A framework for standardised, performance-based completion criteria for mine closure and mine site relinquishment

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Abstract

Many significant advancements have been made in the mine closure process over the past several decades, including “design for closure,” the development of comprehensive mine closure planning and the regulatory requirement for financial assurances for mine site rehabilitation. However, mine closure remains a significant challenge for all major mining jurisdictions around the world. This is largely due to the amorphous nature of the process, inconsistencies in regulations across jurisdictions and inadequate management approaches. To address these challenges in mine closure, the Canada Mining Innovation Council’s Environmental Stewardship Initiative has prioritized the development of standardised, performance-based completion criteria for mine closure and the subsequent relinquishment. The criteria will allow a clear and consistent path to mine closure by defining the conditions acceptable to stakeholders, which, if met, will enable the government and regulatory agencies to accept mine sites into their custody for long-term stewardship. The criteria will serve as a key strategic planning and risk management tool for industry, regulatory agencies and mining stakeholders at large. Mining stakeholders will have certainty regarding how a site will be rehabilitated, decommissioned and closed, and it is anticipated that the criteria will drive closure management from mine design to the ultimate closure of operations.

This paper provides an overview of the initiative by outlining the challenges in mine closure that the project aims to solve. The standardised closure criteria concept is defined, with examples of criteria that will likely be included in the framework. An overview of how industry and regulatory agencies will use the criteria is provided. The benefits that will likely accrue to mining stakeholders are summarised. The main benefits for industry include improved efficiency and consistency in the mine closure process as well as the promotion of a more stable and competitive investment climate. For governments and regulatory agencies, the mine closure process will become more managed and structured, thus enabling a more simplified and efficient regulatory regime. Furthermore, with a managed relinquishment process, the accrual of improperly closed (i.e. abandoned and orphaned sites) will be reduced. This will also provide a key public benefit, as public funds will not be required for associated clean-up costs. Lastly, local stakeholders will be assured that environmental performance will be central to the mine closure process with a view toward establishing positive post-mining legacies.

1 Background

The Canada Mining Innovation Council (CMIC) is a multi-stakeholder, open-innovation business ecosystem. This approach brings together the key mining stakeholders to define the major research, development and innovation challenges facing the mining business. The process is conducted in an open way, such that ideas, technology, risk and innovation are leveraged and shared among the participating groups with a focus on producing real solutions to current challenges.

In the fourth quarter of 2012, CMIC formed the Environmental Stewardship Initiative (ESI) with a mandate to develop — through step-change technological innovation, project development and multi-stakeholder collaboration — solutions to some of the myriad environmental and sustainability challenges facing the Canadian mining industry.
A wide range of activities encompass the spectrum of environmental management related to mining; thus, in 2012, the ESI commissioned the engineering consultancy Hatch Ltd. to undertake a scoping study outlining areas where further research, development and innovation could be focussed. Several multi-stakeholder surveys were also conducted to ascertain stakeholder priorities and needs in terms of research, development and innovation. Based on the results of these activities, the ESI formed three working groups to prioritise and develop specific projects: the closure working group (CWG), the tailings working group (TWG) and the water working group (WWG).

Following a series of workshops and monthly meetings, the ESI prioritised the following projects for project development activities:

- Standardised, performance-based completion criteria for mine closure and mine site relinquishment;
- Passive systems for managing acid rock drainage (ARD) from waste rock piles;
- National database for water quality monitoring data;
- Remote, real-time sensors for water quality monitoring.

Figure 1 provides an overview/timeline of the project development activities undertaken for the projects. This paper provides an overview of the first project: standardised, performance-based completion criteria for mine closure and mine site relinquishment.

2 Problem definition

2.2 The current state of mine closure

As Clark and Clark (2005) note, prior to the 1960s, most mining jurisdictions gave relatively scant consideration to the post-operations phase of mining activities, including site decommissioning, landscape reclamation and ecosystem rehabilitation, or what is now termed “mine closure.” Limited mine closure activities took place, and mine sites were often abandoned with myriad negative consequences for the surrounding environment. Over the past decades, 10,000+ mine sites in Canada alone have been abandoned and/or orphaned, resulting in associated clean-up costs — since 2002 — of more than C$1 million (Tremblay and Hogan, 2014).

