities of substrate were understood. This included the potential contamination of weed sources (e.g. in the seed bank) that may lead to excessive weed cover in the revegetation.

The results were used to determine specific amelioration techniques (e.g. addition of gypsum, lime, organic matter, fertiliser, biosolids etc.) that would be used to overcome potential limitations as well as promote soil biota to enhance vegetation establishment and growth.

Appropriate ameliorants (e.g. gypsum, lime) and organic material (e.g. mulch) were applied based on the outcomes of the characterisation analysis.

Before revegetation activities and/or periodically after revegetation, the prepared substrate was re-characterised to determine whether amelioration measures were successful.

Note: The above components of the revegetation methodology must be described in Part 6.2.4 of the rehabilitation management plan[3]. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found some mines had a level of understanding of the geochemical quality of substrates (e.g. soils), however there were limited or no records documenting the assessment of the soil biota conditions. There was also limited detail provided in Part 6.2.4 of the rehabilitation management plan about the scope of characterisation analysis.

In cases where geochemical characterisation of the substrate occurred, this often focussed only on the risk of erosion and did not extend to risks to revegetation.

In some cases, limited sampling or analysis was undertaken as part of the revegetation campaign. However, in many cases this was included in the rehabilitation monitoring program.

RP3.2 – Tailored revegetation methodology – physical/structural properties of the substrate

The risk

Revegetation methodologies that were not tailored to address any potential physical/structural properties of the substrate present a risk to achieving and sustaining the target revegetation outcomes.

What was assessed

Ameliorants were applied and incorporated: For example, gypsum, lime, sulfur, dolomite, organic matter (e.g. mulches, biosolids, compost, brush-matting etc.) as per nominated revegetation methodology.

Compaction relief was undertaken (where relevant) including ripping, discing, scarification, harrowing, etc and was undertaken in parallel with the contour to minimise erosion.

Drainage control such as contour banks, level spreaders, etc were validated to be constructed as per design to prevent erosion before revegetation.

Seeding and or planting was conducted as soon as possible following growth media preparation (e.g. following ripping/scarifying).

If revegetation was delayed after growth media preparation, an assessment was undertaken to determine whether further preparation was required before applying seed. For example to ensure

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[3] Refer to Form and Way: Rehabilitation management plan for large mines available on the website for the mandatory requirements to be included in a rehabilitation management plan.

sufficient surface roughness (e.g. to break up any crusting that may have resulted from rainfall events and or to promote rainfall infiltration).

Appropriate earthmoving equipment (e.g. not oversized) was used to avoid compaction of the rehabilitation substrate.

Rock raking was undertaken to ensure suitability for agricultural land use (where applicable).

Note: The above components of the revegetation methodology must be described in Part 6.2.4 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found while various techniques were implemented across some mines to address physical constraints (e.g. compaction), there were limited or no records documenting the assessment of potential physical/structural properties of the substrate. There was also limited detail provided in Part 6.2.4 of the rehabilitation management plan about characterisation analysis.

In many cases, limited or no assessment was undertaken as part of the revegetation campaign and there were limited records demonstrating the substrate was suitably prepared. However, in many cases this was included in the rehabilitation monitoring program and there was anecdotal evidence to indicate that such assessments were undertaken.

In one case, no ripping to break down compaction of the substrate was undertaken before supplementary planting. Instead, the process relied on manually planting the tubestock, which is likely to have limited success in promoting plant root development through the substrate.

At one mine, an innovative seeder was used for a native revegetation outcomes where the seed was drilled into the substrate and the depth of the drills could be adjusted depending upon the revegetation outcome. This process demonstrated advantages over deep ripping where creating differential flow paths could be avoided and the technique allowed for machinery movement upslope and downslope as opposed to being restricted to parallel with the contours.

RP4.3 – Revegetation strategy – unseasonal/adverse weather conditions

The risk

Revegetation strategies that were not developed and implemented to avoid and/or minimise impacts to rehabilitation as a result of adverse seasonal and/or weather conditions, present a risk to effective establishment and the transition to the ecosystem and land use development phase as soon as reasonably practicable.

What was assessed

TARPs (or similar) were in place to reschedule revegetation activities to avoid adverse weather conditions such as extreme heat, prolonged rainfall and/or storms.

Temporary measures were implemented to protect the substrate where revegetation activities were delayed (e.g. sown with a sterile cover crop, sediment control fences installed, mulch applied, catch drains and sediment dams) to prevent soil erosion and minimise soil loss).

Conditions and actions were noted in revegetation methodology establishment records.

Note: The above components of the revegetation strategy must be described in Parts 6.2.5 and 7 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found there were limited or no records documenting whether the revegetation programs were accounting for unseasonal/adverse weather conditions. There was also limited detail provided in Parts 6.2.5 and 7 of the rehabilitation management plan.

