

Queensland's Abandoned Mine Land Program: improving the way we manage abandoned mines in Queensland

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Abstract

For over 150 years mining has played a significant role in the history of Queensland, Australia, and during that time many mines have been abandoned. These mines can pose significant hazards to community health and safety, and the environment. In recent years, the Queensland Government has significantly enhanced the management of abandoned mines through a series of policy, strategic and operational reforms.

The Queensland Government enacted mine rehabilitation reform which included the release of a State Abandoned Mines Management Policy (the Policy), introduced the Financial Provisioning Scheme and amended legislation to authorise a broad range of remediation activities on abandoned mines. These reforms provided a platform for better management of existing abandoned mines and greater protection to the state from future abandonment.

The Abandoned Mine Lands Program (AMLPL) is a Queensland Government initiative to mitigate risk associated with approximately 120 high-risk abandoned mines. The AMLPL is guided by the Policy, which aims to make abandoned mines safe, secure, durable through remediation and productive through re-commercialisation and repurposing of sites in collaboration with our stakeholders.

To assist in the delivery of the AMLPL, the Queensland Government released the Risk and Prioritisation Framework for Abandoned Mine Management and Remediation (Department of Resources 2021a) (the Framework). The Framework sets out a transparent, robust, repeatable and risk-based approach to addressing hazards associated with abandoned mines. The Framework also considers the re-commercialisation opportunities of the mineral waste material and/or unmined resources as well as a repurposing possibility. Based on the Framework, Wolfram Camp mine and the surrounding area were selected as a re-commercialisation pilot program in 2023.

The aim of our paper is to distil the outcomes of the rehabilitation reform process and implementation of the Framework and Policy, and to provide an update of the deliverables from the AMLPL. The information presented may be helpful in policy making and regulatory understanding.

Keywords: *abandoned mines, risk management, mining legacies, remediation, rehabilitation reform, re-commercialisation, repurpose, post-mining land use, risk and prioritisation*

1 Introduction

Queensland is recognised as a leading mining and resource destination with diverse geology and resource potential. Mining is a valuable industry for the Queensland economy and provides employment opportunities and development in regional areas, along with essential commodities and critical minerals for domestic and foreign trade.

While mining has provided positive economic and social improvements to Queensland over the last 150 years, many mines have been abandoned. Abandoned mines can pose significant public health and safety, and environmental, risks. In 2018 a Queensland Government review identified approximately

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120 high-risk abandoned mines covering approximately 10,300 hectares as well as an estimated 15,000 small-scale historical mining disturbances (Queensland Treasury 2018; Department of Resources 2019; Queensland Government 2020). The review also highlighted that despite the thousands of records of historical mines, only 34 abandoned mines were classified as having high enough risk to be prioritised for major remediation work. Most abandoned mines in Queensland pre-date 2000, before laws were amended to provide stronger environmental management. Demand is increasing for remediation and the ongoing care and maintenance (C&M) of abandoned mines in Queensland, primarily due to approximately one to two mines being disclaimed each year. Appointed liquidators are able to disclaim resources tenure (e.g. mining leases) as onerous property in accordance with s568 of the *Corporations Act 2001* (Commonwealth of Australia 2001), thereby rendering the mine abandoned.

The Abandoned Mine Lands Program (AMLPL) is responsible for managing abandoned mine sites with a focus on reducing public health and safety, and environmental, risks. The Risk and Prioritisation Framework for Abandoned Mine Management and Remediation (Department of Resources 2021a) (the Framework) uses the risk profile of abandoned mines sites to prioritise remediation activities across the AMLP. The Queensland Abandoned Mines Management Policy (Department of Resources 2019) (the Policy) informs the AMLP to make abandoned mines safe, secure, durable and, where possible, productive. The Policy also guides the state's approach to abandoned legacy petroleum and gas wells, and other abandoned operating plant as defined in the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) (Government of Queensland 2004). Further, it encourages opportunities to re-commercialise or repurpose abandoned mines to achieve social, environmental and economic benefits for regional Queensland communities. The AMLP has been supported and enhanced by recent legislative and policy reforms.

There has been a significant growth in recent years in demand for the AMLP to undertake C&M and remediation activities, due to ongoing mine abandonment and increasing community expectations concerning management of existing legacy abandoned mines. To enhance the operational delivery of the AMLP, the Queensland Government has also invested in building its capacity to deliver large-scale remediation works by establishing a project delivery-focused unit supported by recruitment of employees with the right technical skills and the embedding of best practice project management systems and controls.

