Asia-Pacific Economic Cooperation

MINE CLOSURE

Checklist for Governments

APEC Mining Task Force

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Natural Resources Canada
580 Booth Street
Ottawa, Canada, K1A 0E4
Website: www.nrcan.gc.ca

Golder Associates Ltd
Suite 200-2920 Virtual Way
Vancouver, Canada, V5M 0C4
Email: Bjorn_Weeks@Golder.com
Website: www.golder.com

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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ABOUT THE MINE CLOSURE CHECKLIST FOR GOVERNMENTS

ABOUT MINE CLOSURE

All mines have a finite life span. Mining operations are based around the extraction and processing of mineral deposits. Once the economically available products have been extracted and sold, the productive life of the mine is effectively over. This moment may come in a planned way, as known quantities of material are extracted on a defined schedule, or it may happen suddenly such as when market conditions change, and continued extraction is no longer profitable.

Historically, the closure of a mine was often an uncontrolled process. Equipment and materials without salvage value were abandoned in place, mine openings were left unattended, and—at best—it was assumed that nature would reclaim the lands. Any impacts on surrounding communities were considered part of the natural economic cycle of boom and bust.

The consequences of such abandonments are now well recognized

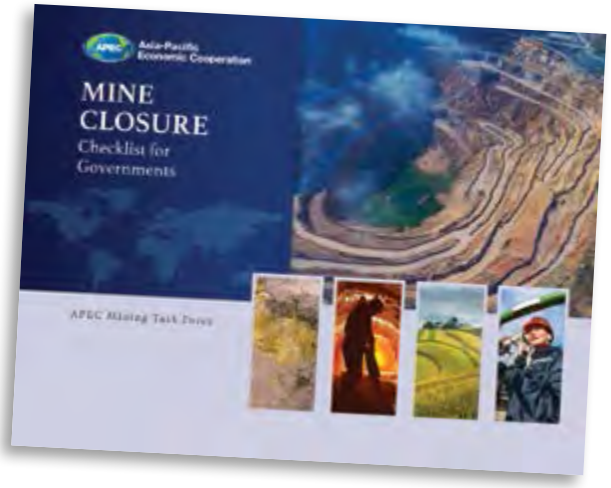
- Untended mine openings and derelict buildings present a physical hazard to those who are tempted to explore them.
- Open deposits of mine waste may result in environmental impacts, such as damage to the quality of water, soil, and air.
- Depending on the nature of the site, vegetation may be slow to regrow, and the biodiversity of the sector may be permanently reduced.
- Negative social impacts on neighbouring communities may linger for decades after the mine closure. In the absence of the mining companies that once profited from the exploitation of the mineral deposit, the responsibility and cost for any sort of remediation activity falls to the government and the community. Especially in developing economies, the financial burden implied by this has often meant that no remedial activities are undertaken, and impacts linger on.

The global history of abandoned sites and their consequences has resulted in the rise of regulations intended to prevent abandonment and ensure that mine sites are closed in a safe and sustainable manner. The global development of these regulations has been uneven, with some jurisdictions still having little or no regulation in the matter, while others possess a robust governance framework.

ABOUT THE MINE CLOSURE CHECKLIST FOR GOVERNMENTS

The objective of the Mine Closure Checklist for Governments is to provide policy makers in the APEC region with the essential elements of a successful mine closure governance framework based on leading international guidelines and standards, as well as international experience. This Checklist is designed to provide a logical, sequential series of steps that will allow policy makers to identify gaps in their current mine closure framework and identify how to address those gaps. A clear, effective mine closure framework will help protect the environment and interests of the community, and will also encourage the benefits that are brought by investment and development of mining opportunities.

For policy makers in the APEC region, there is no single jurisdiction in the world that can be looked at as the ideal model for mine closure policy. Many of the developed nations have relatively advanced closure policies, which have been created assuming the existence of a large and well-funded regulatory oversight body. This assumption may not apply in the developing world. The geographic size and diversity of the jurisdiction also shapes the development of policy. Closure policy for some smaller nations may contain prescriptive elements that are only applicable within a relatively limited climatic or geographical zone. As there is no single model to follow, there is a need for clear guidance on what is required in closure policy.



History shows that in the absence of policy there can be lasting economic, environmental and social costs, especially for local communities, including women, who are often most vulnerable to the consequences of a mine closure. Poor policy that is not in line with the best international practices can have unintended consequences, such as stifling innovative solutions, or discouraging well-managed mining projects that can bring benefits such as investment and economic development.

Mine closure should be a process, and the design of mining projects should incorporate design for closure from the outset, with the closure aspect reviewed and approved by the appropriate regulatory authority. Appropriate closure can result in mines becoming engines for development beyond their own life, through a process that minimizes adverse impacts and maximizes after-use benefits in the long term.

INTRODUCTION TO THE CHECKLIST

WHO IS THE CHECKLIST FOR?

The intended audience for this Checklist is both technical and non-technical government members and advisers with an interest in mine closure. These might include both policy *developers* and policy *implementers*.

The Checklist particularly advises government policies with respect to mine closure and how these policies should be implemented and sustained (including administration and governance).

WHO DEVELOPED THE CHECKLIST?

The Checklist was developed by the Mining Task Force of APEC, in a program coordinated by Natural Resources Canada, with development carried out by Golder Associates. The preparation of the Checklist involved mine closure practitioners globally, including government, industry, and non-government organization (NGO) representatives, among others.

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The Checklist is Divided Into Four Phases

PHASE 1: Getting Started	**Purpose:** **Put in place structures for the development of mine closure policy**	• Form a task force • Understand the role of closure policy • Understand closure in the mining life cycle • Assess current policy and identify gaps • Identify stakeholders and engage with partners
PHASE 2: Developing Policy for the Closure Plan	**Purpose:** **Summarize the policy needs that will be addressed through the development of closure plans**	• Define the needs and content of the closure plan • Understand the role of the regulator in evaluating technical content • Define post-closure land use • Promote physical and chemical stability – the technology of closure • Set acceptable design criteria and planning horizons • Factor in climate change • Engage stakeholders • Management and monitoring requirements • Set finanacial requirements
PHASE 3: Developing Policy for Managing Closure	**Purpose:** **Address the policy needs for the over-arching management of closure within a jurisdiction, covering key transversal issues that need to be addressed in closure policy**	• Define Relinquishment Pathways • Design how to handle temporary and sudden closure • Link with abandoned site policy • Manage expectations
PHASE 4: Implementing the Closure Policy	**Purpose:** **Set a strategy to transition to new closure policies from existing regulations**	• Prepare to implement new closure policy • Evaluate policy effectiveness and update as required

GETTING STARTED

Purpose:

To put in place structures for the development of mine closure policy, in the context of a clear understanding of the role of closure policy and the status of any existing policy in the jurisdiction. With this information, stakeholders and partners that will be needed for the policy are engaged.

