FROM RECLAMATION TO RELINQUISHMENT: IS THIS AN ACHIEVABLE GOAL IN BRITISH COLUMBIA?

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ABSTRACT

Transitioning a mine from reclamation to relinquishment is a significant challenge. The International Council for Metals and Mining (ICMM) defines relinquishment as "the transition of ownership and residual liability to the jurisdictional authority or a third party". But, is mine relinquishment achievable within British Columbia (BC)? Are there clear regulatory mechanisms that support a pathway from progressive reclamation to relinquishment? Are all mine closure domains including tailings facilities possible to relinquish? And, why is assessment of post-closure residual risk crucial regardless of the presence of a clear regulatory mechanism in place?

This paper discusses some of these key challenges on the pathway from progressive reclamation towards potential mine relinquishment. We focus on tailings facilities as these assets typically represent the greatest post-closure residual risk for a mine operator. The paper begins with a discussion on the current mine relinquishment regulatory framework in BC compared to other global policy examples. We then explore aspects of a mine relinquishment framework in the context of landform design and provide potential completion criteria to support risk assessment and closure objectives. We conclude with a discussion on risk-based Front-End Loading (FEL) practices that are needed for integrated closure planning regardless of a whether a mechanism for relinquishment is in place.

Keywords: tailings facility, relinquishment, front-end loading, post-closure residual risk

INTRODUCTION

The International Council for Metals and Mining (ICMM) Integrated Mine Closure Guide defines relinquishment as the "transition of ownership and residual liability to the jurisdictional authority or a third party" (ICMM 2019). Transitioning a mine from reclamation to relinquishment is a significant challenge. However, it is a necessary mechanism to establish clear goalposts for Owners while building societal trust. The potential to relinquish is recognized if the Owner can demonstrate an acceptable level of residual risk, but there remain very few examples of demonstrated success. This includes, but is not limited to, the following:

- unclear regulatory mechanisms that support a pathway for closure stakeholders from progressive reclamation to relinquishment (components of regulatory mechanisms are summarized in this paper);
- underestimation of the closure design uncertainties and post-closure residual risk prior to mine construction and throughout the life of mine (LOM). This is particularly true for tailings and mine waste facilities that carry several chemical, physical stability and end land use failure modes; and
- uncertainty with evolving societal and regulatory expectations on closure objectives and completion criteria that can leave mine owners with hesitation investing. Increasing societal expectations can be enhanced by poor industry performance such as recent global tailings facility failures.

This paper identifies some of the key challenges on the pathway from progressive reclamation towards potential mine relinquishment within British Columbia (BC). Achieving mine relinquishment is a challenge across all mine closure domains, but we focus on tailings facilities as these assets typically represent the greatest post-closure residual risk for a mine operator.

We begin with a discussion on the current mine relinquishment regulatory framework in BC compared to other global policy examples. We then explore aspects of a mine relinquishment framework with a focus on landform design and provide potential completion criteria to support risk assessment and closure objectives. We conclude with a discussion on risk-based Front-End Loading (FEL) practices that are needed for integrated closure planning and engagement on post-closure residual risk with closure stakeholders.

MINE RELINQUISHMENT REGULATORY MECHANISMS

A key recommendation from the National Orphaned/Abandoned Mines Initiative (NOAMI) is that Canadian jurisdictions should have a managed relinquishment process, which is clear, unfettered and is specific about what will not be accepted (Cowan et al. 2013). Similarly, the 2018 Asia-Pacific Economic Cooperation's (APEC) Mine Closure Checklist for Governments states that regulators should provide mechanisms that: returns a site (or portions) to the jurisdiction or third parties; provides contractual recognition of transfer of liabilities; and quantifies residual liabilities and provides the Owner with the funds to address those liabilities (APEC 2018).

Mine relinquishment mechanisms may include a variety of regulatory and community requirements, similar to an environmental authority (EA) submission process. Regardless of the detail, a mechanism needs to include a systematic process involving multi-disciplinary decision making and stakeholder engagement to transfer knowledge, secure commitment, allow for conflict resolution and reach a relinquishment decision.

