Mine Closure and Reclamation in Mexico: Unearthing Hidden Savings with Continuous Planning and Innovative Strategies

Much international guidance has been written on mine closure. The interest in the topic has been recently trending upwards in Mexico and Latin America as evident by the number of workshops and participants attending. In this article we summarize some of the key facts and present some new insights on anticipating future disruptions and optimizing the mine for successful closure/reclamation with innovative strategies. These concepts have the potential to materialize into significant savings for the operation and at the same time maximize the beneficial post closure land uses available for the adjacent communities.

All mines have a finite lifespan and the mining industry is therefore a temporary user of the land. In a perfect world closure will follow a defined mine schedule and timeline. More realistically though it has occurred more suddenly than expected and is usually driven by external factors such as low commodity prices, technical catastrophes, political consequences, social unrest, etc.; factors that are found outside of the operations direct control.

The industry has historically underestimated the challenges it will face during mine closure and as a result of lessons learnt, current best practices dictate that all mines should be 'designed for closure' from the onset- with adequate financial assurances in place to cover the existing liabilities present.

Regrettably this concept has still not found a firm international footing with all companies in all countries and we routinely see short-term cost savings (such as improper material characterizations) winning out against potentially unexpected negative and costly long-term closure issues (such as improper material segregation and placement).

Optimizing cost reductions for mining operations begins with a clear understanding of the risks and liabilities involved

In its most general terms, risk management entails the thorough identification, assessment and mitigation of hazards. Operating mines face a variety of technical and complex problems when faced with closure, many of which do not occur exclusively of one another. These complexities are only magnified by the long-term implications of closure, the correspondingly challenging design lives involved and the interrelated and oftentimes unforeseen interactions of the different components that come into play.

Comprehending the severity from the likelihood and consequence of the hazards present is needed to navigate the scale and complexities of mine closure. Misjudging the risk and underestimating the costs and liabilities involved would present problems at the worst time for the operation when revenues are declining, and capital is most constrained. A holistic approach to quantifying risk in this regard begins with a qualitative analysis based on a review of data gaps, probabilities, and potential costs (liabilities).

With this initial understanding quantified, assessment and mitigation strategies follow and will be the starting point for the innovative planning required to decrease the associated obligations. By executing on the closure plan and performing the proper studies at the optimal time, collectively exhaustive solutions can be implemented to solve the endemic closure challenges facing many operations today.

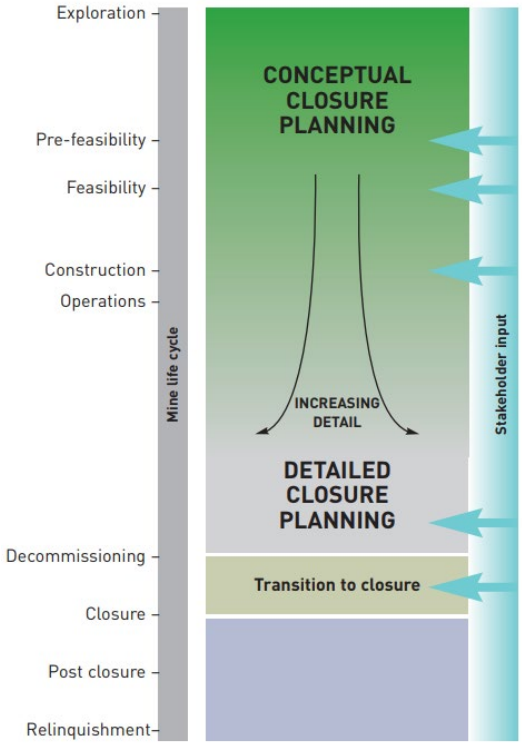
Forward-looking operations that have invested in closure plans will realize the largest cost savings with integrated approaches and solutions to mine closure

A mine closure plan is a living document (flexible and updateable) that describes the plan for the site after closure, the activities that need to be undertaken to decommission, close and rehabilitate the site as well as the cost of the activities described. Although the problems to be faced in mine closure are complicated because of the range of variables involved and the variability of the natural forces to be encountered; the situation needs to be considered in all of its complexity as the true legacy of the organization will be embodied by the final landforms and the environmental conditions that were left behind for the communities.