In many cases, there was anecdotal evidence to indicate consideration of unseasonal/adverse weather conditions was a constant consideration when undertaking revegetation activities.

In some cases, we found mines were in the process of evaluating the risk of climate change on rehabilitation programs. However, this was not consistently documented or referenced in the rehabilitation risk assessment.

RP5.2 – Tailored revegetation methodology – revegetation in optimal seasonal conditions

The risk

For rehabilitation to be successful, it must be effectively integrated into mine planning to:

- maximise the quantity of disturbed mine areas to be available for revegetation activities in optimal seasonal conditions, and
- maximise opportunities for the direct return of cleared biological resources (e.g. growth media, organic materials) for use in revegetation activities.

What was assessed

Optimal seasonal periods were identified for the mine to target revegetation activities.

Short-to-medium term mine planning schedules maximise areas available for revegetation in optimal seasonal conditions.

Short to medium term mine planning schedules maximise opportunities for direct return of cleared biological resources (e.g. topsoil, vegetative material such as logs, etc).

Where required, biological materials and or substitutes (e.g. stags, nest boxes, etc) were scheduled for erection (pre-revegetation) to avoid delays to revegetation in optimal seasonal conditions.

Conditions and actions were noted in revegetation methodology establishment records.

Note: The above components of the revegetation methodology must be described in Parts 6.2 and 7 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found the larger mines had an integrated process to facilitate revegetation activities in optimal seasonal conditions, which included the mine planning, technical services and environment teams.

However, in the majority of cases there was limited documentation of this process in Parts 6.2 and 7 of the rehabilitation management plan.

RP6.1 and RP6.2 – Tailored revegetation methodology – availability and integrity of seed resource

The risk

Revegetation methodologies that were not developed and implemented to maximise the quality, suitability and condition of the seed resources and tubestock, present a risk to achieving and sustaining the target revegetation outcomes.

What was assessed

For a native revegetation final land use outcome the following was assessed:

- Native vegetation activities used local provenance seed for direct seeding and or tubestock propagation (e.g. validated by seed merchant records).
- Seed harvesting and collection of plant material was planned in advance of clearing and in consultation with suitably qualified practitioners (e.g. a 3-year lead time with a rolling collection program).
- A seed collection program was in place to maximise the amount of viable seed of local provenance for use in rehabilitation and revegetation activities. The program should include:
  — a seed calendar that contains information relating to fruiting and seed collection times for key native species.
  — data on seed collection including species, collection location and date of collection.
  — seed assessment of native vegetation within the proposed disturbance areas to allow for seed collection prior to or immediately following clearing.
  — required volumes of seed to be collected to enable adequate supply of native seed for reuse.
  — appropriate treatment and storage to maintain viability.

For an agricultural revegetation outcome the following was assessed:

- Suitably qualified expertise (e.g. agronomist) was used to select the seed mix, treatment and sowing rates for the target agricultural outcome.
- Agricultural establishment techniques may involve several rounds of sowing over subsequent seasons with different seed mixes to achieve target revegetation outcome.

For all revegetation outcomes the following was assessed:

- Seed stock was purchased from reputable suppliers with quality control processes, including seed viability testing. (Note: It is good practice to record the name of the supplier and batch of seed being applied. Recording such details may assist in prevention/management of misidentified seeds).
- The above information on seed stock and or tubestock used in each revegetation campaign was included in revegetation methodology record forms and validated as part of QA/QC programs (e.g. inspection test plans).

- Undertake treatment of seed to address issues such as seed dormancy and insect predation. Timing of treatment is to be aligned to timing of application with a focus on reducing the storage time of treated seed.

Note: The above components of the revegetation methodology must be described in Part 6.2.5 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found there were some mines that implemented robust seed collection and handling processes, which validated the type, source and viability of seed used in revegetation programs. In the majority of cases, mines relied on external seed suppliers with quality control processes. In many cases, there were also site records that included the results of seed treatment and handling for each revegetation campaign. However, in the majority of cases there was limited documentation of the overall seed collection and integrity process in Part 6.2.5 of the rehabilitation management plan.

At a few mines, a native seed nursery was established with the longer-term goal of meeting both the mine site rehabilitation and ecological offset requirements.

In many cases, we noted the availability of suitable seed supply was one of the key risks that could ultimately delay rehabilitation. Noting that where there was a concentration of mines (e.g. Hunter Valley) where the demand for similar native seed would be increasing, the TAP recommended more widespread adoption of methodologies to address this issue. This included:

- implementing a program of periodic independent testing to validate seed viability results and to confirm the appropriate seed mix for the target rehabilitation areas to be established across the mine site.

- ensuring the seed collection program targets species found to be deficient in the revegetation areas from the findings of rehabilitation monitoring programs.