However, with the increasing awareness of the environmental risks associated with inadequate mine closure, along with the advent of “sustainable mining,” mining stakeholders are increasingly expecting a positive environmental and social legacy from mining operations. Thus, mine closure has become a central component of mining projects from the business, regulatory and stakeholder engagement perspectives. Specifically, in most major mining jurisdictions, mine closure plans are now required before mining commences and are updated at regular intervals throughout the life of mine cycle. In turn, mining companies...
now plan for closure at the outset of mine development, typically through what is known as ‘design for closure’ (Caldwell and McPhail, 2012). Financial assurances for closure activities are typically required to help ensure that adequate funds are available for the closure costs. Companies are also expected to actively engage stakeholders throughout the process to help ensure that community needs are met and positive environmental and social legacies are maintained.

Despite these important advancements, comprehensive mine closure remains a challenge for virtually every mining jurisdiction in the world, as it is an amorphous concept with no defined end in many instances. Closure completion criteria are often ambiguous, ill defined and/or inconsistent across jurisdictions, resulting in uncertainty in approaches to mine closure for mine operators, unclear standards for regulatory agencies and confused expectations among mine communities and stakeholders at large. Furthermore, the lack of a defined end often leads to the management of sites in perpetuity; should a company dissolve, the responsibility of managing site rehabilitation and closure activities reverts to the government.

To address these challenges in mine closure and site relinquishment, the ESI is implementing a national program to develop a framework for standardised, performance-based completion criteria for mine closure and site relinquishment. These criteria aim to provide a clear path to mine closure and the subsequent relinquishment by defining the conditions acceptable to mining stakeholders, which, if met, will enable the governments to accept sites into their custody for long-term stewardship.

2.2 Relinquishment in advanced mining jurisdictions

Many advanced mining jurisdictions have formal legal stipulations that allow the relinquishment of mine sites to a “responsible authority,” defined as “any government body empowered to approve activities associated with the mine closure process” (Australian and New Zealand Minerals Council and Minerals Council of Australia, 2000). In Canada, the relevant responsible authority is typically the provincial government, or, in the case of the territories and uranium sites, the provincial or territorial government in conjunction with the federal government. In Canada, some of the major mining jurisdictions (i.e. British Columbia, Ontario, Quebec and Saskatchewan) allow for relinquishment in mining legislation and/or regulations. For example, Section 149 (1) of the Ontario Mining Act states:

*The Minister may accept a surrender of mining lands [i.e. relinquishment] from a proponent on the conditions specified by the Minister if,

a) the project relating to the mining lands is closed out; or,

b) the project relating to the mining lands is not closed out only because it is subject to long-term monitoring and maintenance by the proponent.*

An example outside of Canada is Western Australia, where relinquishment of a mine site requires:

*formal acceptance from the relevant regulatory agencies that all obligations under the Mine Closure Plan associated with the tenement, including achievement of the closure completion criteria have been met, and that arrangements for future management and maintenance of the tenement have been agreed to by the subsequent owners or land managers.* (Government of Western Australia Department of Mines and Petroleum, 2014)

Despite some *de jure* stipulations across jurisdictions, few mine sites have been successfully relinquished to the respective responsible authorities. For example, in Ontario, no mine site has been relinquished under the current regulatory regime. In Australia, only three mine sites were found to have been successfully relinquished to a responsible authority.

The aforementioned pre-feasibility study (see Figure 1) conducted by the ESI determined that a key gap precluding more widespread relinquishment is the lack of comprehensive legal and regulatory regimes. In the example of the Ontario Mining Act mentioned above, there are no formal stipulations as to what comprises “the conditions specified by the Minister.”
An exception to this is found in Saskatchewan, which has developed the Institutional Control Program (ICP). In 2007, the Saskatchewan government enacted the *Reclaimed Industrial Sites Act* and the *Reclaimed Industrial Sites Regulations* to enforce the ICP. Under the program, a closed site enters a period of “transition phase monitoring,” during which the mine operators are required to continue monitoring the site at their own expense. If the site performs in accordance with the decommissioning and reclamation plan and achieves the predicted stability (i.e. chemical, biological and physical stability) during the transition phase, the mine operator may make an application for release from decommissioning and reclamation. Upon approval of the release, the mine operator may apply for a release from its surface lease, which allows the transfer of custodial responsibility for the property to the provincial government (Saskatchewan Ministry of Energy and Resources, 2009).