Key aspects of relinquishment may include, but, is not limited to:

- a formal regulatory closure, sign-off and relinquishment mechanism with supporting guidelines and instruments to guide financial assurance, residual risk estimates and formal LOM reclamation certification;
- regular revisions to the risk-informed LOM closure plan that includes quantitative completion criteria supporting the closure objectives (broadly that fit under physical stability, chemical

stability, end land use and social transition). Compliance permit obligations need to be aligned with these risk-based completion criteria;

- technical peer review of closure plans and residual risk assessments with closure stakeholder engagement prior to formal review and recommendations for sign off;
- submission of formal application for progressive reclamation certification of each mine closure domain, with the aim to cumulatively hand over the entire mining lease. Sites that have been assessed and clearly meet their completion criteria can be presented for formal sign off approval;
- a process to manage those sites that do not meet completion criteria, while providing financial incentives for companies that do meet these milestones; and
- legal instruments for appeals and to formally sign and hand over custodial duties.

Within BC, relinquishment of a Mines Act permit is at the discretion by the Chief Inspector. Section 10 of the BC Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) details the minimum requirements for closure. Section 10.7.22 refers to mine relinquishment and states that "*If all conditions of the Act, code and permit have been fulfilled to the satisfaction of the chief inspector and there are no on-going inspection, monitoring, mitigation or maintenance requirements, the owner, agent or manager will be released from all further obligations under the BC Mines Act*" (EMPR 2017). Apart from this broad policy statement, there remains no clear regulatory mechanism and supporting tools in BC to allow an Owner relinquishment of a mining lease.

An Owner would need to demonstrate the proposed mine closure landforms do not require on-going monitoring and maintenance under normal, unusual and event-driven conditions (i.e., flood, seismic event, etc.) to meet current policy requirements. This is challenging for most global tailings technologies and designs (including filtered and co-disposed tailings) to demonstrate as credible failure modes will exist and ongoing dam safety inspections are necessary unless the facility can be declassified as a dam. In this paper, we provide potential physical stability completion criteria for what declassification from a dam to a 'mine waste structure' landform may look like (Table 1).

Within Canada, there remains a wide range of variability within mining jurisdictions for establishing clear mechanisms in identifying and transferring mine closure residual risk from the Owner to the province/territory. For example:

- **Ontario, Canada**: discretion for relinquishment is by the Director. Ontario. Reg. 240/00: Mine Development and Closure Under Part VII of the Mining Act details the minimum requirements for closure. Section 24 (3) states that "*The proponent shall restore the site to its former use or condition or to an alternate use or condition that the Director sees fit*". (Ontario. Reg. 240/00, 2012)
- **Saskatchewan, Canada**: a mechanism for relinquishment is in place. The *Reclaimed Industrial Sites Act* and Regulations under which the Institutional Control Monitoring and Maintenance Fund and the Institutional Control Unforeseen Events Fund operate. Transfer of title is made to the Crown (Government of Saskatchewan 2018). There are a handful of examples, however many mines in Saskatchewan have longer mine lives (e.g., Potash), thus testing of the mechanism can be considered preliminary.
- **Alberta, Canada**: a mechanism for relinquishment is in place. Under the *Mines and Minerals Act*, it states that a lessee of an agreement under section 116 may apply to the Minister for a closure

certificate in accordance with the regulations (s. 120) and includes assumptions on transfer of liability including indemnification (s. 121) (Mines and Minerals Act 2016). A post-closure stewardship fund is established (s. 122). Risk-assessment rules for reclamation certificate applications are established via the Specified Enactment Direction 002: Direction for Reclamation Application Submissions for Well Sites and Associated Facilities.