RP7.3 – Tailored revegetation methodology – protection of substrates and revegetation from damage

The risk

Revegetation methodologies that were not developed and implemented to prevent damage to prepared substrates and established revegetation areas, present a risk to achieving and sustaining the target revegetation outcomes.

What was assessed

Appropriately sized earthmoving and revegetation equipment were used to prevent over compaction of the substrate and/or adverse deformation of the profile that led to erosion from diverted overland flow.

Plant and soil protection from predatory species (e.g. native fauna, rabbits, goats, pigs, etc) such as barriers (e.g. fencing, tree guards, etc) or control programs such as culling, baiting, etc.

Wind breaks such as sediment fencing were used (where required) to revegetation areas that were exposed to adverse weather conditions such as prevailing strong winds.

Rehabilitation areas were sign-posted to avoid unauthorised disturbance activities.

Rehabilitation areas were appropriately barricaded to avoid unauthorised access (based on risk) and or vandalism (e.g. 4WD or trail bike riders, illegal rubbish dumping, etc).

Formal bushfire trails were constructed in consultation with the Rural Fire Service to maximise efficiency of bushfire management efforts and minimise fire-related impacts to revegetation.

Note: The above components of the revegetation methodology must be described in Parts 6.2.4 and 6.2.5 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found most mines had a range of programs in place to prevent physical damage to revegetation areas including feral animal control programs, use of appropriate earthmoving equipment and access control. However, there was limited information provided in Part 6.2.4 of the rehabilitation management plans.

In many cases, further work was required to consult with appropriate bushfire experts (e.g. NSW Rural Fire Service) to ensure retained access tracks through rehabilitation areas were appropriate for bushfire control purposes.

RP8.1 – Tailored revegetation methodology – landform aspect or unit

The risk

Revegetation methodologies that were not developed and implemented to consider landform aspects (e.g. direction a landform faces) and/or units (i.e. the area), present a risk to achieving and sustaining the nominated revegetation outcome.

What was assessed

The grade and/or soil capability of the final landform was suitable for the target agricultural land capability (where relevant).

The aspect and or grade/topography was appropriate to sustain the target native vegetation community (e.g. terrestrial vs riparian; or westerly vs easterly aspects).

In regard to landform unit (area), areas were graded to be free-draining where the target vegetation was not suited to periods of inundation caused by ponded surface water flow.

Note: The above components of the revegetation methodology must be described in Part 6.2.5 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

In most case, we found locally occurring species were being used in the revegetation and were therefore not sensitive to particular aspects of the landform.

We noted, in a minority of cases, the requirement to establish a particular native vegetation community would require further study - in particular whether boundary adjustments would be

needed where the landform aspects are not optimal in meeting the quantum of vegetation required in the final land use.

RM1.1, RM2.1 and RM3.1 – Implement rehabilitation monitoring program

The risk

Without the preparation and implementation of rehabilitation monitoring and correction action programs, there was a risk that processes were not in place to identify and quickly respond to potential revegetation failure and/or damage.

What was assessed

The following was assessed as being relevant to the initial establishment monitoring:

- Revegetation areas were inspected after adverse weather and or seasonal conditions.
- Revegetation areas were inspected on a formal schedule cycle (e.g. 3 to 6 monthly for at least 2 years) to determine:
  — whether target species had emerged or were establishing.
  — if there was evidence of excess weed infestation or feral animal predation.
  — if there was evidence of erosion and or revegetation failure or poor health.
  — actual or emerging issues that had the potential to delay establishment.

The following was assessed as being relevant to native revegetation:

- Habitat structures were monitored for use to ensure that they were fit-for-purpose for the target fauna species and the integrity of the structure was sound (where relevant).
- Long term rehabilitation monitoring programs were implemented using suitably qualified experts and or industry accepted techniques to track trajectory towards meeting the rehabilitation objectives and rehabilitation completion criteria.
- Suitable analogue and or baseline monitoring points were established and monitored based on the advice of suitably qualified experts.

The following was assessed as being relevant to agricultural revegetation:

- Long term rehabilitation monitoring programs were implemented using suitably qualified experts and or industry accepted techniques to track trajectory towards meeting the rehabilitation objectives and rehabilitation completion criteria.
- Suitable analogue and or baseline monitoring points were established and monitored based on the advice of suitably qualified experts.
- Monitoring programs included performance and health of livestock using rehabilitation areas.

The following was assessed as relevant to research and trials:

- Formal research and trial programs were implemented and were monitored to address defined knowledge gaps for revegetation establishment.

Note: The above components of the rehabilitation monitoring program must be described in Parts 8 and 9 of the rehabilitation management plan. The matters set out in the plan must be implemented

(refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We found while monitoring programs associated with native vegetation final land uses were often comprehensive, the methods were very focussed on ecological function and did not include performance indices of species composition and structure to compare with reference sites. In addition, the number of monitoring reference sites was often limited.