Mining and rehabilitation requirements in Queensland are primarily managed through mining tenure issued under the *Mineral Resources Act 1989* (MR Act) (Government of Queensland 1989), an Environmental Authority (EA) issued under the *Environmental Protection Act 1994* (EP Act) (Government of Queensland 1994) and the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERF Act) (Government of Queensland 2018) to manage provisioning requirements. A mine is considered abandoned when there is no longer a current mining tenement nor an EA in place (MR Act 1989). We provide details on how the implementation of legislative and policy reforms has been enacted in Queensland in the delivery of the AMLP. The following sections provide details on the Queensland Government's approach to managing abandoned mines to achieve better environmental and social outcomes through a series of policy, strategic and operational reforms. The information may be helpful to other jurisdictions in policy making and assist in regulatory understanding.

2 Legislative amendments

Mine rehabilitation regulations in Queensland have been subjected to significant reform processes since 2014. The reforms have mainly occurred as a result of changing community expectations where rehabilitation is believed to be important to complete, mining companies are being seen as avoiding their mine rehabilitation obligations (Cooper 2019) and finding that the rehabilitation financial assurance held by Queensland Government was insufficient to cover the estimated rehabilitation cost if resource operators were to default on their rehabilitation responsibilities (Queensland Audit Office 2014). During this time, reform regarding abandoned mines was also identified as needing to include a greater capacity to mitigate risks at abandoned resource sites, and opportunities to commercialise resources and develop new initiatives to provide incentives for private investment in abandoned mines (Queensland Treasury 2018).

A collaborative inter-agency response by the Queensland Government was undertaken, which resulted in multiple amendments to legislation and regulation including the EP Act, MR Act, Mineral and Energy Resources (Common Provisions) Regulation 2016, and introduction of the MERF Act. Authority to undertake the range of remediation activities on abandoned sites to manage both onsite and offsite impacts was also expanded. The P&G Act was also amended to achieve consistency for remediation activities, such as those for abandoned mines under the MR Act. These reforms provide a platform for better management of current abandoned resource sites and greater protection to the state from future abandonment.

2.1 Financial Provisioning Scheme for resource activity environmental authorities

The MERF Act came into force on 1 April 2019. The act replaced the prior financial assurance arrangements for resource activities under the EP Act with the Financial Provisioning Scheme (FPS). The FPS is administered by the Scheme Manager, a statutory officer supported by the Queensland Treasury (Queensland Treasury 2019 and 2024).

The purpose of the FPS is to improve the state's management of its financial risk in the event that holders of a resource activity EA (holders) or small-scale mining tenure fail to comply with their rehabilitation obligations. The FPS involves an assessment of a company's rehabilitation obligations, its likelihood of default and its asset saleability. Based on estimated rehabilitation costs (ERC) and a risk assessment, mining companies make an annual contribution to an insurance-style fund or provide surety equal to the ERC (Queensland Government 2020). The ERC should capture the maximum potential amount of liability to the state for the period for which the EA holder has applied (Department of Environment and Science 2022).

The FPS also provides grant funding to support remediation of abandoned mines (Queensland Treasury 2019). The FPS committee assesses applications to the FPS for funding and makes recommendations to the FPS manager. To date, the AMLP has secured funding from the FPS to plan and undertake remediation activities across numerous abandoned mines. Funded projects have included site-based investigation, options assessment and engineering designs to undertake remediation at three tailings storage facilities (TSFs) and associated processing areas; decommissioning of a process water pond which contains acid-generating tailings; and securing and making safe abandoned mines (Eastwood 2023). Recent amendments to the FPS (Government of Queensland 2024) ensure abandoned petroleum and gas sites are also eligible for remediation grants.

2.2 Mineral Resources Act 1989

The MR Act was significantly amended via the *Mineral and Energy Resources and Other Legislation Amendment Bill 2020* (Government of Queensland 2020) to broaden the state's authorised person powers for remediating an abandoned mine and abandoned operating plant sites, and to expand the details of remediation activities. The changes included authorised persons being able to access abandoned mine sites for the purpose of undertaking remediation activities. The powers also permit access to land that is outside the original tenure boundary to carry out remediation activities required on lands affected by activities from the original resource site. The consent of the owner and occupiers is required to enter affected land (Government of Queensland 2020).

The amendment also allowed the state's targeted release for re-commercialisation of sites that have been abandoned, and where an opportunity to commercialise a potentially economic mineral resource exists. The changes introduced a competitive tender process to allow a successful tenderer to apply directly for a mining tenure. Complementary amendments included disqualification criteria against which applicants, transferees and associates of applicants and transferees of prescribed resource authorities may be assessed prior to the resource authority's grant. The disqualification criteria allow the state to better assess the risk associated with applicants in relation to their ability to adequately manage their tenure and remain compliant with tenure obligations (Queensland Government 2020), thereby offering greater protection of the state from future abandonment.

2.3 Mineral and Energy Resources (Common Provisions) Regulations 2016

Provision was made in the Mineral and Energy Resources (Common Provisions) Regulations 2016 for the minister to consider whether the proposed transferee of a mining tenure has the financial resources to fund the estimated rehabilitation cost for the resource activity as stated in the ERC decision. This means that the minister must consider the financial ability of the proposed transferee to fulfil their rehabilitation obligation (Government of Queensland 2024).