Steps:

1.1 Forming a Task Force
Establish a governmental task force to lead the development of the mine closure policy or policy update.

1.2 Understanding the Role of Closure Policy
Ensure that task force members have a clear and consistent understanding of the roles and limitations of closure policy.

1.3 Understanding Closure in the Mining Life Cycle
Ensure a common understanding of the role of mine closure throughout the mining life cycle and of the implications for policy.

1.4 Assessing Current Policy and Identify Gaps
Evaluate any current closure policy against current best practices and identify gaps.

1.5 Identifying and Engaging with Stakeholders and Partners
Identify parties that should be consulted or involved in the development/updating of mine closure policy for the jurisdiction and create a forum for engagement.

Outputs:

- a mine closure policy task force
- a high-level diagnostic assessment of potential gaps in policy
- identification of potential partners and stakeholders
- requirements for closure planning alignment with Environmental and Social Impact Assessments (ESIAs) and local, district, and national development targets, strategies, and plans

1.1 FORMING A TASK FORCE

Updating or developing mine closure policy for a jurisdiction is not a trivial undertaking. The development of policy will need to take into account the interactions of development goals for the jurisdiction, existing legal structures, and the interactions between different levels of government and different branches of government.

A governmental task force with adequate resources is needed to develop policy and policy updates. Characteristics of a successful task force include:

- A relatively small group of individuals (usually 5 to 10) is practical for spearheading the development or assessment of policy.
- Members can represent key ministries, departments, and agencies central to the management of the mining sector in the jurisdiction.
- Consideration should be given to representing areas such as mining, finance, environment, and land use planning bodies, as well as incorporating gender balance considerations.
- While the number of task force members should be limited for efficiency purposes, the task force should consult widely with other groups not necessarily represented within the task force (mining communities, vulnerable groups, NGOs and mining companies, among others) to ensure that a variety of viewpoints are considered. A stakeholder closure forum can be established to facilitate consultations.
- The task force should have a clear mandate and be adequately empowered to evaluate, modify, or develop mine closure policy for the jurisdiction, with a corresponding level of resources to carry out that mandate. This usually implies high-level government support, such that issues that bridge more than one governmental department or various levels of government can be adequately addressed.

1.2 UNDERSTANDING THE ROLE OF POLICY – LEGAL/REGULATORY FRAMEWORKS

Many large mining companies have strong internal policies around mine closure. These policies are driven by corporate standards and are often informed by the recognition that the effective closure of operating sites is a powerful tool to obtain social licence for new projects. Nevertheless, defining and enforcing closure policy is the role of the government.

> ***Good closure policy in the jurisdiction protects the interests of the public and the environment. It also provides a level playing field for all mining companies that operate in the jurisdiction.***

Good closure policy also provides an opportunity to both envision and plan for an improved socio-economic transition after the end of mining.

WHAT REGULATIONS ADDRESS

Amongst other points, modern regulatory frameworks require that:

- at the end of operations, adequate measures are in place to close the mine
- there will be sufficient funds set aside to finance closure activities
- there is a definition of what adequate measures are, or some mechanism to define for each site what is adequate
- there is a definition of what constitutes sufficient funds
- there is a definition of what constitutes satisfactory stakeholder engagement

The points above can be thought of as the “minimum components” of effective regulations.

Ideally the regulations will reach out to broader topics, such as:

- protecting and enhancing the social interests of communities
- ensuring more vulnerable groups—such as women—are not unduly impacted by closure
- providing clear guidance on managing temporary or sudden closure
- providing a clear pathway through post-closure and relinquishment
- requiring that research on closure needs and measures is conducted during operations, to ensure that proposed closure measures are viable and sufficient

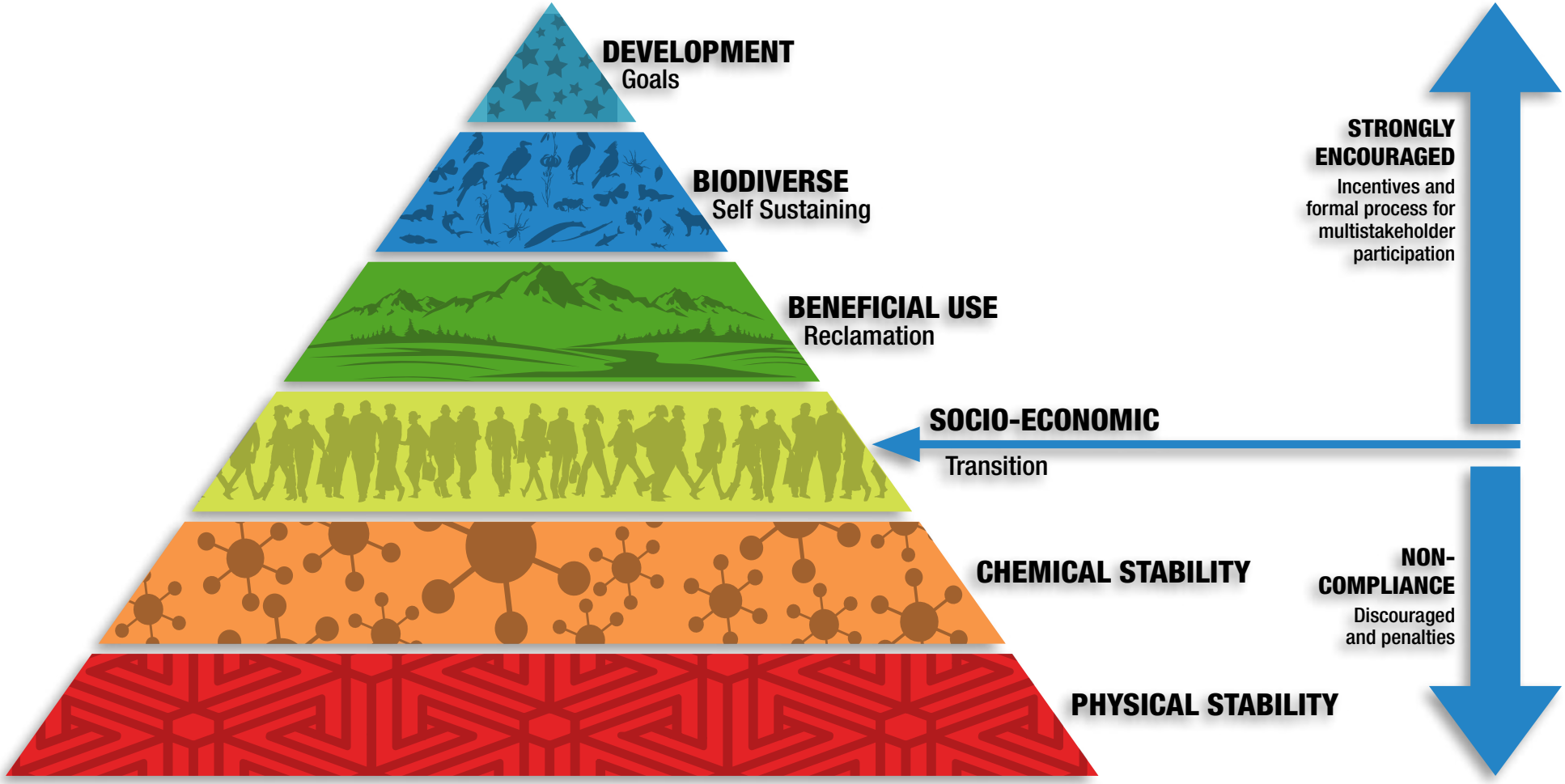
These and related topics are discussed in more detail throughout this document.