Since the program was initiated, six sites have been transferred into provincial custody, including five uranium sites and one gold mine. Between 2012 and 2017, the MoER anticipates that two more sites will make applications for acceptance into the ICP.

The province of Alberta has established a comprehensive legal and regulatory framework for the relinquishment of oil sands sites. According to the Alberta *Environmental Protection and Enhancement Act* (EPEA), oil sands operators are required to work towards achieving reclamation certification for disturbed sites. Once certification is granted, the operator is relieved of further reclamation responsibilities and the site enters provincial custody for long-term stewardship.

As of 2014, one site has been returned to the Alberta provincial government: an overburden dump at Syncrude’s Gateway Hill project. One of the challenges for operators and the regulatory agencies in having more sites enter into provincial custody is the lack of streamlined criteria for determining whether reclamation objectives have been met and what the regulatory agencies deem acceptable (Charette and Poscente, 2012). This results in uncertainty for operators regarding how the regulatory agencies will evaluate an application. Similarly, regulatory agencies experience difficulty applying reclamation criteria in a fair and consistent manner (Charette and Poscente, 2012).

Consequently, oil sands stakeholders deemed the need to develop clear and consistent criteria for site reclamation and release a priority through the Cumulative Environment Management Association (CEMA) — a multi-stakeholder group comprising Aboriginal groups, environmental non-governmental organisations (ENGOs) and industry that serves as a key advisor to the provincial and federal governments on environmental issues related to the oil sands. In 2010, a three-year process was undertaken to establish the criteria through an extensive, iterative stakeholder consultation process. In late 2014, the Alberta Government preliminarily accepted the criteria framework subject to further review, development and field demonstration/assessment (Alberta Environment and Sustainable Resource Development, 2014).

### 3 Project overview

#### 3.1 Criteria definition

The standardised criteria will be structured as a suite of conditions operators will be required to meet when closing a mine site in order for the site to be acceptable and ready for the ensuing transfer to a responsible authority. Crucially, this includes a set of environmental performance endpoints that must be achieved — or be on course to being achieved — to ensure that the overarching objectives of mine closure are met, including minimising public health and safety risks, minimising ongoing negative environmental impacts, and achieving an acceptable, productive and sustainable post-mining land use.

The performance-based completion criteria will be standardised and will be able to be applied broadly across mine sites and jurisdictions using a similar approach as that used by Alberta for the oil sands sites. The criteria will be structured using a framework approach, enabling flexibility for — and adaptability to — local, site-specific conditions. The provincial and territorial governments will be able to adapt and tailor the framework to align with their legislation and regulations, as well as the needs and priorities of local stakeholders.
Furthermore, the criteria will be designed with the aim of ensuring continual improvement so as to align the criteria with new technologies, regulations and management practices.

It is important to note that the criteria will not serve as a one-off checklist of site conditions for mine closure completion and relinquishment approval. Rather, the criteria will serve as a key planning and risk management tool that will be used throughout the life of mine cycle, from mine conception design through to operations and final closure. Thus, the criteria will serve as the basis for a comprehensive, managed and structured process for mine closure planning, implementation and assessment. The mine closure process will become more streamlined, efficient and consistent, thus improving environmental management, and, ultimately, environmental outcomes, while providing investors with a clear understanding of the closure and rehabilitation needs for site release.

The criteria will serve as a key catalyst/driver for the overall improvement of the mine closure process. Specifically, with the development of the acceptable conditions for relinquishment, governments and regulatory agencies will be able to devise regulations that enable the process to occur clearly and smoothly, as has been done in Saskatchewan with the ICP. Similarly, the criteria will help to drive the development of new technologies that will aid in achieving the defined endpoint conditions. For example, some performance conditions that would be acceptable for stakeholders may not be currently achievable because of technological limitations and/or the associated costs. Notwithstanding this, the criteria conditions will serve as the goal that operators, service providers and researchers will need to work towards meeting through technology development, adaptation of current methods/techniques and/or new management approaches.