Other global mining jurisdictions such as New Zealand and Pennsylvania in the U.S. have clear and transparent mechanisms for identifying and transferring residual risk from mining assets to the state or third party. Several closed mines including the Martha Mine and Golden Cross Mine located in New Zealand have a clear link between risk assessments, reclamation completion criteria, closure costing and relinquishment agreements with regulators.

States and territories across Australia have recently increased scrutiny on residual risk as it relates to mine closure rehabilitation securities; however, in all cases, the provision of the security bond does not currently release the company of their obligations. Within Queensland, there is now an improved mechanism and regulatory instrument for financial assurance that is tied to mine plans and formal reclamation certification over the LOM. The changes aim to enforce site performance while offering a clearer pathway for Owners that include financial incentives for companies that meet or exceed completion criteria. A second mechanism is being introduced to capture residual risk financial calculations, designed to protect the state financially during potential planned and unplanned relinquishment scenarios (QTC 2018). These mechanisms hope to build a foundation from progressively certified reclamation to relinquishment.

LANDFORM CONSIDERATIONS

The following sections summarizes considerations when establishing relinquishment completion criteria as it relates to risk-informed mine landform design.

Definition of a Landform

The definition of post-mining landforms and how to design these for closure varies across mining jurisdictions. The 2017 BC HSRC defines a landform as "*a designated structure that can be considered to have a risk profile similar to the surrounding environment*." In addition, part 10.7.9 of the HSRC states that "*where practicable, land and watercourses shall be reclaimed in a manner that is consistent with the adjacent landforms*." With these definitions, there are challenges in defining what a 'risk profile similar to the surrounding environment' can be and supports the importance in risk-informed closure planning. Do adjacent landforms or the surrounding environment include historic mining activities, and can tailings facilities fit a risk profile similar to the surrounding environment?

The Canadian Dam Association (CDA) states that mining dams are not considered "landforms" unless it can be demonstrated that the facility is physically, chemically and ecologically "stable", and the risk of release of material is negligible. A risk-informed analysis and assessment approach to support the creation of a landform would be consistent with Section 6 of the CDA (2013) and other relevant guidelines.

Regardless of the exact definition, a comprehensive understanding of risk and the interrelated aspects between physical stability (i.e., geotechnical and hydrotechnical failure mechanisms), chemical stability (i.e., source-pathway receptors for human and ecological health) and end land use components is important when considering post-mining landform design. Communicating this to closure stakeholders in support of end land uses is equally important.

Getting to a Landform

Determining appropriate landform elements is site-specific and requires a comprehensive knowledge base of how natural and reclaimed landforms perform.

As part of the FEL stages of closure planning, the mine lease should be broken into logical mine closure domains that represent common elements as part of an interconnected ecological system. Closure domains should reflect characteristics of mature landforms (both natural and manmade) adjacent to the site that captures end land uses and site-wide hydrology. A closure design basis that includes objectives and completion criteria can then be developed on this basis so that reclamation prescriptions can be focused and constructed with greater certainty. The design basis is an evolving document over the LOM with improved certainty through research, benchmarking and site-specific field trials.

Various levels of detail can be assessed when defining the landform that supports each mine closure domain and overall end land use objectives. Dr. Gord McKenna and J.A. Pollard provide a useful overview of landform definitions and have created a list of 97 landform elements for mine reclamation for the most common types of mining landforms such as tailings facilities, waste dumps and open pits (McKenna 2018). Landform evolution models (LEM) such as GeoFluv™ fluvial geomorphic modelling can be a useful tool in guiding mine planners to design mined landforms that reflect natural landforms. Lacy (2019) provides a landscape review of landform practices and these design tools as it relates to his experience in Western Australian mining industry.

Getting to Reclamation

Once a decision has been made on what the closure objectives and completion criteria are for a mine closure domain, a closure design must be approved by the chief inspector per Section 10.7.4 of the HSRC: "*The land surface shall be reclaimed to an end land use approved by the chief inspector that considers previous and potential uses*."

