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'Walkaway' mine closure is rare: acknowledging the need for ongoing stewardship

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Abstract

Post-licence relinquishment, in some jurisdictions (such as Victoria) referred to as 'post-closure' and describes to the period after a mine has been rehabilitated and the closure criteria have been achieved. This period begins once an application for relinquishment has been made by the licence holder and signed off by government. The rehabilitated mine sites are no longer regulated under operational/rehabilitating mining legislation because the land is no longer considered an active or operational mine site. Once relinquished, responsibility for the land and associated residual risks may transfer to various parties depending on the jurisdiction and land ownership. Over the long timeframes associated with post-relinquishment periods, extreme environmental events exceeding design criteria are likely to occur, including major rainfall events or earthquakes. Such events can compromise landform performance, potentially leading to elevated risks if systems are not adequately monitored or maintained. Final landform designs developed during mine closure typically involve substantial civil engineering to enable sustainable land re-use and to minimise risks to people and the environment. These engineered structures, such as covers and drainage systems, have finite design lives and generally require ongoing monitoring, maintenance, and periodic repair and replacement to continue functioning as intended. Few, if any, engineered features can be expected to perform 'in perpetuity' without some ongoing intervention. Evidence from Australian Standards demonstrates that even well-designed infrastructure assumes inspection, maintenance and renewal cycles. This reality raises several key questions for government, industry, and communities. These include: how to distinguish ongoing land use management from mining-related residual risk and liability management; who should bear responsibility for such long-term risks; and how financial provisions should be calculated to reflect the level of confidence in data, design, construction quality, and regulatory oversight? The answers to some of these questions are likely to impact on a government's willingness to accept licence relinquishment. High-quality evidence provided by mining companies may justify reduced financial remittance, but poor-quality information increases uncertainty and cost.

Keywords: *post-license relinquishment, closure planning, closure policy, residual risk and liability, post-license relinquishment provisioning, sustainability, future uses, legacy management*

1 Introduction

Mine closure is a process involving the rehabilitation and remediation of a mine site, undertaken by the mining company, so that it can be used for other purposes. Current practice suggests that closure culminates in an application for the surrender or relinquishment of the mining licence to a state, after which regulatory oversight under mining legislation ceases.

Final landforms frequently incorporate engineered structures, for example; drainage and water controls networks, erosion controls, encapsulation covers, safety structures and access infrastructure. These elements can be analogous to conventional infrastructure such as weirs, roads and stormwater systems, where ongoing maintenance is assumed and factored into the ongoing running costs. Potential ongoing maintenance

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requirements are largely not dealt with in most Australian states and around the world. The exceptions to this include the Institutional Control Program in Saskatchewan, where there is a fully formed and operational approach, in Victoria, Australia for a small group of high risk 'declared' mines and in Queensland where work on this issue is currently underway.

The underlying understanding that these structures are likely to require management into the future creates one of the concerns for regulating authority when signing off on the achievement of rehabilitation at mine sites. This could potentially cause delays in achieving relinquishment, once mining companies have rehabilitated the site to the legislated requirements.

The expectation in Victoria is that rehabilitated declared mines are safe, stable and sustainable, and will remain that way long into the future; with the landform suitable for agreed post-mining land uses. However, this expectation must be reconciled with established civil engineering practice, which recognises that all engineered systems degrade over time and require some form of active management. Victoria's approach has been addressed in the Mineral Resources (Sustainable Development) Act 1990 (State Government of Victoria 1990), with a Post-Closure Plan and associated costs to be developed over the life of the Declared Mine, with the dollar value of that plan to be provided to government (into a 'fund') at mining license relinquishment. However, there is a lot of detail still to be developed to make this an implementable approach.

It is recognised that post-license relinquishment outcomes are site-specific and that not all mine sites will require ongoing management of residual risks and liabilities. Where closure has successfully achieved a stable, non-polluting landform aligned with an agreed post-mining land use, ongoing management may be limited to routine land stewardship consistent with that use (ICMM 2025). In such cases, responsibility for land management can reasonably transfer to the subsequent landholder without the need for additional intervention beyond standard practice.