We noted there was a limited focus on monitoring agricultural revegetation areas. However, there were good practices observed at a limited number of mines where cattle grazing programs were conducted on rehabilitation, with agronomists engaged to monitor the quality of pasture and soils to validate land use capability.

Noting the commencement of Schedule 8A of the Mining Regulation 2016 in 2021, it was found the majority of mines would need to review and refine their existing rehabilitation monitoring programs to ensure the measured performance indices align with the rehabilitation objectives and rehabilitation completion criteria statements that need to be approved by the Regulator. This will ensure improvement across industry to accurately track the trajectory of rehabilitation towards meeting the approved final land use(s) for each site.

The majority of monitoring programs did not evaluate the phase of rehabilitation (e.g. ecosystem land use establishment vs ecosystem and land use development). As a result, it was noted some rehabilitation was classed in the incorrect phase when comparing observations from the site inspections with the latest annual rehabilitation report (i.e. potentially represents an under-reporting of rehabilitation performance).

There were some mines that implemented a robust quality assurance process (such as an inspection test plan) for each rehabilitation area/campaign that covered all the phases of rehabilitation to ensure all risks were addressed before progressing to the next phase. More widespread adoption of this process was recommended across the mining industry.

RM3.2 – Implement rehabilitation care and maintenance program/adaptive management program

The risk

Without the preparation and implementation of rehabilitation care and maintenance/adaptive management programs, there is a risk that revegetation will not be successfully established and will not meet the rehabilitation objectives, rehabilitation completion criteria and final land use as soon as reasonably practicable.

What was assessed

A formal rehabilitation care and maintenance program was in place and was included in the mine's annual budget that was:

- assigned to responsible and suitably qualified personnel and or contractors
- implemented, formally tracked and recorded.

The scope of the rehabilitation care and maintenance and/or adaptive management program was developed in consideration of rehabilitation TARPs and other contingency strategies to address emerging threats to rehabilitation as indicated by monitoring (e.g. management of excessive weed and or cover crops; limited emergence of target species; erosion; poor vegetation health, etc.).

Agricultural grazing rehabilitation areas were actively managed, including:

- suitable infrastructure such as fencing, stock watering troughs, cattle loading yards, etc were incorporated to facilitate rotational grazing,
- agricultural grazing areas were managed through a cycle of active grazing with periods of resting.

Agricultural cropping areas were actively managed through a cycle of harvesting followed by sowing with the next target crop.

Note: The above components of the rehabilitation care and maintenance/adaptive management programs must be described in Part 10 of the rehabilitation management plan. The matters set out in the plan must be implemented (refer to the standard conditions of mining leases set out in clauses 9 and 10 in Schedule 8A of Mining Regulation 2016).

What we found

We observed there was generally anecdotal evidence and correspondence to demonstrate a rehabilitation care and maintenance program was in place across most mines. However, in many cases there was limited documentation of the processes in the rehabilitation management plan.

There was often not a clear link between the findings and recommendations from the rehabilitation monitoring programs and how these were implemented to continually progress revegetated areas towards meeting the nominated final land use. In some cases, this resulted in the program focussing on more recent rehabilitation areas while neglecting more mature areas of rehabilitation. In other cases, rehabilitation areas on site were being reported in the incorrect rehabilitation phase resulting in skewed key performance scores in the annual rehabilitation report.

Based on good practices identified at some sites, the TAP recommended more widespread adoption of measures such as:

- adopting a rehabilitation scorecard system to track performance of rehabilitation for each rehabilitation campaign across the mine site, which includes the results of the rehabilitation monitoring program to validate the nominated phase of rehabilitation as well as detailing further works required (if any) to further progress rehabilitation maturity.
- geospatial records management tools to record when and where maintenance actions have been conducted on rehabilitation areas.

We noted where there was evidence (based on site inspections) showing mature revegetation areas progressively tracking towards meeting the rehabilitation objectives. However, often the key focus was on implementing rehabilitation activities rather than evaluating whether these rehabilitation areas have achieved, or on a trajectory towards achieving, the final land use.

Assessment findings by mine

The assessment findings by mine are summarised in the figures overleaf. More details explaining the assessment system are at Appendix B.

Figures 1 and 2 present the overall findings for each assessment category.