Section 10.6.12 of the HSRC reads "*the manager of a tailings storage facility or dam that can be considered a landform may apply to the chief inspector for the release of permit obligations under the Mines Act*." A detailed final closure plan to achieve the approved end land and water use objectives must be submitted and a permanent spillway must be designed and installed, but there does not appear to be a standard for reclamation of impoundment and dam surfaces. The pre-mining end land use of a tailings facility closure domain is vastly different from its potential use and the chance that the risk profile is similar to adjacent landforms is likely low. By comparison, reclaiming a waste dump within the definition of reclamation in the HSRC and supporting guidance carries with it less uncertainty in terms of physical design than reclaiming a tailings facility.

Is it possible, then, to determine the end land use objective, quantitative completion criteria and reclamation methods necessary for tailings facilities to be considered a landform? Perhaps the landforms in the area include fens, marshes, wetlands or lakes and the landform elements selected during the landform design phase make up one of these landforms. But, without a regulatory mechanism for reclamation certification with an aim for future relinquishment of tailings facilities, the risk to the mining company is in planning for and designing reclamation measures that are not to the satisfaction of the chief inspector of the day.

Comparison can be made to Alberta regulations that have greater structure around the pathway towards certified reclamation. Energy Education (2019) outlines four types of reclamation statuses for the oil sands industry: ready for reclamation; temporary reclaimed; permanently reclaimed; and certified reclaimed. A certified reclaimed site "*is approved by the government as reclaimed and it is no longer the responsibility of the mining company to monitor and care for it*". (Energy Education 2019).

Certification is achieved under the *Environmental Protection and Enhancement Act*. The Alberta Energy Regulator (AER) issues a reclamation certificate to a mining company when it can demonstrate that the site is functioning similarly to how it did before it was disturbed, and no longer needs intervention. The AER says that only companies with a reclamation certificate—which shows that all reclamation requirements have been met—can close their projects and end their surface leases (AER 2019). Similar to BC, the issuance of the certificate is up to the discretion of the Mines Inspector.

A checklist provided by the AER details how a company can apply for the certificate, pointing to the EPEA Conservation and Reclamation Regulation for additional information, but does not clearly detail a metric for approval. In March 2015, the Government of Alberta released the Lower Athabasca Region: Tailings Management Framework for Mineable Athabasca Oil Sands (TMF). The framework outlines the objective that fluid tailings are ready to reclaim within ten years of the end of mine life and that land use must be returned to Albertans sustainable ecosystem, liability is minimized to Albertans, and environmental effects are managed.

Getting to Relinquishment

The CDA (2014) provides an overview of post-closure scenarios for managing residual risk in relation to operation, maintenance and surveillance (OMS) of mining dams. These include Active Care and Passive Care stages as summarized below. Custodial transfer discussions with regulators and communities of interest can then be established as part of the passive care stage. Each post-closure scenario has its own unique challenges and opportunities. An Owner's business case for closure planning must be weighed between the ongoing post-closure residual risk costs for OMS activities and the capital costs and uncertainties in implementing a plan to secure relinquishment.

Active care can either be during operations (i.e., temporary suspension/care and maintenance) or at the end of mine life following closure transition/mill decommissioning. For tailings management, during active care, there is on-going operation, maintenance and surveillance, usually for the purposes of accommodating a water management system. Activities could include surveillance and maintenance of the mining dam and monitoring to verify the performance expected during design. Once pore pressures have stabilized after various closure activities, the dam erosion control measures are effective, and deformations are either non-existent or are at a steady-state and do not present a concern with respect to the stability of the dam, the dam could be considered for Closure – Passive Care stage.

Passive care in a closure state considers that mine waste structures are stable, with self-sustaining processes requiring typically infrequent monitoring and maintenance with little to no human interference. A passive care phase is the precursor to eventual custodial transfer to government or surrounding communities. The dam is in a steady-state condition and past monitoring demonstrates that no further intervention is required by the Owner. Some level of inspection by dam safety engineers and dam safety reviews will likely continue with minor maintenance undertaken, as required.