However, this paper focuses specifically on those sites where residual risks and liabilities persist beyond what could reasonably be managed under the intended post-mining land use. In these cases, ongoing monitoring, maintenance or intervention is required to ensure landform stability, environmental protection, or containment of contaminants. These requirements extend beyond conventional land management obligations and raise important questions regarding responsibility, funding, and long-term governance following relinquishment.

2 Post-relinquishment period

The key to understanding this paper is the definition and terminology of the time period which is being discussed. This period has been referred to as 'post-license relinquishment/ surrender' or 'post closure' in Victoria's legislation. For this paper, this period will be referred to as post-license relinquishment. This is described by the Mine Land Rehabilitation Authority's (MLRA) guidance document on Post-Closure Risk Assessment 2025 (Scrase 2025) as:

> *"the period following the completion of all the following activities by the declared mine licensee:*
>
> - *mining operations*
> - *rehabilitation (active and passive rehabilitation) activities*
> - *achievement of closure criteria (also referred to as closure determination)*
> - *surrender of the mining licence*
> - *return of the bond*
> - *provision to the MLRA of prescribed records and information*
> - *registration of the declared mine land and the post-closure plan with the MLRA and adding them to the declared mine land register, and*
> - *receipt of payment into the Declared Mine Fund."*

Given that this post relinquishment should apply to all mines and quarries, the above definition for declared mines should be widened or something similar should be developed and applied accordingly.

Following license relinquishment, responsibility for land, the associated residual risks and liabilities will, depending on the jurisdiction, either stay with the mining company or transfer to other parties, such as government, Traditional Owners, community or different businesses. One of the questions that arises, is how long should a mining company be responsible for residual risks and liabilities associated with the mitigation of historic mining activates? In Victoria for the declared mines and for mines in Saskatchewan, the associated ‘in perpetuity’ costs currently sit with the mining company.

The post-license relinquishment period has no end point, it is infinite, and therefore over these long timeframes, environmental conditions exceeding design assumptions are inevitable. Design standards are probabilistic, not absolute, meaning exceedance events will occur (Australian Rainfall and Runoff [Ball et al. 2019]).

Mine closure literature recognises that closure rarely represents a complete end point, often requiring long-term monitoring and adaptive management (ICMM 2025; Laurence 2006; Sánchez et al. 2014). Many sites remain in care and maintenance or require ongoing oversight due to residual risks and uncertainties and the unwillingness of governments to agree to the relinquishment of the license when ongoing residual risks and liabilities are known to exist but not accounted for (Laurence 2006).

3 Challenges for mine licence relinquishment

There are many challenges associated with relinquishing mining licences. Commonly observed challenges include:

- Construction quality and verification of completion standards: demonstrating that landforms have been constructed in accordance with design specifications can be difficult, particularly where as-built records, material variability and long-term performance data are limited. Closure guidance emphasises the importance of quality assurance and verification, noting that inadequate construction records increase uncertainty and delay relinquishment (ICMM 2025; Kemp et al. 2016).
- Long performance timeframes relative to design life: rehabilitated landforms are expected to perform over very long timeframes, often exceeding the design life assumptions of engineered components and materials. Civil engineering standards recognise finite service lives and the need for maintenance (ISO 2018; Austroads 2021), while closure literature highlights the difficulty of demonstrating performance over decades to centuries (Laurence 2006; Sánchez et al. 2014).
- Volume and quality of baseline and monitoring data: insufficient or poor-quality baseline data and monitoring records reduce confidence in performance predictions from models whose outputs are incorporated within the landform designs and therefore on the long-term achievement of the closure outcomes. Effective closure requires robust datasets to demonstrate trends and stability over time (ICMM 2025; CRC TiME 2023).
- Inability to demonstrate achievement of closure criteria: mining companies may be unable to prove that closure criteria have been met, or criteria may prove unrealistic or unachievable in practice. This is a widely recognised issue where criteria are poorly defined, not measurable, or not aligned with land capability (Sánchez et al. 2014; ICMM 2025).
- Evolving regulatory expectations over the life of mine: regulatory frameworks, standards and community expectations often changeover the life of a mine, creating misalignment between original approvals and contemporary expectations at closure. Often requiring the mining companies to retrospectively apply new requirements, causing increases in uncertainty across all aspects of closure, such as, costs, time delays and stakeholder engagement and trust (ICMM 2025; Hamblin et al. 2022).