Figure 1: Overall assessment findings ratings by critical control and threat/cause

Critical control	Ref	Threat/cause	Not applicable	Poor	Fair	Good	Total
Rehabilitation risk assessment	MRP1.1	Risk assessment		3	26	15	44
Tailored revegetation methodology	RP1.2	Geochemical / soil biota constraints	1	4	27	12	44
	RP3.2	Physical / structural properties of the substrate	1	6	23	14	44
Revegetation strategy	RP4.3	Unseasonal / adverse weather conditions	1	3	34	6	44
	RP5.2	Revegetation in optimal seasonal conditions	3	4	28	9	44
Tailored revegetation methodology	RP6.1 RP6.2	Availability and integrity of seed resource		3	26	15	44
	RP7.3	Protection of substrates and revegetation from damage		2	27	15	44
	RP8.1	Landform aspect or unit	1	3	32	8	44
Implement rehabilitation monitoring program	RM1.1 RM2.1 RM3.1	Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure		4	36	4	44
Implement rehabilitation care and maintenance / adaptive management program	RM3.2	Revegetation failure	1	5	33	5	44

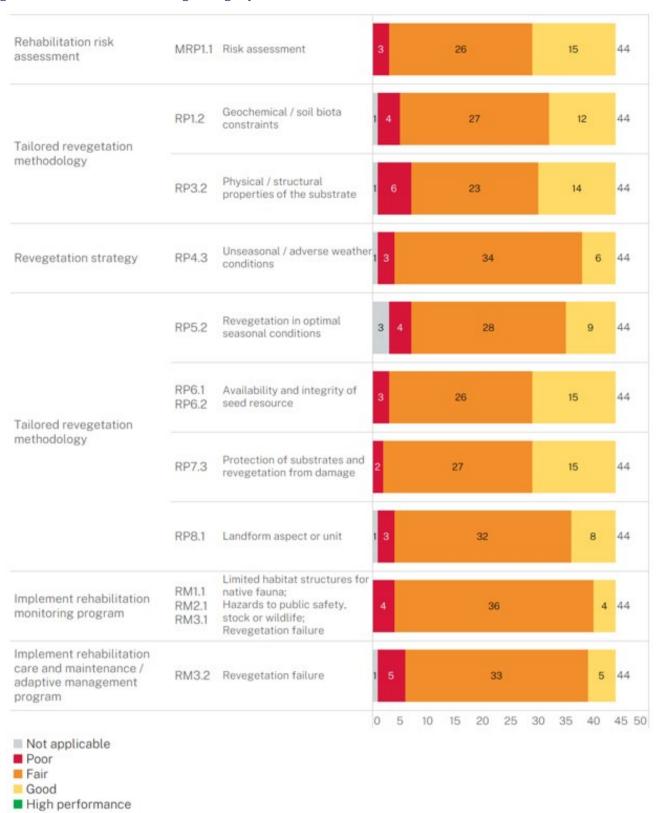Legend:
- Not applicable
- Poor
- Fair
- Good
- High performance

Figure 2: Overall findings results by critical control and threat/cause

Critical control	Critical control number	Threat line / cause	
Rehabilitation risk assessment	MRP1.1	Risk assessment	57%
Tailored revegetation methodology	RP1.2	Geochemical / soil biota constraints	55%
	RP3.2	Physical / structural properties of the substrate	55%
Revegetation strategy	RP4.3	Unseasonal / adverse weather conditions	52%
Tailored revegetation methodology	RP5.2	Revegetation in optimal seasonal conditions	53%
	RP6.1 RP6.2	Availability and integrity of seed resource	57%
	RP7.3	Protection of substrates and revegetation from damage	57%
	RP8.1	Landform aspect or unit	53%
Implement rehabilitation monitoring program	RM1.1 RM2.1 RM3.1	Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure	50%
Implement rehabilitation care and maintenance / adaptive management program	RM3.2	Revegetation failure	50%
Grand Total			54%

- ■ Green (>75%)
- ■ Yellow (>50% and <=75%)
- ■ Orange (>25% and <=50%)
- ■ Red (<=25%)
- ■ Not applicable

Figures 3, 4, 5 and 6 overleaf present the overall assessment findings for each of the assessment categories.

Figure 3 shows mines that scored <50% of possible points.

Figure 4 shows mines that scored =50% of possible points.

Figure 5 shows mines that scored >50% and ≤60% of possible points.

Figure 6 shows mines that scored >60% of possible points.

Figure 3: Overall findings for each of the assessment categories – overall grand total result <50%

Mine Location	Rehabilitation risk assessment	Tailored revegetation methodology		Revegetation strategy	Tailored revegetation methodology				Implement rehabilitation monitoring program	Implement rehabilitation care and maintenance / adaptive management program	Grand Total
	MRP1.1	RP1.2	RP3.2	RP4.3	RP5.2	RP6.1 RP6.2	RP7.3	RP8.1	RM1.1 RM2.1 RM3.1	RM3.2	
	Risk assessment	Geochemical / soil biota constraints	Physical / structural properties of the substrate	Unseasonal / adverse weather conditions	Revegetation in optimal seasonal conditions	Availability and integrity of seed resource	Protection of substrates and revegetation from damage	Landform aspect or unit	Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure	Revegetation failure	
Mine N	25%	25%	25%	25%	25%	50%	25%	25%	25%	25%	28%
Mine AI	25%	25%	25%	25%	25%	50%	25%	25%	25%	25%	28%
Mine U	50%	50%	25%	25%	25%	25%	50%	50%	25%	25%	35%
Mine M	50%	25%	25%	50%	50%	25%	50%	50%	50%	50%	43%
Mine Q	50%	25%	25%	50%	50%	25%	50%	50%	50%	50%	43%
Mine AP	50%	50%	25%	50%	25%	50%	50%	50%	50%	25%	43%
Mine B	50%	50%	50%	50%	50%	50%	50%	50%	25%	50%	48%
Mine AE	25%	50%	50%	50%	50%	50%	50%	50%	50%	50%	48%