In almost all jurisdictions where there is closure legislation, regulations require the mining company to develop a closure plan (i.e., reclamation plan, closure and reclamation plan). The closure plan—which should be legally binding—outlines in detail how the above topics will be addressed. At a minimum, the closure plan describes the activities that will be undertaken at the end of mine life, the plan for the site after closure, and the cost of the activities described.

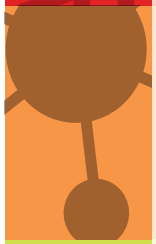
WHAT ASPECTS OF CLOSURE SHOULD POLICY INCLUDE?

There is no universally accepted understanding of what is needed for closure and what aspects of closure should be addressed by closure regulations. Nevertheless, the evolution of mine closure practice and the accompanying regulations have generally moved up the hierarchy of needs shown on next page. The elements at the base of the pyramid must be achieved by closure policy, and should be enshrined in regulations. The elements higher up the pyramid are desirable, and may be incentives based, but may or may not be regulated. Exactly where the dividing line between what must be addressed in closure policy, and what is desirable is subject to debate. Ultimately, each jurisdiction must decide for itself where that line should be placed, reflecting the values and needs of the public.

THE HIERARCHY OF CLOSURE NEEDS



***Physical Stability*—**At the most fundamental, closure regulation needs to address the physical stability of the mine site at closure. For example, large dams and waste rock dumps should not present collapse hazards that could put the public at risk. For underground mines, open workings without adequate control can pose a fall hazard, or risks to either artisanal miners or explorers who are tempted to enter the abandoned mine. Underground mines may also present a risk of ground movement above the mined areas that can affect land use. Regulations should ensure that it is not permissible to leave physical hazards for the public at closure.



***Chemical Stability*—**This concept is generally used to embrace all aspects of the closure plan that are oriented towards preventing or reducing environmental degradation. While nothing is ever truly "chemically stable," many mine wastes may be very reactive and prone to generating impact on contact water. For instance, the problem of "acid rock drainage" (ARD) results when runoff water from precipitation contacts reactive mine waste and generates acidic discharges that can adversely impact the environment. Numerous techniques are available to prevent, limit, or treat reactive mine wastes and their discharges, and regulation should ensure that appropriate techniques are implemented to prevent or reduce environmental degradation.

***Socio-economic Transition*—**Mines can bring benefits to communities and governments, including jobs and tax revenue. However, when the mine life comes to an end, the transition can be difficult. Job loss, loss of social programs, and loss of taxes can have lasting negative impacts, especially in economies where the mine was the main employer. This transition can be greatly mitigated by communication, economic development projects, retraining, and other activities undertaken prior to closure. Policy can play a role in ensuring a positive transition from operation to closure and post-closure.

***Beneficial Use – Reclamation*—**During mining, land use is altered, and following the mine life, the landscape is permanently changed. In some jurisdictions considerable emphasis is placed on reclamation activities, designed to either restore the mined landscape to its pre-mining use or ensure that some other beneficial use of the land is possible following closure.

***Biodiversity – Self-Sustaining*—**Emerging closure practice aspires to take the site closure and reclamation beyond a defined beneficial use, and seeks to attain a post-closure landscape that has a biodiversity equal to (or even greater than) the pre-mining conditions, with self-sustaining ecosystems attained. This level of closure is not the subject of current regulation, but may be an aspirational goal either in governmental or mining corporation policy.[1]

***Development Goals*—**Ideally, closure planning and closure policy should be designed to support the overall development goals of the jurisdiction. Mining projects can bring numerous economic and development benefits to both developing and developed nations. Properly managed, the complete mine life cycle, from planning and development through to operations, closure, and post closure, can provide a net development benefit to the jurisdiction, providing a long-lasting positive impact in terms of aspects such as community development, education, and economic diversification. While the closure and post-closure phase of mine life will generate undesirable impacts, careful planning for closure from the earliest stages of operation can result in a legacy that is an overall positive.

1. For instance, there is at least one international mining company that has a stated goal of attaining closure reclamation of its sites with biodiversity greater than the pre-mining condition.

At a minimum, mine closure regulations should ensure that the closure plan addresses issues of physical and chemical stability. Socio-economic transition and beneficial use – reclamation may or may not be addressed, depending on the needs of the jurisdiction. It is the key role of mine closure policy to provide a framework that leads toward successful mine closure and relinquishment of mine lands. Policy should ideally encourage and reward good behaviour and avoid generating obstacles to successful outcomes.

SOME CHARACTERISTICS OF GOOD POLICY

Considerable experience has been gained over the years with the development of closure policy, and various lessons have been learned.

Ensure Adequate Financial Assurance	• Mines should be required to develop credible, auditable estimates of closure costs (historically, closure costs tend to have been underestimated) • A mechanism is put in place to ensure that this amount is set aside to fund closure, independent of the success or failure of the mine as an economic venture • When mining companies are required to set aside these closure funds as a condition of permitting (often called financial assurance), there is a strong incentive for operators to proactively close out the mine and obtain a release of the financial assurance funding
Avoid Prescriptions	• Prescriptive regulations define in detail how a goal should be achieved, rather than what the goal is. • Can stifle innovation, or simply become out of date as science advances faster than regulations can change
Updates Mechanisms	• Mine plans are dynamic, and mines do not typically arrive at closure with the same configuration or on the same date as was planned prior to the start of operations. • A regular program of closure plan updates and approvals is needed during the mine life, allowing changes in the mine plan to be incorporated, as well as the results of ongoing research • The amount of the financial assurance should also be updated, increasing as the mine expands or decreasing as the mine undergoes progressive reclamation. • If the closure policy includes prescriptive elements, it is critical that the policy itself include update mechanisms. For instance, some jurisdictions have systems in place to estimate the minimum amount of financial assurance. If these mechanisms are not updated regularly, rising costs can render them obsolete.
Define Outcomes	• The desired results of closure should be defined by key stakeholders in concert with each other, rather than imposed through blanket policy.
Legislate Stakeholder Involvement	• The benefits of stakeholder involvement have been well established. • Governments can ensure through regulation that stakeholders will be properly informed and consulted about the plans for closure.
Alignment	• Mine closure policy should be developed in a way that aligns with the existing regulatory framework, such as: – The structures around Environmental and Social Impact Assessments (ESIAs) and related management plans – Closure commitments for closure that are made as part of the ESIA process – Applicable environment and mining legislation • Policy should also be developed in alignment with the development targets for the jurisdiction as well as strategies and plans for the mining sector as a whole.