For a tailings facility to be considered for custodial transfer (some jurisdictions refer to this as institutional control or mine relinquishment), the post-closure scenario requires clear evidence that a dam can be delicensed, and the tailings facility reclassified into a mine waste structure. If dam safety failure modes can be removed through design and deemed "non-credible" under a variety of trigger event conditions with the implementation of closure measures, a business case can be established to meet this performance objective and help refocus LOM planning, permitting and stakeholder engagement.

Table 1 summarizes typical dam safety tailings credible failure modes and suggested qualitative criteria. Such criteria can be used to guide more quantitative and site-specific completion criteria to assist in demonstrating a case for passive care and potential reclassification of a tailings facility from a dam to a mine waste structure that may lead to relinquishment. Chemical stability, end land use and social transition hazards/failure modes are not included and are recommended to be reviewed in context of potential dam safety failure modes.

Table 1: Potential Dam Safety Completion Criteria to Demonstrate a Tailings Mine Waste Structure (Sanders et al. 2019).

Typical Dam Safety Failure Modes for Tailings Facilities	Potential Completion Criteria to Demonstrate Passive Care for a Tailings Mine Waste Structure
Overtopping: surface water from the impoundment overtops and erodes the embankment releasing contents.	The ultimate tailings facility either cannot form a pond on the surface (including variations with climate change) and/or has a fixed feature that is a lower spill point away from the dam.
Slope/foundation instability (static or seismic conditions): slumping or rapid runout of a mine waste structure resulting from slope or foundation failure.	Materials in the dam, tailings material and foundation are competent and dilative. There will not be liquefaction flow or strain weakening behaviour under static or seismic conditions. Deformations (settlement or horizontal) have stopped or reached a steady-state, which does not pose a concern with respect to the stability of the dam. If there are elements in the dam or foundation that are prone to strain weakening, then measures have been taken to prevent this.

Typical Dam Safety Failure Modes for Tailings Facilities	Potential Completion Criteria to Demonstrate Passive Care for a Tailings Mine Waste Structure
Piping / Internal Erosion: enlargement of a continuous tunnel between upstream and downstream.	There is no requirement for a filter layer to retain base soils and maintain low seepage forces on the embankment. The pore pressures in the dam are low under a range of climatic conditions. If there is a requirement for a filter zone to perform, then it has been demonstrated that it will work well in the future considering changes in seepage patterns and behaviour of the filter due to geochemical effects.
Surface erosion: gully erosion that reduces the factor of safety of a dam structure (e.g., eroding a toe buttress). This failure mode assumes that a pond is not present at closure, such that erosion can cause backwards regression on slopes that can create a dam overtopping event.	Cover design can withstand a design precipitation event adequate for the dam safety consequence classification and recognizing landform evolution changes that may occur. If the surface does erode, evidence is required to show that the cover can "self-heal" through natural landform evolution.
Geochemical: changes in material properties leads to reduced effectiveness of design controls (e.g., clogging drainage/filter layers).	Geochemical characterization and predictions for an agreed upper-case prediction range do not affect the intended design function of the mine waste structure. The facility operates passively without any human or mechanical intervention such as: pumping; water treatment; construction; or frequent maintenance.

FRONT-END LOADING (FEL) PRACTICES

The best opportunity to make a positive impact on the post-closure residual risk profile is during the early conceptual and planning stages– typically known as the front-end loading (FEL) phase. FEL requirements on capital projects include robust planning and design early in a project's life-cycle, at a time when the ability to influence changes in design is relatively high and the cost to make those changes is relatively low. These FEL practices support an Owner's transition from reclamation to relinquishment, should such a regulatory mechanism be in place.

Some of the key FEL practices for integrated LOM closure planning are outlined in the 2019 ICMM closure guide. These include establishing a knowledge base, setting objectives, assessing risk and opportunities and developing performance indicators with completion criteria (ICMM, 2019). We have summarized two key FEL practices below that should be incorporated into LOM closure planning.