3.1 Criteria examples

The criteria will cover the major components of mine closure, including site/facility decommissioning, land reclamation and ecosystem rehabilitation (among others). Where possible, the criteria will be quantifiable. Some criteria and associated indicators may be achieved by meeting a milestone (e.g. geotechnical design). Others may take several years to fully achieve; accordingly, some criteria may have an element based on time (e.g. the criterion is being on trend to being achieved). Therefore, mechanisms to mitigate residual risk will be incorporated into the framework.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Examples of completion criteria classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Criteria example</td>
</tr>
<tr>
<td>Physical stability</td>
<td>Pit slopes; mine workings; underground openings; tailings impoundments; waste rock piles; dams, dykes, and other containment structures</td>
</tr>
<tr>
<td>Geochemical stability</td>
<td>Water quality; water quantity; seepage from waste rock piles; seepage from tailings storage facilities; ARD; metal leaching (ML)</td>
</tr>
<tr>
<td>Land reclamation</td>
<td>Landscape integration with surrounding landforms/topography; post-mining land use; land capability</td>
</tr>
<tr>
<td>Ecosystem rehabilitation</td>
<td>Biodiversity; wildlife habitat</td>
</tr>
<tr>
<td>Site infrastructure and waste</td>
<td>Building demolition; asset transfers; hazardous waste disposal</td>
</tr>
<tr>
<td>Financial assurance</td>
<td>Monitoring and maintenance funds; unforeseen events funds; ongoing liabilities</td>
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</tbody>
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Table 1 outlines some examples of completion general criteria classes that may be included in the framework, which will be further refined by the stakeholder consultation process. Table 2 provides a few specific examples of completion criteria that could be included in the framework.

Table 2  Examples of potential completion criteria

<table>
<thead>
<tr>
<th>Criteria class</th>
<th>Potential examples</th>
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</thead>
<tbody>
<tr>
<td>Physical stability</td>
<td>• Dams, dykes, and containment structures designed to meet a minimum 1:100 year standard &lt;br&gt;• Pits are closed such that stability and erosion standards are met &lt;br&gt;• Tailings impoundment structures meet design standards and include detailed declarations of quantitative performance objectives &lt;br&gt;• Non-critical structures are designed to meet 1:100 year flood event; critical structures are designed to meet 1:1000 year flood event &lt;br&gt;• Mine rock piles have the required structural stability &lt;br&gt;• Mine openings are sealed to prevent access &lt;br&gt;• Underground workings are backfilled to blend in with surrounding topography</td>
</tr>
<tr>
<td>Geochemical stability</td>
<td>• Receiving water bodies meet water quality objectives (e.g. regulatory, reference points, natural variation) &lt;br&gt;• Site does not require any active water treatment &lt;br&gt;• Site poses no further risk of ARD or ML &lt;br&gt;• Soil pH, salinity, nutrients, depth, water infiltration, crusting and slope meet prescribed limits from reference sites or regional studies (e.g. pH in range 5.0–8.5; salinity &lt; 0.2% chloride; EC (1:5 H2O) &lt; Y dS/m-1)</td>
</tr>
<tr>
<td>Land reclamation</td>
<td>• Land is reclaimed to allow for agreed upon post-mining land use &lt;br&gt;• Landscape is integrated with surrounding landforms and topography</td>
</tr>
<tr>
<td>Ecosystem rehabilitation</td>
<td>• Reaching agreed species or ecosystem diversity targets, such as areas have to have at least X of particular species per m² &lt;br&gt;• Species richness is greater than or equal to Y% of the mean value recorded in all 20 m by 20 m reference plots in analogue sites in the target ecosystem</td>
</tr>
<tr>
<td>Site infrastructure and waste</td>
<td>• All hazardous waste is disposed of safely &lt;br&gt;• All site infrastructure is dismantled or transferred to an appropriate third party</td>
</tr>
<tr>
<td>Financial assurance</td>
<td>• Monitoring and maintenance funds are posted &lt;br&gt;• Unforeseen events funds are posted</td>
</tr>
</tbody>
</table>
3.2 Stakeholder benefits

3.2.1 Governments and regulatory agencies

The criteria framework will serve as a key strategic planning and risk management tool for regulatory agencies and governments. With the development of the criteria, the mine closure process will become more structured, managed and streamlined in contrast to some of the current and past mine closure practices, where mines are/were sometimes closed in an inconsistent and haphazard manner. As mentioned, over the past decades, 10,000+ abandoned and/or orphaned mine sites with associated clean-up costs in excess of C$1 billion have accrued to the Crown, and, ultimately, the public. The criteria approach will help to prevent this in future, as the return of mine sites to the Crown will be done on managed terms and with far greater environmental protection, thereby reducing the burden of long-term stewardship on the regulatory agencies and governments.