These are just some of the characteristics of good policy—many others are described throughout this document.

> ***Closure policy and regulations need to be tailored to the characteristics of the jurisdiction, including the available institutions, funding, and expertise of the individuals who will be tasked with implementing the policy or regulations.***

POLICY IN DEVELOPED AND DEVELOPING NATIONS

Developed nations generally have:

- a more extensive civil service
- more funding to support the hiring of highly trained staff
- the ability to support larger administrative responsibilities

Developing nations often have:

- smaller numbers of staff available
- staff who may not have the same level of training as in developed nations

In this context, it is important that the regulatory framework take into account such limitations and provide mechanisms to support enforcement, monitoring, and evaluation. Mechanisms to support the technical evaluation of closure plans are discussed in Section 2.2 "Evaluating Technical Content – Role of the Regulator" (page 37).

REGULATORY FRAMEWORKS

One of the challenges for many jurisdictions in the development of closure policy is fitting mine closure into existing regulatory frameworks. It is common to encounter issues with overlapping institutions, such as overlaps between environmental agencies and mining or natural resource agencies. Many closure issues—but not all—affect the environment. In some jurisdictions, closure plans may be reviewed and approved by both mining and environmental agencies. In others, responsibilities are separate, and closure obligations may be incurred both through the environmental and social impact assessment process and through a separate process for the approval of mine closure plans.

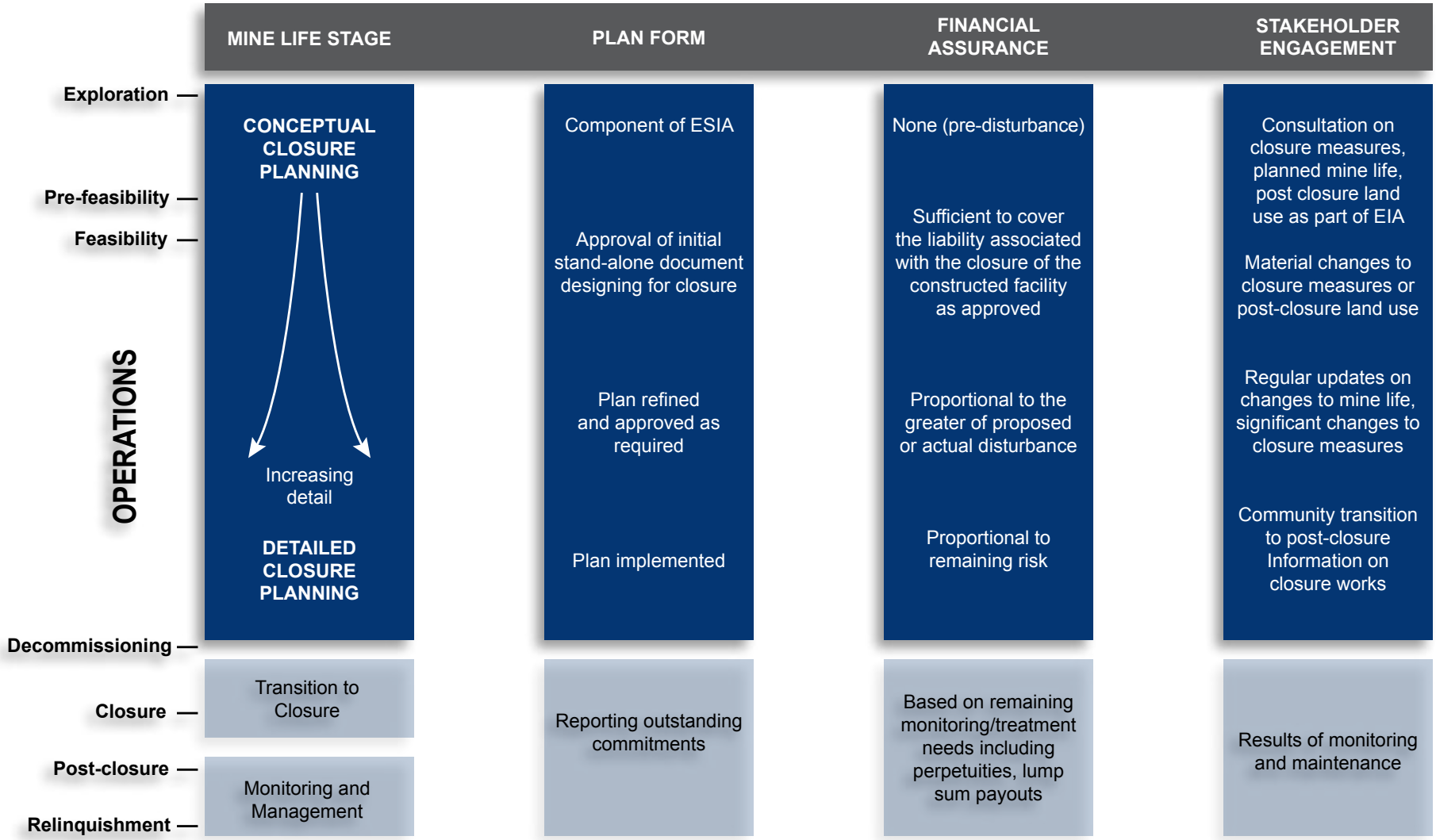
Due to the diversity of institutions around the world, it is not possible to say where the responsibility for the oversight of mine closure should lie. As a general principle, if it lies with more than one institution, considerable care should be taken to avoid the duplication of requirements or, worse, contradictory requirements. If oversight lies within a single institution (such as environment), care should be taken to address the aspects of closure that may lie outside of its usual purview.

1.3 UNDERSTANDING CLOSURE IN THE MINING LIFE CYCLE

> ***Good closure policy should encourage the development of carefully thought-out closure plans early in the mine life, prior to permit approval and construction, with regular updates and approvals throughout operation and closure.***

The figure on the next page shows the typical evolution of the closure plan over the mine life, from a more conceptual level in the early stages of project development, through to more detailed planning to the date of closure. Also shown is how this development relates to issues such as financial assurance and social engagement, topics that are covered later in this document.