Objectives Framing and Structured Decision Analysis

Closure options and strategic possibility can be lost as mining progresses and irrevocable decisions are made on the final closure landform. An objectives framing and structured decision-making approach for closure options are essential to support a closure concept and can help facilitate engagement amongst closure stakeholders.

While closure goals and principles are important in setting broad commitments (e.g., safe, stable and non-polluting landforms), closure objectives provide the concrete, site-specific and typically measurable statements of what closure prescriptions aim to achieve (ICMM, 2019). The most beneficial objectives are those which allow a closure working group to make the most useful decisions and measure completion criteria to determine if the objective has been achieved. Objectives can be site wide or for individual mine closure domains.

Objectives setting is typically an initial stage of structured decision analysis that provides much of the detail for the decision context. Objectives that utilize the specific, measurable, attainable, relevant and time-bound (SMART) approach helps focus attention and action (e.g., surface water runoff from the waste rock landform meets freshwater water quality completion criteria at location B by the year 2030). The SMART model for selecting objectives needs to have corresponding completion criteria to monitor and evaluate performance against. Once a list of objectives has been developed, an objectives hierarchy is a useful approach to identify either foundation or supporting objectives for a range of technical and non-technical closure principles (e.g., physical stability, chemical stability, end lands use, social transition).

Objectives that are developed with a range of closure stakeholders creates a sense of shared responsibility. End land use planning and risk assessment workshops facilitated with closure stakeholders can be useful platforms to uncover key concerns and opportunities that can then be converted into objective statements. Revising closure objectives during the LOM is important to ensure these remain current with changing standards and expectations from communities of interest. A clear mechanism for relinquishment helps formalize this process.

A structured decision analysis using a multiple account analysis (MAA) is a useful approach to identify, select and document a preferred closure option(s) based on a combination of technical merit, risk management and cost. While simple cost-benefit or value-ease matrix assessment can be useful tools, the MAA approach better incorporates a variety of supporting and conflicting objectives, assessment of costs and risk. Figure 1 summarizes a typical workflow that can be adopted in closure planning and decision making for identifying a closure concept and assessing reclamation prescriptions (e.g., alternatives for water management infrastructure or cover design, etc). Each step represents a consensus point that the decision team need to establish prior to deciding on a preferred option.

A key part of this MAA process relies on the options characterization to be at a reasonable level of design accuracy supported by an established knowledge base, so greater confidence can be given when selecting a closure option. For this reason, we recommend a shift closure planning mentality from “conceptual” LOM closure planning during permitting to “pre-feasibility” design. As the LOM progresses, closure alternatives and risks/opportunities can be optimized and a more-informed discussion on post-closure risk can be made with closure stakeholders.