- Green (>75%)
- Yellow (>50% and <=75%)
- Orange (>25% and <=50%)
- Red (<=25%)
- Not applicable

Figure 4: Overall findings for each of the assessment categories – overall grand total result =50%

Mine Location	Rehabilitation risk assessment	Tailored revegetation methodology		Revegetation strategy	Tailored revegetation methodology					Implement rehabilitation monitoring program	Implement rehabilitation care and maintenance / adaptive management program	Grand Total
	MRP1.1	RP1.2	RP3.2	RP4.3	RP5.2	RP6.1 RP6.2	RP7.3	RP8.1		RM1.1 RM2.1 RM3.1	RM3.2	
	Risk assessment	Geochemical / soil biota constraints	Physical / structural properties of the substrate	Unseasonal / adverse weather conditions	Revegetation in optimal seasonal conditions	Availability and integrity of seed resource	Protection of substrates and revegetation from damage	Landform aspect or unit		Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure	Revegetation failure	
Mine D	50%					50%	75%	25%		50%	50%	50%
Mine I	75%	50%	50%	50%	50%	50%	50%	50%		50%	25%	50%
Mine L	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine R	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine AB	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine AC	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine AJ	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine AM	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%
Mine AQ	50%	50%	50%	50%	50%	50%	50%	50%		50%	50%	50%

- Green (>75%)
- Yellow (>50% and <=75%)
- Orange (>25% and <=50%)
- Red (<=25%)
- Not applicable

Figure 5: Overall findings for each of the assessment categories – overall grand total result >50% and ≤60%

Mine Location	Rehabilitation risk assessment MRP1.1 Risk assessment	Tailored revegetation methodology RP1.2 Geochemical / soil biota constraints	RP3.2 Physical / structural properties of the substrate	Revegetation strategy RP4.3 Unseasonal / adverse weather conditions	Tailored revegetation methodology RP5.2 Revegetation in optimal seasonal conditions	RP6.1 RP6.2 Availability and integrity of seed resource	RP7.3 Protection of substrates and revegetation from damage	RP8.1 Landform aspect or unit	Implement rehabilitation monitoring program RM1.1 RM2.1 RM3.1 Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure	Implement rehabilitation care and maintenance / adaptive management program RM3.2 Revegetation failure	Grand Total
Mine E	50%	50%	50%	50%	50%	75%	50%	50%	50%	50%	53%
Mine H	50%	50%	50%	50%	50%	50%	75%	50%	50%	50%	53%
Mine K	50%	50%	50%	50%	50%	50%	50%	50%	50%	75%	53%
Mine AF	50%	50%	50%	50%	50%	50%	75%	50%	50%	50%	53%
Mine AL	50%	50%	50%	50%	50%	50%	50%	75%	50%	50%	53%
Mine O	50%	50%	50%	50%		75%	50%	50%	50%	50%	53%
Mine F	50%	75%	75%	50%	50%	50%	50%	50%	50%	50%	55%
Mine P	50%	50%	75%	50%	50%	75%	50%	50%	50%	50%	55%
Mine X	75%	50%	50%	50%	50%	50%	75%	50%	50%	50%	55%
Mine Y	75%	50%	50%	50%	50%	75%	50%	50%	50%	50%	55%
Mine AO	75%	50%	50%	50%	50%	75%	50%	50%	50%	50%	55%
Mine A	50%	75%	75%	50%	50%	50%	50%	75%	50%	50%	58%
Mine J	50%	50%	50%	50%	75%	50%	75%	75%	50%	50%	58%
Mine AA	75%	50%	75%	50%	50%	50%	75%	50%	50%	50%	58%
Mine S	75%	75%	75%	50%	50%	50%	50%	50%	75%	50%	60%
Mine Z	75%	50%	75%	50%	50%	75%	75%	50%	50%	50%	60%
Mine AG	50%	75%	75%	50%	75%	50%	50%	50%	50%	75%	60%

■ Green (>75%)
■ Yellow (>50% and <=75%)
■ Orange (>25% and <=50%)
■ Red (<=25%)
■ Not applicable

Figure 6: Overall findings for each of the assessment categories – overall grand total result >60%