- Post-closure land use viability: proposed land uses may not be economically or socially sustainable or may impose ongoing management burdens inconsistent with relinquishment expectations (CRC TiME 2022; ICMM 2025).
- Disconnect between government and industry understanding of residual risk: differences in risk tolerance and interpretation of residual risk can delay relinquishment, particularly where uncertainty remains regarding long-term performance or liability (CRC TiME 2023; Saskatchewan Government 2024).
- Uncertainty associated with long-term landform performance: predicting geomorphic stability, erosion rates and hydrological behaviour over long timeframes is inherently uncertain, particularly under changing climatic conditions (Ball et al. 2019; Sawatsky et al. 2008).
- Residual liability and financial assurance adequacy: governments may be reluctant to accept relinquishment where there is uncertainty about whether financial provisions are sufficient to cover long-term risks (Chambers 2024; Resource Policy 2024).
- Institutional arrangements for long-term management: lack of acknowledgement that ongoing management is likely to be required in some cases and therefore no clear mechanisms for managing residual risks after relinquishment, including funding and governance structures, can delay acceptance by regulators (Saskatchewan Government 2024; CRC TiME 2023).

With reference to this paper, the expected long life-span of landforms, potential for ongoing management of remaining engineered structures, the last four dot points are relevant. Below are items that may need to be considered to resolve some of the post-license relinquishments challenges, prior to the application for license relinquishment to provide a smoother process and assist in relinquishment of the mining license:

- Distinguishing between:
  - general land management requirements
  - residual risks and liabilities associated with mining.
- Determining who is responsible for the ongoing management and post-license relinquishment fund/provision and the associated required governance.
- Determining the approach for developing the financial provision:
  - how to determine the costs for management of residual risks and liabilities
  - how to determine the cost for a catastrophic failure
  - determine the most appropriate way and timeframe for the monies to be made available
  - determine how the fund/provision should be held to ensure continued growth of the fund to cover ongoing requirements perpetuity.

Financial assurance frameworks have evolved to address these risks, recognising that post-closure obligations, such as monitoring, maintenance and water treatment, are often substantial and long-term.

4 Relevance to rehabilitated landforms

When a mine has finished operating, the land within the license area is altered permanently. Once all transportable machinery, equipment, waste etc has been removed from the license area, there is often a mix of open cut pits, tailings dams, waste rock dumps, landfills and underground workings remaining. These remaining landforms are usually required by government to be made “safe, stable and sustainable”. The designs for these landforms must consider a multitude of site-specific inputs to create a reusable area (if possible). To achieve legislated requirements, rehabilitated landforms typically comprise engineered cover systems, regraded slopes and batters, integrated surface water drainage networks, erosion protection layers, and revegetated growth media, together forming a geomorphologically stable landform designed to manage water, control erosion and support the intended post-mining land use (Pollard et al. 2018; Sawatsky et al. 2008; MEND/INAP guidance). Ultimately, what is left behind after the site has been rehabilitated are:

- engineered systems (not natural landscapes)
- hydrologically active systems (drainage-dependent)
- multi-component systems (each with failure modes).

Rehabilitated landforms include engineered drainage systems, covers, slopes, water control structures and access tracks. These features are subject to the same degradation mechanisms as conventional infrastructure.

Closure planning research confirms that mine closure is a dynamic, iterative process requiring ongoing measures to manage environmental risks and enable sustainable land use.

No recognised engineering standard supports the assumption of indefinite performance without maintenance.