The criteria will also help to promote consistency and efficiency in the approvals and permitting process. The application of fair and consistent assessment standards will be promoted, as the regulators will be provided with a tool for objectively determining the acceptability and readiness of a site for transfer into provincial custody. In turn, this will help to create a more stable and competitive investment climate for current and future mining developments, which will likely help to attract additional mining investment and general public economic benefits over time. The general public will further benefit, as taxpayer funds will not be required for the associated clean-up costs of abandoned/orphaned mines.

Lastly, as outlined above, one of the major gaps in relation to the long-term stewardship of closed mine sites is the lack of comprehensive regulatory, policy and legislative frameworks for site relinquishment. With the development of the criteria, governments and regulators will be provided with an understanding of stakeholder expectations and requirements for achieving relinquishment. This will enable the criteria to drive the development of the appropriate regulations, policies and legislation toward this end. Given that few jurisdictions around the world have such programs in place, Canada will also further its position as a leader in terms of sustainability and competitiveness in the mining business.

3.2.2 Industry

As with the regulatory agencies/governments, the criteria framework will serve as a key strategic planning and risk management tool for operators throughout the life of mine cycle. With established completion criteria/performance endpoints for relinquishment, mine operators will be able to proceed with mine closure with greater certainty, and, therefore, less risk. The overall mine closure process will also become more efficient. Taken together, these benefits will result in a more stable and attractive investment climate for current mine operators as well as future mine proponents.

The criteria will be used for initial planning as part of the design for closure process. The initial planning and design process will be strengthened, as operating sites and new mining projects will be able to use the criteria to design for relinquishment (Cowan et al., 2010). Progressive rehabilitation will also be strengthened, as there will be an increased incentive for operators to close sites in line with the completion criteria. Specifically, once the performance conditions are met, operators will be released from all further monitoring and maintenance requirements. This will help to decrease mine closure obligations over time, thus providing a financial incentive for implementing and progressively achieving the completion criteria. To be sure, operators will not be fully released from the liabilities associated with the site; in line with the “polluter pays” principle, operators will still be liable for any deleterious environmental impacts (e.g. contamination).

Efficiency will be increased still further as mine proponents use the framework as the foundation for gaining stakeholder acceptance for specific projects, thereby simplifying the permitting and consultation process. Specifically, mine operators/proponents will have fewer requirements for gaining acceptance; instead, it is anticipated that the main requirements for achieving acceptance will be tailoring the performance-based conditions outlined as part of the criteria for the site-specific conditions.
3.2.3 **Local stakeholders**

As confusion surrounding the mine closure process will be reduced, it is anticipated that local stakeholder confidence in mining will increase with the development of the criteria. Local stakeholders will have more assurance that mining activities will cease without unacceptable consequences for the local communities and the environment, which, in turn, will increase local buy-in for current and future mining development.

The criteria will provide local mining stakeholders with an increased understanding of the mine closure process as a whole. These stakeholders will know what to expect from mining operators and the regulatory agencies when mining ceases and the closure process is complete. Local stakeholders will also have more assurance that mine closure will be conducted in a managed and structured way with robust protection for the environment. Similarly, they will be assured that mines will not be abandoned, with the associated environmental and economic costs externalised to local communities and the general public.

Given that the development of the criteria will include extensive stakeholder consultation, local stakeholders will be further assured that the general needs of local mining communities (e.g. a productive, post-mining land use) are accounted for. Local stakeholders will also be able to use the criteria as a tool/framework for tailoring site-specific criteria to help further ensure that local needs and priorities are met.

4 **Project implementation**

Stakeholder consultation is a key aspect of the mine closure process. Proactive and ongoing stakeholder engagement throughout the life of mine — from initial planning to final closure — helps ensure that local needs and priorities are met, thus helping to secure and maintain a project proponent’s social license to operate. This includes the development of mine closure completion criteria aligned with the regulatory requirements and stakeholder needs.