Closure Planning Policy Requirements for all Stages of Mine Life (after ICMM 2008)



Closure policy MUST ensure that closure planning begins early in project development. Early planning:

- allows flexibility in closure options, resulting in better closure outcomes
- limits inappropriate handling or placement of materials (e.g., prevents additional costs for rehandling or to cover acid generating materials)
- improves the ability of operators to carry out and pay for closure measures during operation (progressive closure) while there is positive cash flow to support the activities

Policy should ensure that closure plans should be in place for all stages of mine life, from pre-construction through to post-closure. Good policy recognizes and enshrines that planning is an ongoing process, and that plans should be revised on a regular basis, incorporating changes in the project. As more knowledge is gained about risks for closure, and better understanding developed about how those risks can be managed, the level of detail in the closure plan should increase.

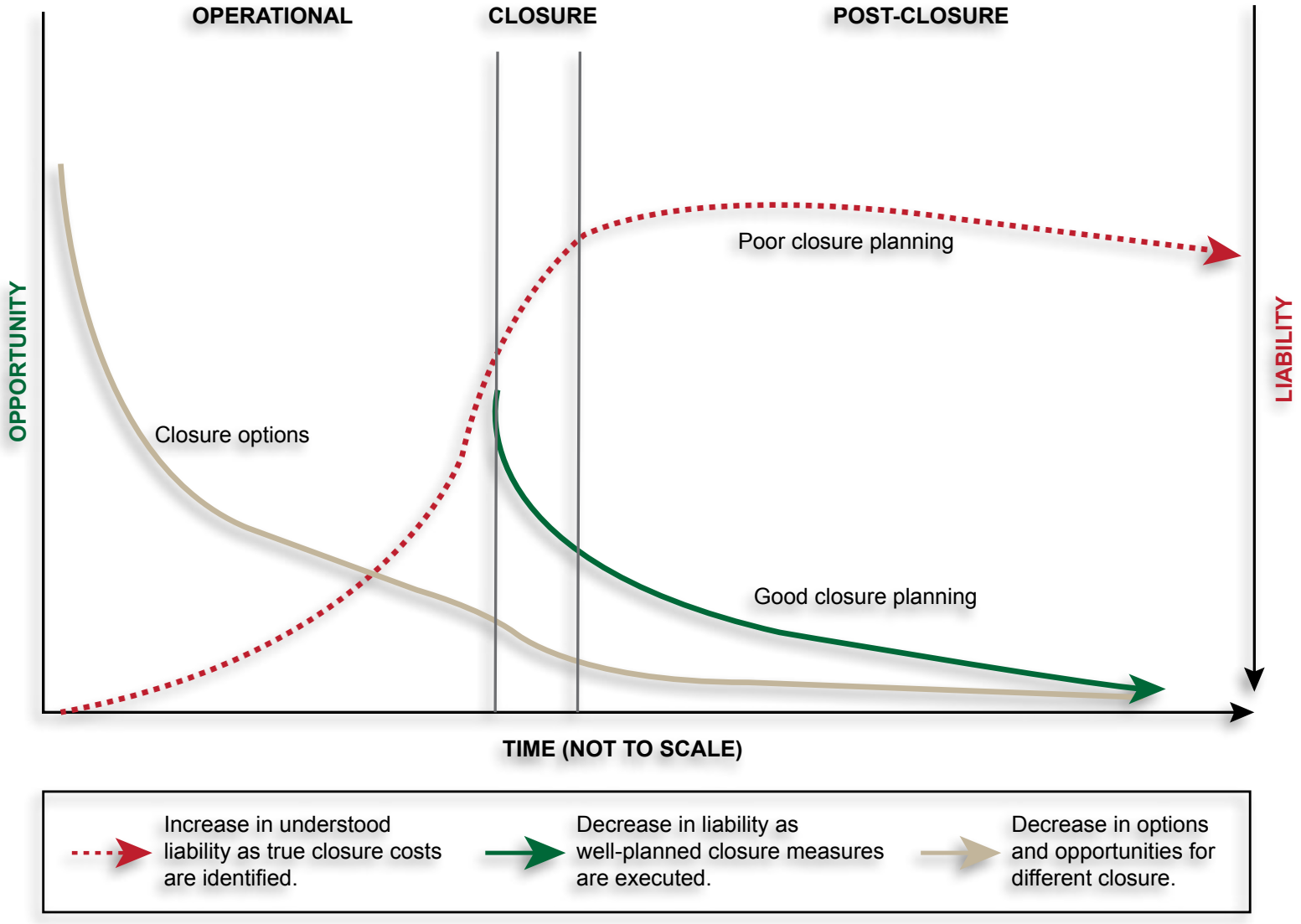
IMPLICATIONS FOR POLICY

- Regulations should ensure that all mines have a closure plan developed prior to construction.
- The earliest closure plans will be conceptual, but should be well thought out and subject to careful preparation and review by experienced external experts and approval by the competent regulatory authority. Poorly thought out closure plans early in mine life can negatively impact the options that are available for closure in the future.
- There should be a process in place to ensure that closure plans are updated regularly. Five years is a common maximum period between updates, but it may be more often, especially when there are major changes in the mining project.
- While the level of detail in the plan should be required to increase over the mine life, the plan will usually be largely conceptual (in engineering terms) until a period 5 to 10 years before closure. Care should be taken to avoid policy that specifies too much detail for the closure plan too early in the mine life, as such detail is likely unrealistic and can lead to excessive and unnecessary effort in the plan revision.

CHANGES IN OPPORTUNITY AND LIABILITY OVER THE MINE LIFE

Mining can be highly disruptive to the pre-mining environmental and socio-economic state in the immediate (and sometimes broader) project area.

As mining progresses and the degree of disturbance increases, the liability associated with the project also increases. This liability refers to the legal obligation held by the mining company to address this disturbance, often quantified as the closure cost and reflected in the financial assurance amount (discussed in detail in Section 2.9 of the Checklist). This increase over time is illustrated on the next page. Although progressive closure may mitigate the increase in liability, it will typically peak prior to closure.



Good Closure Policy Encourages Planning to Identify and Address Closure Risks Proactively (after Mauric et al. 2012)

Similarly, the opportunities to achieve sustainable next land uses may decrease over time. Poor decisions in planning and operating (such as not properly salvaging soil in mined areas or waste deposits) can reduce opportunities and result in a variety of poorer closure outcomes that may affect land stability and fertility, water quality, aesthetics, and biodiversity.