Mine Location	Rehabilitation risk assessment MRP1.1 Risk assessment	Tailored revegetation methodology RP1.2 Geochemical / soil biota constraints	RP3.2 Physical / structural properties of the substrate	Revegetation strategy RP4.3 Unseasonal / adverse weather conditions	Tailored revegetation methodology RP5.2 Revegetation in optimal seasonal conditions	RP6.1 RP6.2 Availability and integrity of seed resource	RP7.3 Protection of substrates and revegetation from damage	RP8.1 Landform aspect or unit	Implement rehabilitation monitoring program RM1.1 RM2.1 RM3.1 Limited habitat structures for native fauna; Hazards to public safety, stock or wildlife; Revegetation failure	Implement rehabilitation care and maintenance / adaptive management program RM3.2 Revegetation failure	Grand Total
Mine W	75%	75%	50%	75%	75%	75%	50%	50%	50%	50%	63%
Mine AK	75%	75%	50%	50%	75%	75%	75%	50%	50%	50%	63%
Mine C	50%	50%	75%	75%		75%	75%		50%		64%
Mine T	75%	75%	75%	50%	50%	75%	75%	75%	50%	50%	65%
Mine AH	75%	50%	75%	75%	75%	75%	75%	50%	50%	50%	65%
Mine AR	75%	75%	50%	50%	50%	75%	75%	75%	75%	50%	65%
Mine G	50%	75%	75%	50%	75%	75%	75%	75%	50%	75%	68%
Mine V	75%	75%	75%	75%	75%	75%	75%	50%	50%	50%	68%
Mine AD	75%	75%	75%	75%	75%	75%	50%	75%	75%	75%	73%
Mine AN	75%	75%	75%	75%	75%	50%	75%	75%	75%	75%	73%

■ Green (>75%)
■ Yellow (>50% and <=75%)
■ Orange (>25% and <=50%)
■ Red (<=25%)
■ Not applicable

Response to mines

Assessment finding letters were issued to each mine in the program, which included a summary of key observations made by the Regulator during the assessment as well as recommendations for improvement in the medium to longer term.

Notices issued

Of the 44 mines assessed under the inspection program, 4 mines also received notices pursuant to section 240 of the *Mining Act 1992*. These notices directed the mine operators to take specific actions relating to preparing and implementing revegetation measures to achieve sustainable rehabilitation outcomes that will support achievement of the final land use. These notices included some or all of the following directions:

- To engage a suitably qualified and independent person(s) to undertake a review of the adequacy of the rehabilitation risk assessment, the rehabilitation management plan and the trajectory of rehabilitation areas towards establishing the range of self-sustaining vegetation required to achieve the final land use.

- To engage a suitably qualified and independent person(s) to develop a rehabilitation enhancement strategy to address the deficiencies of a range of existing rehabilitation areas identified by the Regulator. The rehabilitation enhancement strategy is required to include:
  - methodologies designed to address the deficiencies of the existing rehabilitation areas to ensure that the rehabilitation achieves the final land use
  - detailed methodologies to address any geochemical and or soil biota constraints of the substrate
  - detailed methodologies to address any physical constraints to the substrate, including compaction
  - detailed methodologies for weed controls in order to promote the emergence of other species commensurate with the target vegetation species specified in the approved rehabilitation objectives statement
  - detailed methodologies to establish other growth forms of species commensurate with the target vegetation species.

Recommendations

It is recommended mine operators, on reading this report, review and amend (where relevant), their site's rehabilitation risk assessment, rehabilitation management plan, monitoring and management practices to manage the risks associated with preparing and implementing revegetation activities that are unique to their site.

During the review process, mine operators are encouraged to consider the matters outlined above in the 'Response to mines' and implement these recommendations as relevant to their site.

Further information

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

Contact type	Contact details
Email	nswresourcesregulator@service-now.com
Phone	1300 814 609 (option 2, then 5)
Website	www.resources.nsw.gov.au
Address	516 High Street Maitland NSW 2320

Appendix A - TAP assessment set-up

The critical control consolidation process resulted in 5 critical control groups for assessment in the TAP. For each of these critical controls, the threats that they address, the objective and the assessment criteria used in the TAP are listed in Table 1 below.

Table 1: Critical controls and associated objectives assessed in TAP

Critical control	Threat	Control objective	Assessment criteria (control support)
MRP1.1 Rehabilitation risk assessment	n/a	To ensure the range of risks associated with revegetation are identified and appropriate controls are in place to facilitate sustainable rehabilitation outcomes.	• Risk assessment
RP1.2 Tailored revegetation methodology	Substrate geochemical and soil biota	To ensure revegetation methodologies are developed to address potential geochemical/soil biota constraints/opportunities for rehabilitation.	• Revegetation methodology developed to address the substrate geochemical and soil biota conditions
RP3.2 Tailored revegetation methodology	Physical / structural properties of substrate	To ensure revegetation methodologies are developed to address potential physical/structural properties of the substrate.	• Revegetation methodologies developed to address the physical/structural properties of the substrate
RP4.3 Revegetation strategy	Unseasonal / adverse weather	To ensure the revegetation strategy includes measures (refer to Part 6.2.5 of the rehabilitation management plan) to avoid and or minimise impacts to rehabilitation as a result of adverse seasonal and weather conditions.	• Revegetation program accounts for unseasonal/adverse weather
RP5.2 Tailored revegetation methodology	Availability of areas for revegetation in optimal conditions	Ensure rehabilitation is effectively integrated into mine planning to maximise the use of salvaged biological materials from clearing	• Tailored revegetation methodology accounts for revegetation activities to be conducted in optimal conditions