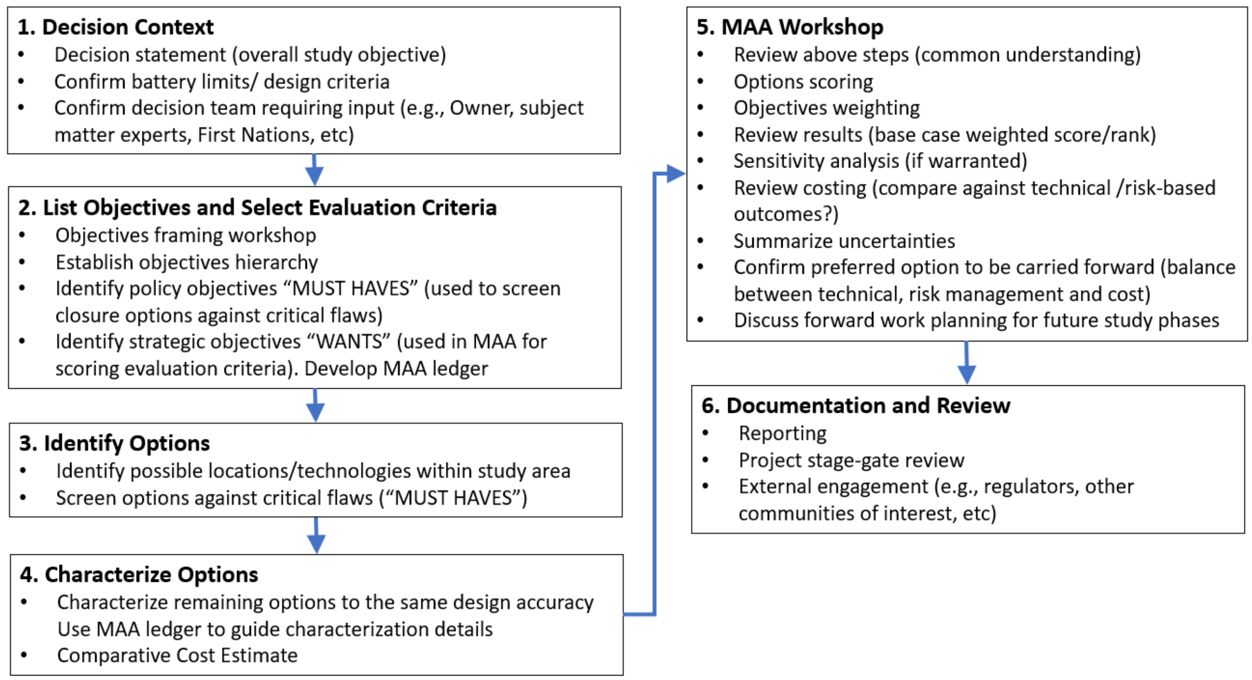

Figure 1 Typical Structured Decision Analysis Approach

Risk Assessment

Having a comprehensive knowledge of the triggering events and credible failure modes that may impact achieving mine relinquishment is crucial. Performance evaluation and completion criteria can then be properly aligned to determine whether proposed closure objectives can be achieved. Physical stability (i.e., geotechnical stability, hydrotechnical/water management, landform erosion aspects) and chemical stability (i.e., surface and groundwater quality/quantity, fugitive dust, land contamination, etc.) aspects are crucial. Meaningful engagement with stakeholders around a post-mining end land use may not be feasible unless this can be demonstrated.

Identifying and managing credible failure modes for tailings and mine waste relative to mine closure residual risk is described in Sanders et al. (2019). The authors summarize the following opportunities to imbed risk management practices into closure planning, including:

- identifying and designing a mine component. Risk assessment elements can be incorporated into decision-making evaluation criteria as part of a formal multiple account analysis (MAA) decision support approach;
- preparing a new closure plan. Risk assessments can provide a platform for engaging on objectives setting, end land use planning, establishing reclamation prescriptions/treatment measures, and setting measurable completion criteria to meet closure objectives;
- updating an existing closure plan. Typically required as part of permit conditions this presents an opportunity to engage with a wide range of closure stakeholders; and

- long-term integrated LOM planning. A dam safety risk assessment assessing a current operations risk scenario can inform where the risk profile needs to shift to meet identified land use targets and objectives (e.g., design to eliminate or reduce the potential for stored water within a tailings facility impoundment).

If completed early as part of FEL engineering practices, the risk management process can be a useful vehicle for change and supporting cost-benefit trade-offs for managing LOM changes (e.g., tailings construction method and technologies, footprint changes, mill process changes, etc.). Conducting a risk assessment focuses attention and resources on risks/opportunities that should be prioritized (i.e., non-urgent/important tasks) and reduces silos of communication and planning between mine departments.

RELINQUISHMENT SUCCESS STORIES?

There are 160 temporarily or permanently closed mines in BC; however, these facilities are under various states of active or passive care (BC Auditor General 2016). The authors are unaware of any BC sites to date that have been relinquished through the existing regulatory process. Table 2 provides a brief summary of a selection of international sites that have achieved various states of relinquishment.