Accordingly, an extensive stakeholder consultation program will drive the development of the criteria. The main objective of the consultation process is to enable stakeholders to arrive at a broad consensus regarding the acceptable conditions for mine closure completion and the subsequent relinquishment.

The main stakeholders to be involved in the process are as follows:

- Governments and regulatory agencies
- Industry/industry associations
- Local/Aboriginal communities and community associations
- Service providers
- Technical experts
- ENGOs
- Public interest groups
- Mining research organizations

As the criteria will be standardised across jurisdictions, the stakeholder consultation program will be national, with a focus on the major mining jurisdictions and regional groupings (i.e. British Columbia, Ontario, Quebec, Saskatchewan, the Territories and the Maritimes). As mentioned, the criteria will be structured as a framework approach, which will help to solve some of the challenges with standardisation. Jurisdictions can tailor the criteria to their specific legal requirements and site-specific needs, based on varying risk appetites and the requirements for local stakeholders. Furthermore, a key goal of the development of the criteria framework is greater streamlining of the mine closure process across jurisdictions, which will allow investors to understand their closure obligations at the onset of the project. Although these challenges may seem daunting, the resulting framework should be beneficial to all, and, as such, should be pursued and achieved.
Following an initial period of partnership development (Phase 1), it is anticipated that the consultation process will be carried out over 48 months beginning in the first quarter of 2016. The process will be broken down into the following phases:

- Phase 2: Stakeholder sensitisation (12 months)
- Phase 3: Detailed, iterative stakeholder consultations (21 months)
- Phase 4: Government acceptance (15 months)

The stakeholder-sensitisation phase will provide the primary mining stakeholders with an understanding of the purpose and benefits of establishing the standardised criteria. In turn, the project implementation team will be provided an understanding of the stakeholders’ key initial needs, concerns and priorities related to mine closure completion and the subsequent relinquishment. Parallel to these consultations, draft criteria will be developed by amalgamating, streamlining and more clearly defining some of the existing mine closure completion criteria across Canadian — and some international — mining jurisdictions. The initial stakeholder consultations will help to further inform the required inputs, which will be incorporated into a second iteration of the criteria.

Phase 3 will involve consulting with the various stakeholders on the various criteria components. As the process is designed to be iterative, several rounds of consultations will take place to ensure that the feedback from each stakeholder group is continually incorporated into the successive iterations of the draft criteria. A key component of Phase 3 will be consultation with various technical experts to determine the feasibility and practicability of the conditions acceptable to stakeholders. Consequently, expectation management will also be a key component of this phase. Phase 3 will be completed once a broad consensus has been formed on the criteria framework.

Government acceptance of the criteria will be the central focus of the final phase of the consultation process. To be sure, governments and regulatory agencies will be engaged from the beginning of the entire process, as early engagement is typically a key principle for achieving buy-in. Accordingly, this phase of the consultations will focus on determining ways of formalising the criteria into regulations and legislation. This will likely include modifying the criteria for individual provincial requirements and perhaps, as is the case in Alberta, field demonstrations and assessment.

An overview of the stakeholder consultation process is presented in Figure 2.

![Figure 2 Overview of the project stakeholder consultation process](image)

### 5 Conclusions

In conclusion, the development of the standardised closure completion criteria will help to solve many of the challenges most advanced mining jurisdictions currently face. A clear, consistent path to mine closure and the subsequent site relinquishment will be established, aiming to provide certainty and efficiency for all
Standardised, performance-based completion criteria for mine closure and mine site relinquishment

R. Holmes, M. Flynn and M.B. Thorpe

Mining stakeholders. Industry, regulatory agencies and governments will be provided a key strategic planning and risk management tool that will help ensure mine closure is conducted through a structured and managed process. Crucially, environmental performance will be the central focus of the initiative, thus contributing to the enhancement of environmental outcomes as well as helping to ensure that positive and sustainable post-mining legacies are achieved. This will help to increase local stakeholders’ confidence and buy-in for mining developments while creating a more competitive and stable investment climate. Taken together, these benefits will help to make great strides in advancing the sustainability of the mining business as a whole.

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