2.4 Environmental Protection Act

A Progressive Rehabilitation and Closure Plan (PRCP) is a critical element of the Queensland Government's Mined Land Rehabilitation Policy (Government of Queensland 2024). A PRCP requires the holder of an EA to plan for how, where and when activities will be carried out on land in a way that maximises the progressive rehabilitation of that land and provide details on the condition of the mine rehabilitation (Department of Environment and Science 2023). Residual risk is not included in the PRCP process. The residual risk framework will be applied to an EA as part of the surrender application.

Amendments to the EP Act were also enacted to allow another state government agency who incurs costs and expenses in taking mitigation to minimise environmental harm, or in rehabilitating or restoring the environment, and for which an assurance has been given, to claim or realise the assurance (Queensland Government 2022) from the administering authority (Department of Environment, Science and Innovation). An example is permitting the Department of Resources to recoup surety to fund remediation works of abandoned resource sites.

Additionally, during 2016, the Queensland Government became concerned with an increasing trend in the inability of companies to meet their environmental obligations. Amendments were made to the EP Act to impose 'chain of responsibility' on companies and their related parties who undertake mining or environmentally relevant activities, and to bear the cost of rehabilitation (Cooper 2019).

3 Abandoned Mines Land Program

The Queensland Government's AMLP is responsible for assessing abandoned mine sites and reducing public health and safety risks. The AMLP also includes high-risk underground coal gasification (UCG) sites and legacy petroleum sites. A total of AUD 36.6 M in the 2024–2025 Queensland Budget has been approved for the AMLP (Queensland Government 2024a). Funding for the AMLP is predominately provided from a combination of Queensland Government contributions, claimed surety and grant allocations from the FPS.

The AMLP contributes to improving the resources industry's social licence to operate, promoting private sector investment and enhancing natural resource management within regional Queensland while building local capability and providing employment opportunities.

The Risk and Prioritisation Framework (Department of Resources 2021a) uses the risk profile of the abandoned mines sites to prioritise remediation activities across the AMLP. The Policy (Department of Resources 2019) informs the AMLP to make abandoned mines safe, secure, durable and, where possible, productive.

3.1 Abandoned mines management policy

The Queensland Government developed the Policy in 2019 to provide an overarching framework to guide the implementation of the AMLP and to fulfil its purpose (Department of Resources 2019). This Policy outlines that the allocation of resources to remediate abandoned mines will be based on risk to community health and safety, the environment and property.

The purpose of the AMLP is to undertake works to make abandoned mines safe, secure, durable and productive by:

- preventing potential exposure of the surrounding community to hazards on an abandoned mine site by removing or mitigating hazards (safe)
- implementing control measures to limit the level of adverse impacts on the surrounding and downstream environments (secure)
- minimising the ongoing maintenance and monitoring requirements for a site, including geotechnical and geochemical stability (durable)
- investigating opportunities to commercialise abandoned mines and/or repurpose the land for a future appropriate use, considering the economic, community, cultural and conservation values and constraints of the site (productive) (Department of Resources 2019).

3.2 Risk and prioritisation framework for abandoned mine management and remediation

To deliver on commitments of the Policy, the Queensland Government developed the Framework in 2021. The Framework guides decision-making by the Queensland Government to prioritise, manage and remediate abandoned mines by ensuring appropriate expenditure of public funds (Department of Resources 2021a). The Framework provides a clear, repeatable and consistent risk-based approach to prioritising hazards associated with abandoned mines.

The Framework describes the context of legacy mining in Queensland and includes the rationale for classification of abandoned mine sites and the proposed interaction with the FPS. Mining features in relation to the timing of mining tenure termination, scale of disturbance and risk profile (Department of Resources 2021a) were used to inform how the Framework and subsequent funding pathways are applied. Legacy and pre-commencement mines (as described below) are referred to as program sites (Department of Resources 2021a):

- legacy mines — ceased production before the EP Act amendments on 1 January 2001 and have the mining features of modern mining methods (approximately 70 sites)
- pre-commencement mines — ceased production after EP Act amendments on 1 January 2001 without fulfilling rehabilitation obligations (approximately 30 sites).

When a site is abandoned post-commencement of the *Mineral Resources (Financial Provisioning Scheme) Act 2018* (in effect 1 April 2019), remediation works required at these sites will typically be funded by a financial assurance surety. As such, the Framework doesn't apply to these sites unless all associated financial assurances for the site have been exhausted without remediation being completed, using pooled FPS funds (Department of Resources 2021a).

Approximately 15,000 historical mine disturbances which ceased production prior to the EP Act amendments on 1 January 2001 and are characterised by non-mechanical mining methods (i.e. shafts, shallow pits, etc.) are also not considered as part of the Framework. These mining features are targeted as part of a regional and risk-based shaft remediation or small-scale work program.