Table 2 International Mine Relinquishment Case Studies

Site, Location	Summary
Gateway Hill, Alberta Canada	Within Alberta, Syncrude was the first oil and gas company to receive Alberta government certification for reclaimed land, in 2008. Gateway Hill, a former overburden storage area (S4 Dump), was reclaimed in the 1980s, but it took over 25 years to receive certification (Alberta Environment, 2008). To date, this is the only certified mine land in the oil sands region.
Cannon Mine Tailings Impoundment in Wenatchee, Washington	The Cannon Mine Tailings Impoundment in Wenatchee, Washington was reclaimed and reportedly won the Washington Department of Natural Resources "Recognition for Reclamation Award" in 2003 (Caldwell et al., 2009). The 14 ha tailings impoundment at the gold mine, opened in the early 1980s, included a 140-meter-high embankment with a 335-meter-long crest holding back four to five million tonnes of tailings. By 2004, the mine impoundment was closed and reclaimed. In 2001, county and state-held bonds were released (Caldwell et al., 2009).
Martha Mine and Golden Cross Mine, New Zealand	Implemented examples from New Zealand are the Martha Mine and Golden Cross Mine. For these sites, a risk assessment supports the development of the closure plan and initial fund and potential contingency amounts that reflect both planned and unplanned risk scenarios (Bowben et al., 2001). Mine closure funds are managed in a trust and interest earned and accumulated to continue to manage long-term risks.
Timbarra, NSW Australia	The mine attracted significant opposition from anti-mining groups from its inception in 1998 due to its location within an area of high biodiversity value. Barrick Gold acquired the mine in 2006 and continued the rehabilitation and closure program that included close engagement with anti-mining groups. The lease was successfully relinquished in 2013 after Barrick was able to demonstrates that the site had satisfied the quantifiable completion criteria. (NSW, 2013). This case study provides a great lesson in the value of a collective knowledge base and engagement with a range of closure stakeholders to develop end land use objectives and completion criteria.
Bowen Basin Coal Mine examples, Qld, Australia	Kestrel Coal, a Rio Tinto subsidiary achieved the first sign-off under the progressive rehabilitation provisions in 2014. The sign-off includes 570 Ha of land over previously mined long-wall panels (Australian Government, 2016). In 2017, the Glencore Coal Newlands complex was the first to achieve rehabilitation certification for approximately 74 Ha of overburden spoil (Glencore Coal, 2019).

CONCLUSIONS

Key conclusions from this paper include:

- Within BC, there appears to be some way to go on the path from progressive reclamation towards mine relinquishment. In this paper, we have identified some of the key challenges on the pathway from progressive reclamation towards potential mine relinquishment. There are opportunities to help facilitate a discussion on residual risk with closure stakeholders, regardless of a regulatory mechanism in place.
- There are benefits to mine owners, regulators and closure stakeholders in establishing a mine relinquishment mechanism. A lack of regulatory mechanism adds to the challenges remaining for the industry moving from progressive reclamation to relinquishment. All closure stakeholders must work together to improve the legacy of the mining industry for future generations.
- Tailings facilities remain a key legacy issue that requires robust and resilient design prior to construction. Owners will likely be responsible for long-term management of residual risk for tailings and water management facilities. We have presented in this paper potential dam safety criteria to support declassifying a tailings facility/dam to a mine landform. Criteria should be refined to be quantitative, site-specific and form early design decision making.
- The definition of a landform carries numerous interpretations which present challenges in establishing closure objectives and completion criteria. Regardless of the exact definition, when considering post-mining landform design, implementing FEL practices assists in reducing closure residual risk during the LOM and fosters engagement with closure stakeholders.
- A cultural shift is recommended away from "conceptual" to "pre-feasibility" design accuracy for LOM closure planning during permitting to improve capturing these FEL practices early on. As the LOM progresses, closure alternatives and risks/opportunities can optimize and a more-informed discussion on post-closure risk can be made with closure stakeholders.

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