Closure options and strategic possibilities can be lost as mining progresses and irrevocable decisions are made on final closure landforms. Policy must include regulatory controls that direct appropriate closure decision making for final landform construction. When it comes to mine waste management, many of the long-term issues that the site will face over the entire mine life and into post-closure are defined at the time of deposition. A next land use vision MUST be considered in all mining activities. Careful thought for all planning should be given to:

- placement of mine waste, especially with regard to surface or groundwater flow paths
- the materials used to construct the final landforms (such as waste rock dumps, heap leach piles, and tailings facilities), including presence of physically and geochemically unstable materials
- design of the final landform, including area, height/depth, and slope angles
- the need for covers, such as topsoil and revegetation, or rock armouring
- potential for reuse or re-purposing of mine infrastructure (in place of demolition)
- the proposed post-closure land use for the landform, including closure objectives and closure criteria
- local and/or national land use policies and related socio-economic goals or policies

In the mine closure planning process, each next step depends on both the previous step's outcomes and those from externalities. This process is iterative, in that each time new information is added to the system (e.g., mine plan changes, technology changes, research results), the process is repeated and the plan is updated. Closure may also be temporary (unforeseen short-term closure or care and maintenance) or permanent. Even "permanently" closed sites may be re-opened as technology and commodity prices improve.

1.4 ASSESSING CURRENT POLICY

The first step in developing mine closure policy, or improving current policy, is understanding where your jurisdiction is in relation to best practices. This section provides a diagnostic tool to begin this assessment.

WHAT ARE THE AREAS OF YOUR CLOSURE POLICY THAT REQUIRE ATTENTION?

The "Issues Scorecard" on the next page can be used as a self-evaluation tool to assess current policy and look for gaps.

This scorecard provides a quick way to assess the status of closure policy in your jurisdiction, relative to the best practices identified in this document.

Use this scorecard to evaluate the status of your policy on each issue. Marking "Yes," "No," or "Don't Know" will help identify the areas that need more attention and the sections of this document that should be reviewed.

The remainder of the Checklist provides practical guidance on policy needs for addressing identified gaps. You can use the scorecard to determine which sections of the document to read for guidance or to consult for additional supporting information. This scorecard is organized in the same order as Sections 2 and 3 of the Checklist, so you can go directly to the section of the Checklist that will provide more content for the issues you identify.

ISSUES SCORECARD: DEVELOPING POLICY FOR CLOSURE PLANS (PHASE 2)

As discussed in Phase 2, the mine closure plan is a key element of mine closure policy, for defining how closure will be addressed for each specific site.

THE CLOSURE PLAN – ENSURE ALL MINES HAVE A CLOSURE PLAN IN PLACE			
ISSUE	YES	NO	DON'T KNOW
Is a mine closure plan required as part of the project definition in the Environmental and Social Impact Assessment (ESIA)?			
Is there a requirement for a stand-alone closure plan to be approved by the regulator prior to permitting and construction?			
Do all operating mines have a closure plan approved by a regulatory body?			
Are closure plans required to be updated and approved following the lapse of a specified period of time, or significant changes to mine plan or external context (financial, environmental, social, and regulatory)?			
Is there a requirement for closure activities to be documented (e.g., as-built drawings, monitoring reports) after completion?			

EVALUATING TECHNICAL CONTENT – ENSURE THE PLAN IS TECHNICALLY SOUND			
ISSUE	YES	NO	DON'T KNOW
Is there a requirement for the closure plan to adequately characterize and describe the pre-mining baseline conditions (environmental, cultural, and socio-economic)?			
Are there specialists with appropriate training in closure issues available to the governing body to review closure plans?			
Is there a mechanism for the regulator to contract third party expertise and provide specialist review of the documents?			
Is there a requirement for the closure plan to provide justification for the closure strategies and landform designs selected?			
Are there requirements or mechanisms to ensure that the closure plans will be prepared to international standards?			

POST-CLOSURE LAND USE – DEFINE OBJECTIVES			
ISSUE	YES	NO	DON'T KNOW
Is there a requirement to define post-closure land use?			
Are there requirements to define clearly the objectives to be achieved by closure works and their associated criteria?			
Is there a framework in place to direct post-closure land stewardship?			
Is there a requirement to link post-closure land use with regional planning, such as watershed level and basin level planning and ecosystem services protection and enhancement?			
Are there processes, incentives, or forums to encourage regional land use strategy development and implementation?			

CHEMICAL AND PHYSICAL STABILITY – KEY REQUIREMENTS			
ISSUE	YES	NO	DON'T KNOW
Is there a requirement to adequately characterize mine wastes in terms of geochemical and physical properties, and the life-of-mine quantities?			
Is there a requirement to demonstrate that the mine waste facilities will meet appropriate design criteria with respect to physical and chemical stability?			
Are there requirements that closure measures be planned for all landforms of concern, and that these measures will adequately prevent or mitigate acid and metal drainage?			
Are there requirements to evaluate if the final landforms will impact upon current and future surface water and groundwater quality, and if those impacts will affect environmental or societal values?			
Is there a requirement to assess if water treatment will be required on an ongoing basis after closure?			
If water treatment is needed, is there a requirement to estimate for how long? Is there a requirement for proven treatment methodologies and appropriate cost estimation that is coherent with the duration of required treatment?			
Is there a requirement to link closure water management with watershed level and basin level planning and ecosystem services protection and enhancement?			

DESIGN CRITERIA AND PLANNING HORIZONS – KEY REQUIREMENTS			
ISSUE	YES	NO	DON'T KNOW
Is there a mechanism in place to permit the proponent to develop design criteria on a site-specific basis, through either risk-based or objectives-based methods?			
Is there a requirement to specify and justify planning durations?			
Is there an expectation that the specified planning horizon will take into account the limitations of current engineering practice?			
Do the design criteria recognize the long planning horizon and the limited human intervention associated with closed mines?			
Is there a mechanism to permit use of a risk-based approach to landform design, one that can help ensure appropriateness of landform designs to the site and its context?			
Are the planning horizons and design criteria regulated in a way that is aligned with local and national socio-economic land use strategies and goals?			

CLIMATE CHANGE – ISSUES TO ADDRESS			
ISSUE	YES	NO	DON'T KNOW
Is there a requirement to evaluate the potential impacts of climate change on closure planning?			
Are internationally accepted climate change models incorporated into the evaluation of closure plans on a site-specific basis?			
Is there a requirement that climatic variability and the limitations of current climate datasets (highs and lows) be accounted for? Is there a requirement to take into consideration that historical results may not reflect the variability and intensity of future storms and draughts?			
Is there a requirement to evaluate the impact of climate change on any closure strategy that would rely on maintenance of particular climatic conditions (e.g., retention of permafrost or water covers)?			