The Framework is guided by five principles: risk management, valuing abandoned mine sites, data management and sharing, resourcing and stakeholder engagement, and governance. Risk management is considered the underlying element of the Framework where risks to public health and safety, environment and property associated with abandoned mines, along with risk mitigation and remediation options, are identified. Remediation options consider the cumulative risks of a mine feature, with extreme and high risks being prioritised. The AMLP recognises that many abandoned mines hold significant historical, cultural, social, environmental and/or economic values which are a consideration when developing management

options (Department of Resources 2021a). The likelihood of success, cost benefits and opportunities for repurposing or re-commercialisation are also considered when deliberating remediation preferences.

The Framework provides a three-stage risk and prioritisation process which involves:

- an initial desktop and spatial information review of all sites followed by a site field assessment
- completion of a detailed site risk assessment by experienced and qualified personnel of hazards identified during the preliminary screening
- prioritising of sites for further investigation or remediation based on an aggregation of the cumulative number of high and extreme risks, with consideration of the most imminent risks to public health and safety, serious environmental harm and property/social impacts (Department of Resources 2021a).

The site risk assessments are captured and maintained in a risk management database to facilitate the prioritisation process as it allows for new sites to be added to the system. The site risk assessments are under constant update and review to ensure the prioritisation process is maintained (Department of Resources 2021a).

The collection and management of data from all aspects of managing abandoned mines are essential for reporting and sharing information that can inform remediation or repurposing. The program sites and their features are mapped spatially and are available publicly via the GeoResGlobe[†] portal.

Stakeholder consultation and involvement is an essential part of the management of abandoned mines. Many of the high-priority abandoned mines are on state land or leasehold land where native title has been determined to exist, with some AMLP sites also being on Aboriginal freehold land or land under assessment for transitioning to Aboriginal freehold. The Queensland Government works closely with First Nations people, Traditional Owners and their representative prescribed bodies corporate to ensure Aboriginal cultural heritage considerations are appropriately addressed in the development of site management, remediation options and program execution. Where appropriate, AMLP personnel consult with Traditional Owner groups and their representatives to ensure remediation design and closure landforms accommodate any identified future land use aspirations they may have for sites on Aboriginal freehold land or which are in line with granted Native Title interests.

3.3 Remediation, re-commercialisation and repurposing

The Policy guides the Queensland Government's approach to abandoned legacy petroleum and gas wells, and other abandoned operating plant. It also pursues opportunities to re-commercialise or repurpose abandoned mines, resulting in social, environmental and economic benefits to regional Queensland communities.

3.3.1 Remediation

The AMLP manages legacy mining impacts at abandoned mine sites across Queensland. The AMLP focuses on two major risk mitigation aspects: ongoing C&M and remediation projects. Remediation of abandoned mines aims to be safe, secure, durable, and productive (where possible).

On newly disclaimed sites and several major sites, the AMLP has a significant onsite C&M presence to limit environmental and community risks such as water management, site clean-up and earthworks. During the past five years, the AMLP has demonstrated its capability for delivering large-scale remediation projects in collaboration with key stakeholders.

[†] GeoResGlobe is an online experience where you can view and interact with Queensland's mining and exploration data, including over 600 spatial data layers. GeoResGlobe.information.qld.gov.au

3.3.1.1 Baal Gammon mine remediation

Baal Gammon mine is located 20 km west of Herberton on the Atherton Tablelands in North Queensland (Figure 1). It is a historical copper mine where underground mining occurred for more than 100 years before the operation switched to open cut mining from 2011 to 2016 (Department of Resources 2021d).



Figure 1 Before and after remediation works on the waste rock dump at Baal Gammon mine

The abandoned Baal Gammon mine consists of a large open cut pit, a waste dump, a mine water storage dam, hardstand laydown areas and other general mine infrastructure. Severely impacted by acid metalliferous drainage (AMD), the site is one of Queensland's top-five highest-risk abandoned mines due to its public health and safety, environment and property risks. As such, it has been the focus of significant remediation works (Hall et al. 2022).

The focus of remediation has been on the reduction of AMD water, both by prevention and management. Other works have included:

- removal of waste material from the site
- testing and characterisation of waste rock across the site
- consolidation of acid-forming material in the pit cutback area, followed by capping
- capping of the main waste rock dump (consisting wholly of acid-forming material)
- commencement across all areas of the site of revegetation activities including hydro mulching and tree planting
- installation of lime rock offsite to mitigate against residual acidity
- water treatment and release
- ongoing daily site management tasks including monitoring, security, sampling and operation of site infrastructure such as the seepage pump-back system
- monitoring and management of remediation works.

By consolidating and encapsulating potentially acid-forming waste rock material, the size of the 'dirty water catchment' was reduced by approximately 75%, resulting in a significant reduction in site water storage risk.