A properly developed closure plan provides the clear and structured vision that the organization needs to manage the sites long term liabilities. It will become the roadmap for how the operation will navigate the scale and complexities of the mine closure process on its road to realizing the post-closure objectives.

The document provides the strategy for the mines daily operations to be able to integrate the closure goals into their planning, engineering and environmental processes.

The directionally correct approach for closure planning advocated by Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) in there Guía para Conocer los Principales Trámites y Permisos Ambientales en las Diferentes Etapas del Proceso Minero follows the internationally recognized framework introduced by the International Council on Mining and Metals (ICMM) Planning for Integrated Mine Closure Toolkit and is reproduced below:



As shown, the conceptual closure planning process begins as early as possible in the mine life and requires continual engagement with stakeholders. In its conceptual stage, the closure plan is initially focused on the outcomes and goals for the site and starts with an objective function of what the restored site will look like after closure and whom the land will serve-its post closure land use.

It is important to understand that in this early and abstract phase, the conceptual closure plan should be conservative and will inherently contain numerous assumptions and generalized strategies for realizing the closure outcomes.

The value from the initial document is realized in that the early planning maximizes the benefits from identifying facilities in terms of their risk as it allows for the prioritization for ongoing research and remediation of the highest-hazard areas in-order to take advantage of all available opportunities for mitigation and to do so in the most expeditious manner possible. It provides critical baseline information to the environmental and planning departments and plays a key role when taking into consideration the technical aspects of mine closure as it integrates this post-closure vision together with the applicable regulations and permitting requirements.

The conceptual closure plan should evolve together with the mines life cycle and should be updated at key milestones to reflect changes in the operation and document new risks as well as opportunities that come to light. As the mine life continues to progress, new studies are performed, environmental monitoring results are documented, and this increasing level of detail is incorporated into the closure planning documents.

Realizing closure goals will ultimately require a progressive reduction of risks and unknowns that has been based on sound engineering, science and results. With the closure vision outlined and monitoring plans in place, the closure plan begins to define its assumptions and progressively becomes more technically sound as flawed assumptions are replaced with defensible, fact-based insights.

A detailed closure plan that is well defined is technically defensible and is focused on the granularity of what is involved in the methods to prove and validate that the final goals will be realized; together with the milestones required on the journey to do so. At this level of thorough planning, the document should also include the cost estimates required for implementing the closure and reclamation strategy. As these costs will typically be used for financial assurance, it is important that they are accurately estimated.

As closure approaches, the emphasis on the approach has been comprehensively transformed into gaining and analyzing as much information as possible about the site and its interaction with its natural setting.

Outlining closure goals should reflect the values of the company along with the needs of the public in the communities served

In today's socially and environmentally conscious culture, post-closure land use goals are in a state of disruption and are constantly evolving beyond simply returning the site to its pre-mining land use as the community stakeholders are increasingly holding the resource industries to higher standards.

Although returning the site to its pre-mining land use is still an admirable goal; more and more, renewable energy installations and tourism friendly recreational areas (public parks) are being investigated for their technical feasibilities as most of the infrastructure is already in place and can be re-purposed with minimal effort. With these new approaches, additional value is created for the organization and positive long-term impacts can be left for the communities who will now have new drivers for economic growth and possibly new sources of employment.

Another innovative approach being increasingly examined is exploring the economic feasibility of re-processing the mine waste to extract additional minerals from the legacy facilities. In many instances, especially with older operations, it is possible to realize an obvious economic benefit to the organization while at the same time placing the new residues into modern and engineered facilities compliant with current environmental regulations. Shared value is created as the communities receive continual employment and environmental benefits and the companies enjoy turning the liabilities on their balance sheets into cash generating assets.

The long-term physical and chemical stability of the installations will lay the groundwork for any post closure land use goals and the importance of proper characterizations should not be underestimated. Encompassed in these principles are also included items such as consolidation, infiltration, erosion and degradation whose properties and performance has the potential to erode and change over time.

Proper characterizations of short and long-term material properties will be at the heart of the cost savings to be realized during closure

Closure planning provides the opportunities for the greatest amount of flexibility when considering the tradeoffs involved with items such as the ultimate design of the landforms, the final placement of mine wastes, the materials used during the construction and rehabilitation, etc.