SOCIAL IMPACTS AND BENEFITS OF MINE CLOSURE – ISSUES TO ADDRESS			
ISSUE	YES	NO	DON'T KNOW
Is there a mechanism for the regulator to ensure that stakeholders are identified and involved in closure plan development?			
Is there a mechanism for stakeholder engagement to ensure that women are separately engaged?			
Does stakeholder engagement mechanism ensure that minority groups are separately engaged?			
For planned mines, is there a requirement that stakeholders be informed of anticipated mine life, principal closure measures, and proposed post-closure land use?			
For operating mines, is there a requirement that stakeholders be provided with updates on any significant modifications to the closure plan, including changes to the estimated date of closure? Is stakeholder feedback required for these changes?			
For mines that are completed or closed, is there a requirement that stakeholders be provided with regular updates on outcomes of closure activities and environmental monitoring?			
Is there a requirement for a transition strategy to be in place for local economies and workers to support the period from operations to closure and relinquishment?			
Is there a mechanism to ensure that closure planning will be aligned with local and national development goals and commitments made in the ESIA?			
Are there local and national forums and mechanisms to develop visions and targets for mining and post mining social and economic goals?			

FINANCING CLOSURE – ELEMENTS OF FINANCIAL ASSURANCE			
ISSUE	YES	NO	DON'T KNOW
Does the closure policy ensure that for all operating mines there will be sufficient funds in place to execute all closure activities required when operations cease?			
Does the financial assurance cost estimate follow an appropriate accounting basis?			
Is there a requirement to regularly update the amount of the funding, incorporating information gained during operations, changes in the operations, and recognition of closure activities that have been completed?			
Is there a requirement to take advantage of opportunities for progressive reclamation, with a mechanism for completed progressive reclamation to reduce the financial assurance amount?			
Is there a mechanism to evaluate the sufficiency of the financial assurance (the quality of the closure cost estimate)? Is there a mechanism to have a third party audit?			
Is there a mechanism to calculate the current value of any post-closure treatment requirements, and ensure that adequate financial assurance is provided for this as well?			
Do the permitted forms of financial assurance provide adequate security for the jurisdiction? Is there a framework in place for the jurisdiction to administer the financial assurance funds?			
Are there a diversity of robust fiscal instruments and qualified/approved institutions in place to secure, hold, manage, report on, and administer the financial assurance?			
Is there a clear framework including criteria for the release of the financial assurance after completion of the closure activities?			

INTERPRETING THE RESULTS

After working through the above scorecards for the evaluation of your current regulatory environment, it should be much more clear what aspects of your policy for closure plans will need more work.

- If you answered "yes" to all of the questions under one of the topics, that is a good sign that for this aspect of closure planning, your jurisdiction is aligned with best practices.
- If you answered "no" to a question, we recommend that you review in detail the corresponding section of "Phase 2: Developing Policy for the Closure Plans".
- Answering "don't know" may indicate a gap in closure policy, or a need for further study.

ISSUES SCORECARD: DEVELOPING POLICY FOR MANAGING CLOSURE (PHASE 3)

As discussed in Phase 3, some aspects of closure policy are transversal, and need to consider closure across the entire sector, rather than be addressed through the instrument of a specific closure plan. The diagnostic checklist for these components of policy is presented below and on the next page.

RELINQUISHMENT – IS THERE A PATHWAY?			
ISSUE	**YES**	**NO**	**DON'T KNOW**
Is there a mechanism to return the site to the jurisdiction or to an acceptable third party?			
Is an independent final audit required to demonstrate the property has been closed as per the approved closure plan? Does this audit result in certification of the results, with documentation of supporting evidence and methodology?			
Is there a mechanism for parts of the site to be returned under progressive closure without having to complete closure simultaneously across the entire site?			
Is there a mechanism to quantify residual liabilities (e.g., monitoring, maintenance, water treatment) and to provide the next land owner with funds to address those liabilities as part of a relinquishment?			
Is there a mechanism to address consequences of extraordinary events (force majeure) after relinquishment?			

ADMINISTRATION OF DOCUMENTATION – KEY REQUIREMENTS			
ISSUE	**YES**	**NO**	**DON'T KNOW**
Is there a mechanism to require that closure trials are undertaken and documented appropriately?			
Is there a requirement that monitoring data and reporting be collated in a consistent and readily transparent manner, preferably against established standards?			
Is there a peer-review or benchmarking process for closure monitoring and reporting?			

TEMPORARY AND SUDDEN CLOSURE – POLICY NEEDS			
ISSUE	YES	NO	DON'T KNOW
For operating mines, does the closure policy ensure that there will be sufficient funds in place to execute all closure activities required for immediate or unplanned closure when operations cease, using a third party vendor?			
Is there a requirement to have an approved and appropriate care and maintenance plan for the site under temporary closure?			
Is there a mechanism for regular inspections of sites in temporary closure, and adjustments to bond amounts if conditions change?			

ORPHANED AND ABANDONED SITES – HOW TO MANAGE			
ISSUE	YES	NO	DON'T KNOW
Is there a registry of orphaned and abandoned sites in the jurisdiction?			
Is there a risk-based approach to prioritize which sites should be remediated first?			
Does the approach also consider prioritizing potentially highest benefit sites through maximizing cost/benefit of the remediation?			
Do all high risk abandoned mines have an approved closure plan?			
Is there a mechanism to allow other parties to remediate the sites as an offset for other impacts?			
Is there a mechanism that would allow third parties to remediate abandoned sites without assuming liabilities ("Good Samaritan" provisions)?			

MANAGING EXPECTATIONS			
ISSUE	YES	NO	DON'T KNOW
Are there unrealistic expectations on the part of industry, such as expectations to be exempted from bonding requirements, or special exemptions to requirements for smaller operators?			
Are there unrealistic expectations on the part of communities around the continuity of full employment opportunities after the completion of closure works?			
Are there unrealistic expectations on the part of governments around completely eliminating residual risks associated with closure?			

INTERPRETING THE RESULTS

After working through the above scorecards for the evaluation of your current regulatory environment, it should be much more clear what aspects of your policy for managing closure will need more work.

- If you answered "yes" to all of the questions under one of the topics, that is a good sign that for this aspect of managing closure, you are aligned with best practices.
- If you answered "no" to a question, we recommend that you review in detail the corresponding section of "Phase 3: Developing Policy for Managing Closure".
- Answering "don't know" may indicate a gap in closure policy, or a need for further study.

1.5 IDENTIFYING AND ENGAGING WITH STAKEHOLDERS AND PARTNERS FOR POLICY DEVELOPMENT

Prior to developing closure policy or changes to existing closure policy, it is critical to identify key stakeholders and engage with them in policy development. If a mine closure policy task force has been established (Section 1.1), this task force is ideally suited to identify and engage with stakeholders and potential partners.

- **Stakeholders —**These are individuals or groups with an interest in mine closure policy. They may include community groups, NGOs, mining companies with interests in the jurisdiction, regional mining associations, indigenous people, mining worker unions, and representatives of other levels of government or government departments that have an interest in closure policy but are not represented in the task force.
- **Partners —**These are individuals or organizations that may not have a specific stake in the mine closure policy for the region, but nevertheless can offer useful support to the development of policy. Typical examples include regulators in other jurisdictions who can share their experiences and lessons learned, international development organizations, consulting companies working internationally in mine closure, and civil society organizations. Organizations such as ICARD (the International Council on Acid Rock Drainage) may be able to provide specialist input on key technical issues affecting closure.