3.3.1.2 Goondicum mine remediation

The Goondicum ilmenite and apatite mine ceased production in September 2019, with the mining company disclaiming the mining lease in October 2020 with no rehabilitation completed. The Goondicum site consists of two open cut mining pits, a process water dam, three TSFs, remnants of the processing plant and other wastes (Department of Resources 2022a).

The Goondicum mine sits at the headwaters of the Burnett River, which drains into the southern area of the Great Barrier Reef Marine Park. The mine is on Goondicum Station, half of which is on the crater of a prehistoric volcano, giving it a unique geology and ecosystem. In recent years the mine's eastern domain was successfully remediated by the Department of Resources to mitigate the risks associated with two open cut pits, TSFs and the former process plant (Figure 2). Works commenced in June 2023 to address the remediation of the western domain, including a remaining high-risk TSF as it is constructed from highly erosive material and lacks an adequate spillway. In this condition, the site poses a risk to the local environment, with community concerns regarding potential impacts to the receiving environment, ecosystem health and downstream land-users that could arise from the unrehabilitated state. Remediation of the western domain will remove the need for ongoing site C&M costs and the requirement to upgrade the TSF to meet regulatory dam safety requirements. Remediation works will aim to return the site to grazing land.



Figure 2 The eastern domain before and after remediation

3.3.1.3 Hopeland (ex-Linc Energy) remediation project

Linc Energy operated a UCG project in Hopeland (66 km northwest of Dalby, Queensland). The liquidators disclaimed the resource authorities, and the underlying lot and plan, in July 2016 without completing decommissioning or rehabilitation. The site is now classified as 'abandoned operating plant' as defined under the P&G Act.

Since the site was abandoned, the Queensland Government has continued to manage and progressively decommission the operation while undertaking environmental monitoring and working with other government agencies (Figure 3).



Figure 3 Demolition and remediation works at Hopeland

The Hopeland site included a gas-to-liquid plant, gasifiers, a gathering system and other inoperable infrastructure, five dams used for operations and to store process waters, waste and other substances. Remediation works have included:

- remediation investigation, option assessment and design
- decommissioning, demolition and removal of gas-to-liquid plant and surface infrastructure
- remediation of five process water dams
- consolidation and encapsulation of contaminants in an onsite cell
- installation of new wells to expand the groundwater monitoring network
- telemetry for the groundwater monitoring network
- assessment of gas wells and boreholes
- establishment and enforcement of a site safety management system compliant with the P&G Act
- removal and disposal of 160,000 L of hazardous liquid and 40 m³ of packaged goods and waste
- plugging and abandonment of priority legacy petroleum wells and bores.

3.3.2 Re-commercialisation and repurposing

Recognising the potential value in abandoned mines, the Framework and Policy aim to consider the AMLP's re-commercialisation and repurposing criteria. The criteria are used to evaluate the mineral resource, the potential of mineral recovery from mining and processing wastes, the remaining in situ resources or feasibility of beneficial non-mining repurposing opportunities. Figure 4 lists the criteria considered when looking at re-commercialisation and other repurposing opportunities.



Figure 4 Criteria for evaluating re-commercialisation and repurposing opportunities

3.3.2.1 Re-commercialisation

The re-commercialisation assessment considers available mineral resource information and other data to score the re-commercialisation potential as a trigger for further investigation. The assessment process does not include undertaking feasibility studies for mineral resource development, but rather identifies opportunities for seeking industry interest or collaboration to progress these opportunities (Department of Resources 2021a).

Re-commercialisation of abandoned mines is a key component of the Queensland Resources Industry Development Plan released in June 2022 and the Queensland Critical Minerals Strategy released in 2023. The Queensland Government will establish abandoned mine re-commercialisation principles to guide and inform future re-commercialisation decisions to ensure that they deliver public, economic and net environmental benefit. Feedback from the re-commercialisation pilot program at Wolfram Camp and surrounds (discussed below) will be used to inform these principles (Department of Resources 2022b and 2023a).

3.3.2.2 Secondary prospectivity

The Queensland Government is also developing a strategic framework that looks to facilitate secondary prospectivity by setting up a regulatory framework to support it. This framework will aim to incentivise reprocessing opportunities which include the consideration of a new tenure under the MR Act, and will also consider the current risk assessment criteria and subsequent risk allocation in the FPS (Department of Resources 2023b). While abandoned mines can play a vital role in secondary prospectivity, given there is often considerable mine waste such as tailings, waste rock or low-grade ore stockpiles, it should be noted that existing exploration mining tenure is already common over many abandoned mines.