5 Evidence supporting ongoing adaptive management

5.1 Civil engineering standards

5.1.1 Drainage infrastructure

Australian Rainfall and Runoff (ARR) establishes that flood design is inherently probabilistic, with design events expressed as an annual exceedance probability (AEP), meaning there is always a defined likelihood that larger events will occur in any given year (Ball et al. 2019; Bureau of Meteorology 2024). Importantly, ARR also recognises uncertainty associated with rainfall estimation, catchment response and climate variability, and recommends periodic review and updating of design assumptions as new data becomes available (Ball et al. 2019). This explicitly acknowledges that hydraulic infrastructure cannot be designed to perform indefinitely under fixed conditions. Similarly, AS/NZS 3500 requires drainage systems to incorporate inspection openings, access points and provisions for clearing blockages, reflecting an expectation of ongoing maintenance throughout the asset life (Standards Australia 2018). These requirements are consistent with broader civil engineering practice, where infrastructure performance is managed over time through inspection, maintenance and renewal rather than assumed to be self-sustaining.

Applying these principles to rehabilitated mine landforms, where materials are more heterogeneous, environmental conditions are less predictable, and design uncertainty is typically higher, reinforces the understanding that static design alone cannot ensure long-term performance. Instead, as with conventional infrastructure, sustained functionality depends on monitoring, maintenance and adaptive management to respond to evolving conditions and inevitable exceedance events.

5.1.2 Road infrastructure

In addition, guidance from Austroads reinforces that drainage and road infrastructure are designed with finite service lives and require routine inspection to maintain functionality, particularly where sedimentation, vegetation growth or structural degradation may impair performance (Austroads 2021). This aligns with asset management principles outlined in ISO 55000, which emphasise life cycle management, condition monitoring and planned intervention to sustain performance over time (ISO 2018). Together, these standards demonstrate that even highly controlled, well-characterised infrastructure systems are not expected to operate without ongoing management.

5.2 Extreme events and long timeframes

Over decades or centuries, extreme events beyond design criteria are expected. This includes rainfall events exceeding design AEP thresholds and potential seismic activity.

Erosion is an ongoing natural process that cannot be stopped, closure planning studies use models and field trials to determine erosion rates and alter designs to limit the erosion rates. However, over time, erosion inevitably takes place, necessitating regular maintenance and repairs.

In agricultural systems, ‘tolerable’ soil loss refers to the maximum average annual rate of soil erosion that can occur without compromising long-term soil productivity, commonly formalised as the soil loss tolerance or T factor (NRCS 2023). Reported tolerable values for agricultural soils commonly fall within the range of 1–5 tons per acre per year (approximately 2.2–11.2 t/ha/yr), which is broadly consistent with the frequently cited range of 5–10 t/ha/yr for managed farmland (NRCS 2023; Bui et al. 2011).

In agricultural systems, ‘tolerable’ or ‘acceptable’ soil erosion rates are typically defined as the maximum rate at which soil can be lost while maintaining long-term productivity. Historically, this concept (Universal Soil Loss Equation (USDA NRCS 2001)) defines tolerable erosion as the level that allows sustained crop production over time. In practice, values commonly cited for farmland range from approximately 5–10 tonnes per hectare per year, with around 10 t/ha/yr often considered an upper acceptable limit under managed conditions (Queensland Gov). However, natural soil formation rates are much lower (on the order of ~0.1–1 t/ha/yr), meaning even these acceptable losses represent a net degradation over long periods. This has important implications for rehabilitated mine landforms: if erosion rates approach those tolerated in agriculture, progressive loss of cover material, exposure of underlying waste, and development of rills and gullies can occur. Unlike farmland, where soil loss reduces productivity, erosion in mine landforms can directly compromise engineered functions and rehabilitation success through loss of vegetation, contaminant containment and drainage performance. Consequently, erosion rates that might be considered marginally acceptable in agriculture may still be unacceptable for rehabilitated landforms, reinforcing the need for conservative design, monitoring and ongoing maintenance.

Given these realities, static design cannot ensure perpetual performance. Adaptive management is required to respond to evolving conditions.