The comprehensive characterization of soils, overburden, rock types and other wastes will provide the basis for the rigorous segregation and selective placement of materials that is needed to extract the maximum benefits from the closure planning process.

Once each component of the waste stream has been properly characterized, it can be inventoried to determine where it will serve an optimal benefit during closure. Every component needs to be examined and separated based on the merits it may provide when combined with a different waste stream- such as for example when a waste rock can be used to armor a tailings slope or serve as an individual component of the engineered cover system.

Not only can site disturbances be condensed, but if the rock armor and cover materials are identified and placed near their final resting locations, haulage can be reduced, double handling can be avoided, and numerous other economic benefits can be realized.

For operating mines without proper closure driven studies and characterizations in place, strategies to de-risk the operation usually involve drilling and sampling campaigns. If properly implemented and bundled, significant cost savings can be realized by integrating the geotechnical, geochemical, and geological (re-processing) programs. Additionally, we have seen the additional benefits of concurrently installing long-term monitoring instrumentation at the same stage. A host of automation ready monitoring equipment exists with possibilities for integration to telemetry systems to remotely monitor the sites.

The gain in efficiency for the operation are obvious but early characterization and proper planning are the key drivers to its successful implementation.

Progressive implementation of the closure strategy during the mine life can provide for optimized capital expenditures

When reclamation measures are progressively implemented and backed by the appropriate studies to prove their effectiveness, leading practice mining operations can realize numerous benefits during the operational phase, including reductions in the present-day closure liabilities as well as unexpected cost saving by optimizing the closure strategy.

Operating mines should examine whether they have an opportunity to progressively implement their closure strategy through a cautious approach to concurrent reclamation. If an area of the mine or on one of the installation is no longer in use, the operation can first conduct what would essentially amount to a field trial to test the performance of the potential closure solution. Site-specific responses to and

the effectiveness testing of the cover systems, the erosion protection and the vegetative growth capabilities to be implemented in the closure phase can be measured.

These field trials serve as an innovative proving ground for the closure strategies before their full-scale implementation and allows for ongoing monitoring, assessment and effectiveness feedback. This opportunity allows for creative thinking as the small areas involved can be tested for success or failure with low cost and quick results. Iterations with changes to some of the variables can then be rapidly and cheaply re-conducted on the various facilities to ensure success before scaling the proven solutions across the mine.

This research with the implementation of the closure strategy that is afforded by the field trials are evolutionary approaches to cautiously implement the traditional concurrent reclamation approach as it allows for companies to test ideas, explore various alternatives and perspectives before committing the full resources involved.

Verifiable results from the site-specific responses to the implemented closure strategy (such as erosion reduction and sustainable vegetation cover) have traditionally taken several years to establish as is seen by the long monitoring periods involved post-closure. Operating mines can take full advantage of this time lag if they begin testing closure strategies early. The same financial benefits afforded by using its own personnel and equipment instead of third party contractors are still available and will be significant.

Having a firsthand knowledge from the outcomes of the closure solutions will assist the implementation team with the ability to carefully manage stakeholders and nearby communities as the results will remove some of the associated uncertainty with the results and allow for more focused feedback during the ongoing discussions.

Transparency with stakeholders during the closure planning process recognizes the socioeconomic role that the mining operation shares with the surrounding community

The goals of corporate social responsibility continue to gain traction and we increasingly find internal corporate mine closure policies that fill the void of lax regulations. These leading companies with their strong corporate standards are cognizant of the important role that properly closing existing operations will play with their shareholders as well as with their ability to obtain the necessary requirements to operate new projects.

Operations and communities are coming together to see the shared value that can be created with properly closed sites and self-sustaining reclamation targets that support future development and biodiversity goals.

The business case for the minimal investment required in proper closure planning continues to be strong. It is supported throughout the implementation process with targets to monitor its performance in progressively reducing the risks, unknowns and the associated liabilities. Through a best practices approach to the closure planning process- companies demonstrate to their stockholders, lending

institutions, the public and all other stakeholders that their operations are in control of their financial, environmental and social responsibilities.

The challenges to be encountered during mine closure will surely be significant; however, they can be surmounted through the cautious planning and implementation framework presented herein.

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