The Queensland Government collaborates with the University of Queensland's Mine Waste Transformation through Characterisation (MiWaTCH) research group to characterise mine waste at abandoned Queensland mines. This collaboration is assisting in developing an understanding of opportunities for reprocessing waste materials such as tailings to enable better environmental outcomes (Sustainable Minerals Institute 2023). Numerous abandoned mines in Queensland have waste material that contains significant amounts of rare earth metals and other critical minerals such as cobalt and indium. Research outcomes and deliverables of the AMLP may also contribute to circular economy commitments through the reprocessing of legacy mineral waste and further improve the social performance of the mining industry. This could include reprocessing uncontained historical tailings to extract remaining minerals, including critical or rare earth minerals, disposing of reprocessed material in a modern TSF, and site remediation to reduce the impacts on community, land use and the environment.

3.3.2.3 Repurposing

Mining is considered as a temporary land use and post-mining land use (PMLU) opportunities may include reprocessing wastes, grazing, tourism, recreation, ecosystem services, agroforestry and resource management (Fogarty 2022). There is often more than one land use when a mine is repurposed, but there are few examples worldwide of successful repurposing (Holcombe 2020). Abandoned mines can present a great number of opportunities for a variety of PMLUs and repurposing. However, the opportunity for repurposing abandoned mines can be complex and depends on each site's characteristics and location (Fogarty 2022).

The repurposing assessment uses site information to rate the site's potential for beneficial alternative industrial re-use such as renewable energy projects or quarrying. Where relevant, repurposing opportunities will be included in business case considerations. Where there may be potential for re-commercialisation or repurposing, expressions of interest may be sought from relevant parties.

Pumped hydro energy storage is a great opportunity to repurpose abandoned mines and has many advantages such as existing access to water, transmission infrastructure, roads and existing disturbed landscape. However, the site would require two reservoirs, one higher than the other (Weber 2024). The Kidston Pumped Hydro Storage Project is located in Far North Queensland and is the first project of its type to use an abandoned mine. The project is the integration of three renewable power sources (solar, pumped hydro and wind) (Genex ca. 2023). The Queensland Government has supported the reuse of the former mine through financial investment and permitting (Queensland Cabinet 2022, 2023; Genex ca. 2023), resulting in significant economic outcomes including job creation while contributing to Queensland's transition to a low-carbon economy.

3.3.2.4 *Wolfram Camp mine and Bamford Hill mine re-commercialisation*

The Wolfram Camp mine is located 16 km northwest of Dimbulah and approximately 60 km west of Mareeba on the Atherton Tablelands in North Queensland. Tungsten was discovered around Wolfram Camp in 1891. While there were various mining operations at the site in the 1970s, the most recent operation was commissioned in 2008 and abandoned in 2018. Wolfram Camp mine was not decommissioned or rehabilitated before it was abandoned, and hazards exist that pose risks to public health and safety, and the environment (Department of Resources 2021b).

The Queensland Government has completed the tendering process for a pilot program to re-commercialise the area that includes the former Wolfram Camp mine, Bamford Hill mine and surrounding exploration areas. The preferred tenderer must meet environmental, native title and other approval requirements before an exploration permit (EP) may be granted for a term of five years under the MR Act. The EP holder also needs to complete land access (and potentially other) approval requirements before commencing on-ground exploration. Learnings from this competitive tender process will help to inform the process for future releases (Queensland Government 2023).

EQ Resources, a leading tungsten producer, was awarded the tender for resource exploration at Wolfram Camp and its surrounds. This tender is the first critical next step in the pilot program to re-commercialise the former mine. As of June 2024, EQ Resources has been awarded an EP, which grants EQ Resources exploration rights to over 480 km² of land (Queensland Government 2024b).

3.3.2.5 *Mount Morgan and Heritage Minerals*

The Mount Morgan mine (Figure 5) is located 32 km southwest of Rockhampton in Central Queensland. Mount Morgan was founded as a gold mining town in 1882, with its mining operations continuing until November 1990. It was the largest gold mine in Queensland in the 19th and early 20th centuries, with about 250 tonnes of gold and 360,000 tonnes of copper extracted from the mine and about 134 million tonnes of waste rock and tailings generated (Department of Resources 2021c).



Figure 5 Mount Morgan mine

The Department of Resources has preserved the mining leases over the site with a view that commercial reprocessing of the tailings for gold and copper will facilitate progressive site remediation and minimise ongoing government expenditure at the site (Department of Resources 2021c). The Department of Resources has worked closely with various mining lease holders (currently, Heritage Minerals), local government and other stakeholders to support the innovation necessary to develop a viable reprocessing operation.

Heritage Minerals proposes to establish a tailings processing plant at Mount Morgan mine site with the potential to process nearly 10 million tonnes of historical, contaminated gold ore tailings, recovering an estimated 263,000 ounces of gold and 5,600 tonnes of copper (Queensland Treasury 2023). The project is expected to create over 150 full-time roles when the mine is operating (Rockhampton Regional Council 2022).

The project will establish a tailings processing plant to recover gold and copper, re-commercialising the remaining resources while delivering environmental remediation benefits. The plan includes the construction of a new water treatment plant to lower the level of contamination in the open cut pit, treat all water captured by the site's seepage interception system and help meet regulatory requirements for the release of treated water into the Dee River (Queensland Treasury 2023).