6 Allocation of land management costs versus legacy mining liabilities

As described in Section 5, a critical distinction must be made when determining post-licence relinquishment costs between: (1) costs associated with the agreed post-mining land use, and (2) costs arising solely from the management and mitigation of ongoing historic mining impacts. This distinction is well articulated by Maybee et al. (2024).

6.1 Land use–driven costs

Post-mining land use planning is intended to deliver ongoing social, environmental and economic value, with land uses such as industrial, residential, tourism, agriculture, conservation or energy generation requiring routine management. These costs, such as vegetation management, routine drainage upkeep and land management activities, are inherent to the land use itself and should reasonably be borne by the landholder or beneficiary. This aligns with established asset management principles, including ISO 55000, where the asset owner is responsible for life cycle costs associated with the intended use of the asset (ISO 2018).

6.2 Residual mining liabilities

In contrast, mining activities can create enduring environmental and engineered liabilities that extend beyond normal land use expectations. These include contamination, altered hydrology, hydrogeology, long-term water management requirements, and engineered structures that may require ongoing monitoring, maintenance or intervention. Evidence indicates that post-closure obligations can include long-term or even perpetual management measures, such as water treatment and landform maintenance, which significantly increase closure costs and complexity (Maybee et al. 2024; ICMM 2025).

6.3 Overlap and shared responsibility

The framework presented by Maybee et al. (2024) highlights that there is often an area of overlap between land use management and residual mining liability, where responsibilities are not clearly attributable to either category. This ‘shared zone’ may include, for example, drainage systems or landform features that serve both functional land use purposes and residual risk mitigation. In such cases, clear governance arrangements, risk allocation and, where appropriate, financial mechanisms are required to ensure that responsibilities are equitably assigned and that the long-term performance of the land is maintained. This reinforces the importance of explicitly distinguishing cost categories while recognising that, in practice, some level of integration and shared responsibility is inevitable in post-closure landscapes.

Research further highlights that closure and post-reclamation care liabilities are often underestimated and persist over long timeframes (Maybe et al. 2024).

6.4 Risk of liability transfer

Where these liabilities are not adequately defined and funded, they may transfer to future landowners or governments. Studies indicate that closure costs are often underestimated and, if not properly planned for, can impose significant long-term burdens.

This outcome is inconsistent with the widely accepted ‘polluter pays’ principle embedded in environmental policy and mining regulation.

6.5 Implications

An effective framework should therefore:

- assign land use–related management costs to the land user
- retain or fund mining-related residual liabilities separately
- ensure financial provisioning reflects long-term obligations and uncertainty.

Without this distinction, future land users may inherit disproportionate costs, undermining the viability of post-mining land uses or the post-mining sustainability requirements and discouraging land transfer.

7 Conclusion

Evidence from civil engineering standards and mine closure research demonstrates that no engineered system can be expected to perform indefinitely without intervention. This principle applies directly to mine closure landforms and any engineered structures required to maintain the landform functioning as required.

Governments are in the early stages of addressing the ongoing residual risks and liabilities in the post-relinquishment period through changes in their legislation and policies by:

- recognising the inevitability of ongoing management for relevant mines
- clearly defining the responsibility for future land use management requirements
- defining the management of residual mining risks and liabilities, where they will be allocated and to whom
- provide clear guidance on how to ensure financial provisioning reflects long-term/ in perpetuity obligations, so that future generations do not pay the price for our activities.

Industry and government need to continue the shift away from ‘walkaway’ expectations to some form of continued managed, funded and accountable post-mining landscapes which is necessary to achieve sustainable outcomes.

Questions that arise when needing to deal with the ongoing potential requirement of management of key structures are:

- Who should foot the bill for the ongoing maintenance costs associated with the historic mining activity?
- How should it be decided what management of residual risk and liabilities belong with the historic mining activities and what management and associated costs should be allocated to the new land uses / managers?
- Who, when and how should the ongoing maintenance and replacement of infrastructure be undertaken?

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