Critical control	Threat	Control objective	Assessment criteria (control support)
		activities in revegetation activities as well as advance disturbed areas to be available for rehabilitation in optimal seasonal conditions.	
RP6.1 Seed collection, handling, storage and treatment strategy RP6.2 Tailored revegetation methodology	Availability & integrity of seed resource	Ensure the integrity of both seed/ tubestock quality and type are suitable to achieve the target revegetation outcomes	• Tailored revegetation methodology accounts for availability and integrity of seed resource
RP7.3 Tailored revegetation methodology	Damage to rehabilitation	Ensure measures are in place to protect and secure substrates and revegetation areas from physical damage	• Tailored revegetation methodology ensure measures in place to prevent damage to rehabilitation
RP8.1 Tailored revegetation methodology	Landform aspect or unit	Appropriate landform aspects and or units have been used to sustain the nominated revegetation outcome	• Tailored revegetation methodology ensures revegetation outcome is developed in consideration of landform aspect or unit
RM1.1 Implement rehabilitation monitoring program	Limited habitat structures for native fauna	Monitoring and correction action processes are in place to identify and respond quickly to potential revegetation failure and or damage to ensure the final land use is achieved as soon as reasonably practicable	• Implement rehabilitation monitoring program
RM2.1 Implement rehabilitation monitoring program	Hazards to public safety, stock or wildlife	Monitoring and correction action processes are in place to identify and respond quickly to potential revegetation failure and or damage to	• Implement rehabilitation monitoring program

Critical control	Threat	Control objective	Assessment criteria (control support)
		ensure the final land use is achieved as soon as reasonably practicable	
RM3.1 Implement rehabilitation monitoring program	Revegetation failure	Monitoring and correction action processes are in place to identify and respond quickly to potential revegetation failure and or damage to ensure the final land use is achieved as soon as reasonably practicable	• Implement rehabilitation monitoring program
RM3.2 Implement rehabilitation care and maintenance/ adaptive management program	Revegetation failure	Ensure revegetation areas are actively managed based on outcomes of monitoring programs to meet rehabilitation objectives and rehabilitation completion criteria as soon as reasonably practicable	• Implement long term rehabilitation care and maintenance / adaptive management program

Appendix B - Assessment system explained

We used a bowtie framework to proactively assess how mine sites managed the risks to rehabilitation. Bowties are a widely used risk management tool that integrate preventative and mitigating controls onto threat lines that relate to a material unwanted event.

As part of program planning, controls were categorised in accordance with the ICMM handbook[4] to identify the critical controls.

Standardised assessment checklists for a range of TAPs were developed. Each TAP focused on the implementation of an identified critical control(s) to determine whether measures were identified and implemented to ensure sustainable rehabilitation outcomes.

Assessment findings

During each mine's site assessment, inspectors rated each control support and recorded the findings. Points were awarded on whether there was evidence the control support was documented and/or implemented, as summarised in the table below.

Table 2: Assessment system scoring

Scoring	Finding outcome	Points
High performance	As per good criteria, however, continued improvement could be demonstrated. For example, the scope of control support methodology was updated to reflect feedback from research and monitoring.	4
Good	Methodology was described/documented in the rehabilitation management plan (or other relevant document) and was reflective of constraints and opportunities that were identified. Methodology was implemented.	3
Fair	Methodology was described/documented in the rehabilitation management plan (or	2

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

Scoring	Finding outcome	Points
	other relevant document) but was limited (in terms of scope and implementation).	
Poor	Not documented and not implemented.	1
N/A	Circumstances where the critical control/control support did not apply	n/a

For each critical control, an overall result was calculated on the total points scored as a proportion of the maximum possible points for that critical control. For example, if a critical control comprises 10 control supports and 5 were assessed as high performance and 5 were found to be poor then the overall assessment result for that critical control would be 62.5%.

Critical control calculations 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 3: Scoring criteria and assessment colour bands

Criteria	Colour
An assessment result of >75% of possible points	Green
An assessment result of >50% but ≤75% of possible points	Yellow
An assessment result of >25% but ≤50% of possible points	Orange
An assessment result of ≤25% of possible points	Red
n/a	