3.3.2.6 Charters Towers shaft and heritage works

Abandoned mines can present an insight into Queensland's rich mining history and therefore present opportunities for tourism. The town of Charters Towers in North Queensland was founded on the discovery of gold at Towers Hill in 1870 (Department of Resources 2021e). Towers Hill is listed on the Queensland Heritage Register as it demonstrates the evolution of gold extraction practices in Queensland (Department of Environment, Science and Innovation 2022). Charters Towers Regional Council, in collaboration with the Queensland Government, has developed a miners' memorial walk. This walk shares the history of mining in Charters Towers and honours those that lost their lives in mining accidents. The walk and associated infrastructure, such as replica poppet heads and interpretive signage, showcase the mining of the bygone era (Charters Towers Regional Council 2023). Visitors are able to view historical mine shafts which have been made safe with a glass viewing panel (Figure 6).



Figure 6 The shaft before and during remediation works in Charters Towers

4 Conclusion

The Queensland Government's AMLP is responsible for assessing and managing abandoned mine sites and reducing public health and safety, and environmental, risks. This is achieved through undertaking prioritised works to make abandoned mines safe, secure and durable through C&M and remediation activities. Where possible, the AMLP also pursues opportunities to re-commercialise or repurpose abandoned mines, resulting in social, environmental and economic benefits to regional Queensland communities.

The AMLP is guided by the Abandoned Mines Management Policy introduced in 2018 and the Queensland Government Risk and Prioritisation Framework implemented in March 2021. The Policy and Framework assist to prioritise, manage and remediate abandoned mines through a repeatable and consistent risk-based decision-making process. The AMLP has been supported and enhanced by recent legislative and policy reforms.

The information presented in this paper may be helpful in policy making and regulatory understanding.

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References

- Charters Towers Regional Council 2023, *Charters Towers Miners' Memorial Walk to Spark Interest and Reflection*, viewed 8 May 2024, <https://www.charterstowers.qld.gov.au/news/article/1608/charters-towers-miners-memorial-walk-to-spark-interest-and-reflection>
- Commonwealth of Australia 2001, *Corporations Act*.
- Cooper, S 2019, 'Maximising post-mining land use: Queensland Government reforms', in AB Fourie & M Tibbett (eds), *Mine Closure 2019: Proceedings of the 13th International Conference on Mine Closure*, Australian Centre for Geomechanics, Perth, pp. 969-982, https://doi.org/10.36487/ACG_rep/1915_76_Cooper
- Department of Environment and Science 2022, *User Guide for Estimated Rehabilitation Cost Calculator for Mining*, Brisbane.
- Department of Environment and Science 2023, *Guideline Progressive Rehabilitation and Closure Plans*, Brisbane.
- Department of Environment, Science and Innovation 2022, *Towers Hill*, Brisbane, viewed 10 May 2024, <https://apps.des.qld.gov.au/heritage-register/detail/?id=601851>
- Department of Resources 2019, *Abandoned Mines Management Policy*, Brisbane.
- Department of Resources 2021a, *Risk and Prioritisation Framework for Abandoned Mine Management and Remediation*, Brisbane.
- Department of Resources 2021b, *Wolfram Camp Remediation Project*, Brisbane, viewed 28 March 2024, <https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/wolfram-camp>
- Department of Resources 2021c, *Mount Morgan Remediation Project*, Brisbane, viewed 28 March 2024, <https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/mount-morgan>
- Department of Resources 2021d, *Baal Gammon Remediation Project*, Brisbane, viewed 28 March 2024, <https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/baal-gammon>
- Department of Resources 2021e, *Charters Towers Shaft Repair Program*, Brisbane, viewed 08 May 2024, <https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/charters-towers>
- Department of Resources 2022a, *Goondicum Remediation Project*, Brisbane, viewed 27 March 2024, <https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/goondicum>
- Department of Resources 2022b, *Queensland Resources Industry Development Plan*, Brisbane.
- Department of Resources 2023a, *Revitalised Former Mine to Bring New Jobs to the North*, Brisbane, viewed 19 April 2024, <https://statements.qld.gov.au/statements/98306>
- Department of Resources 2023b, *Queensland Critical Minerals Strategy*, Brisbane.
- Eastwood, A 2023, *Australian Mining, Unlocking Abandoned Mines*, viewed 7 August 2024, <https://www.australianmining.com.au/unlocking-abandoned-mines/>
- Fogarty, K 2022, *Eliciting Post-Mining Land-Use Preferences and Values: an Open Cut Coal Mine in New South Wales, Australia*, PhD thesis, The University of Western Australia, Perth.
- Genex ca. 2023, Sydney, viewed 08 May 2024, <https://genexpower.com.au/250mw-kidston-pumped-storage-hydro-project/>
- Government of Queensland 1989, *Mineral Resources Act 1989*, Australia
- Government of Queensland 1994, *Environmental Protection Act 1994*, Australia.
- Government of Queensland 2004, *Petroleum and Gas (Production and Safety) Act 2004*, Australia.
- Government of Queensland 2018, *Mineral and Energy Resources (Financial Provisioning) Act 2018*, Australia.
- Government of Queensland 2020, *Energy Resources and other legislation Amendment Bill 2020*, Australia.
- Government of Queensland 2024, *Mineral and Energy Resources and Other Legislation Amendment Bill 2024*, Australia.
- Hall, T, Friend, A, Stones, A & Grabski, A 2022, 'Queensland abandoned mines land program and the Baal Gammon copper mine remediation project', *International Conference on Acid Rock Drainage*.
- Holcombe, S & Keenan, J 2020, *Mining as a Temporary Land Use Scoping Project: Transitions and Repurposing*, Centre for Social Responsibility in Mining, The University of Queensland, Brisbane, <https://www.mineclosure.net/media/resources/352/mining-as-a-temporary-land-usefinal200318-f.pdf>
- Queensland Audit Office 2014, *Environmental Regulation of the Resources and Waste Industries*, Brisbane.
- Queensland Cabinet 2022, *Kidston Hydro Project to Deliver Jobs and Clean Energy*, Brisbane, viewed 25 June 2024, <https://statements.qld.gov.au/statements/96794>
- Queensland Cabinet 2023, *Revitalised Former Mine to Bring New Jobs to the North*, Brisbane, viewed 25 March 2024, <https://statements.qld.gov.au/statements/98306>

- Queensland Government 2020, *Mineral and Energy Resources and Other Legislation Amendment Bill 2020, Explanatory Notes*, Brisbane.
- Queensland Government 2022, *Environmental Protection and Other Legislation Amendment Bill 2022*, Australia.
- Queensland Government 2023, *Call for Tenders for an Exploration Permit for Minerals (MLR2023-1)*, Brisbane, viewed 8 June 2024, <https://qtenders.epw.qld.gov.au/qtenders/tender/display/tender-details.do?CSRFNONCE=29DC38F451656319D4D0A9AF016735B0&id=48273&action=display-tender-details&returnUrl=%2Ftender%2Fsearch%2Ftender-search.do%3Faction%3Dadvanced-tender-search-closed-tender%26amp%3BorderBy%3DcloseDate%26amp%3BCSRFNONCE%3D94F270B9158E65420DF9D02493B8ABE95>
- Queensland Government 2024a, *Doing What Matters for the Wide Bay*, Brisbane, viewed 25 June 2024, https://budget.qld.gov.au/files/RAP_2024-25_WideBay.pdf
- Queensland Government 2024b, *Permit Granted to Unlock Critical Minerals And Jobs at Historic Far North Queensland Mine Site*, Brisbane, viewed 20 June 2024, <https://statements.qld.gov.au/statements/100610>
- Queensland Treasury 2018, *Achieving Improved Rehabilitation for Queensland: Addressing the State's Abandoned Mines Legacy - Discussion Paper*.
- Queensland Treasury 2019, *Financial Provisioning Scheme*, Brisbane, viewed 27 March 2024, <https://www.treasury.qld.gov.au/resource/financial-provisioning-scheme/>
- Queensland Treasury 2023, *Heritage Minerals*, Brisbane, viewed 28 Mar 2024, <https://www.treasury.qld.gov.au/investment/investment-growth-stories/heritage-minerals/>
- Queensland Treasury 2024, *Financial Assurance and Rehabilitation in the Resources Sector*, Brisbane, viewed 24 April 2024, <https://www.treasury.qld.gov.au/programs-and-policies/improving-rehabilitation-financial-assurance-outcomes-resources-sector/>
- Rockhampton Regional Council 2022, *Gold Rush for Mount Morgan's Economy*, Brisbane, viewed 20 June 2024, <https://www.rockhamptonregion.qld.gov.au/AboutCouncil/News-and-announcements/Latest-News/Gold-Rush-for-Mount-Morgan%E2%80%99s-Economy>
- Sustainable Minerals Institute 2023, *From Waste to Wonder*, Brisbane, viewed 19 April 2024, <https://stories.uq.edu.au/smi/2022/from-waste-to-wonder/index.html>
- Weber, T & Blakers, A 2024, *Researchers Found 37 Mine Sites in Australia that Could be Converted into Renewable Energy Storage. So What are we Waiting for?*, Australian National University, Canberra, viewed 8 May 2024, <https://iceds.anu.edu.au/news-events/news/researchers-found-37-mine-sites-australia-could-be-converted-renewable-energy#:~:text=In%20Australia%2C%20one%20pumped%20hydro,would%20repurpose%20old%20mining%20pits>