For developing economies, international donors and international development organizations have the potential to bring significant support to the government in the development and implementation of mine closure policy.

Mapping out stakeholders and potential partners is a useful first step. This can be coupled with identifying the relative importance of groups, and outlining—at a preliminary level—the type of input anticipated. Once identified, potential partners and stakeholders can be contacted to further explore the form of the planned relationship. This can be done bilaterally, through existing forums, or through other relationships.

2 PHASE 2: DEVELOPING POLICY FOR THE CLOSURE PLAN

Purpose:

To identify the policy needs that will be addressed through the development of a closure plan, including background on the technical specifics that should be addressed.

Steps:

2.1 Define the Needs and Content for the Closure Plan
In both policy and planning, there should be clarity around the expectations for the content of the closure plan.

2.2 Understand the Role of the Regulator in Reviewing the Closure Plan
When a closure plan is submitted, it will need to be reviewed and approved. The roles and expected capacity of the regulator in reviewing the potentially highly technical and sensitive content of the plan need to be understood and clear.

2.3 Identify Key Aspects of Post-closure Land Use
Requirements are needed for defining the post-closure land use, which can influence many aspects of the closure plan.

2.4 Promote Physical and Chemical Stability – The Technology of Closure
Policy needs to ensure that the principal risk issues for physical and chemical stability of mine sites are identified, along with the closure approach to address those risks.

2.5 Identify Design Criteria and Planning Horizons
Closure policy needs to have clarity around the approach that will be used for developing closure criteria, the types of criteria to be used, and definition of realistic planning horizons.

2.6 Factor in Climate Change
Policy should require that climate change is addressed in closure plans, given the long design life of most closure works (with many closure landforms permanent for all practical purposes).

2.7 Identify Socio-Economic Aspects of Closure
Policy should require that key social aspects of closure be addressed in the closure plan, including stakeholder engagement and transitioning economies, in alignment with local and national sustainable development strategies.

2.8 Identify Closure Management and Monitoring Requirements
Policy should require that closure plans identify the key aspects of monitoring the site after implementation of closure works, including a plan as to how the monitoring will be conducted, and unanticipated results addressed.

2.9 Develop Closure Financing Policy
The methodologies to be used to determine the cost of closure and mechanisms for financial assurance need to be defined.

Outputs:

- a typical table of contents for closure plans to be submitted in the jurisdiction
- a policy paper or other document for the jurisdiction defining the outcome of key decisions on how closure plans will be reviewed, how post-closure land use will be addressed, key aspects of physical and chemical stability, and design criteria
- an approach to design life and climate change
- an approach to address and map the interaction between communities and mine closure and address related socio-economic strategies
- an approach to be followed by proponents for the estimation and evaluation of closure costs, and for the determination of the magnitude and type of financial guarantees

2.1 CLOSURE PLAN – NEEDS AND CONTENT

> ***A fundamental aspect of mine closure policy is the requirement for a closure plan, and ensuring that the contents of the closure plan address key risks associated with mine closure.***

The closure plan:

- provides clear documentation of the results of a planning process, which is guided by government policy
- must be in place for closing and reclaiming completed mines to meet the objectives of regulators, mining companies, and other key stakeholders

This section provides an overview of the needs and content for the closure plan, in the context of mine closure policy development.

Mine closure policy:

- directs the development of explicit objectives based in a vision of the next land use once mining is completed and of the requirements of that land use and other socio-economic objectives
- takes into account practical aspects, legal constraints, and stakeholder expectations
- requires that closure planning begin prior to mining commencement and then continue throughout the life of the mine until final closure and relinquishment
- should explicitly deal with the issue of plan updating; this is often best done on an as-needed basis, where material changes occur, rather than to arbitrary duration (although it is common to specify a maximum duration between updates—typically five years)

The actual writing of a closure plan should:

- meet regulatory obligations
- be prepared in such a way as to address company standards and/or financier requirements, although if these differ significantly from regulatory requirements, the mining company may need to develop a separate document to address divergent needs
- smaller companies that lack internal closure standards and guidelines may find it useful to refer to the publically available standards produced by some of the larger mining companies

Significant changes in the project that might trigger the need for an update in the closure plan could include changes in:

- the mine plan, such as a significant modification in the life of mine
- the biophysical environment, including changes in climate models or climate prediction practices
- regulatory requirements or industry practice, such as revised closure guidelines
- new information, including new technology, research results, and on-site learnings
- emerging environmental issues, such as the unexpected appearance of a constituent of concern in a discharge.
- stakeholder groups views, for example changing views on desirable land use with new generations
- corporate aspirations and standards, particularly where a project comes under new ownership

Determining what constitutes a significant change can be done using a risk-based approach. A risk-based approach will also allow early identification of issues as well as prioritization of staff and funding resources. This is particularly important in early project stages.

Policy needs to direct closure planning and activities during all phases of mining toward four fundamental closure objectives:

Fundamental Closure Objectives

SAFE	• Closed mine sites must be made reasonably safe from risks to humans and wildlife. • Steep or unstable slopes, underground mine openings, pit lakes, and industrial buildings are all potentially dangerous aspects of closed mine sites. • If a specific project area cannot reasonably be made safe, access controls may be needed to prevent inadvertent entry.
STABLE	• Landforms must be geotechnically stable and resist the risks of significant failures, either under normal operation or under the influence of infrequent events such as earthquakes and floods. • The closure landscape should generally attain a level of stability that is compatible with the next land use, and comparable natural analogs within the region. • Erosional stability should also be taken into account, with dust and suspended sediment loads maintained within natural ranges.
GEOCHEMICALLY SAFE	• Geochemical safety should address the risk of any solute concentrations being too high or too low—not just ARD (acid rock drainage). • Elevated metal, metalloid, and non-metal concentrations may lead to environmental or human health impacts. • Nutrient concentrations may be artificially low. • Consideration should be given to baseline conditions prior to contemporary mining disturbance.
SOCIALLY AND ENVIRONMENTALLY SUSTAINABLE	Social and environmental sustainability are intertwined: if environmental sustainability is not attained, it will be difficult to provide social sustainability. • Very few mine sites (particularly those developed prior to the implementation of modern closure design) will achieve complete walk-away with no maintenance, but there should be an expectation that the mine closure does not result in any significant and ongoing impacts to the broader environment or socio-economic dynamics. • Where possible, there should be a positive legacy from mining, such as: – a more developed local and regional economy – a better educated and healthier population stimulated by the previous presence of an active mine – a population with skills and business experience, greater capacity to innovate • Preparatory measures should be taken to ensure a managed economic transition from mining to a post-mining state, and ameliorate economic hardship.

ALIGNMENT AND LINKAGES

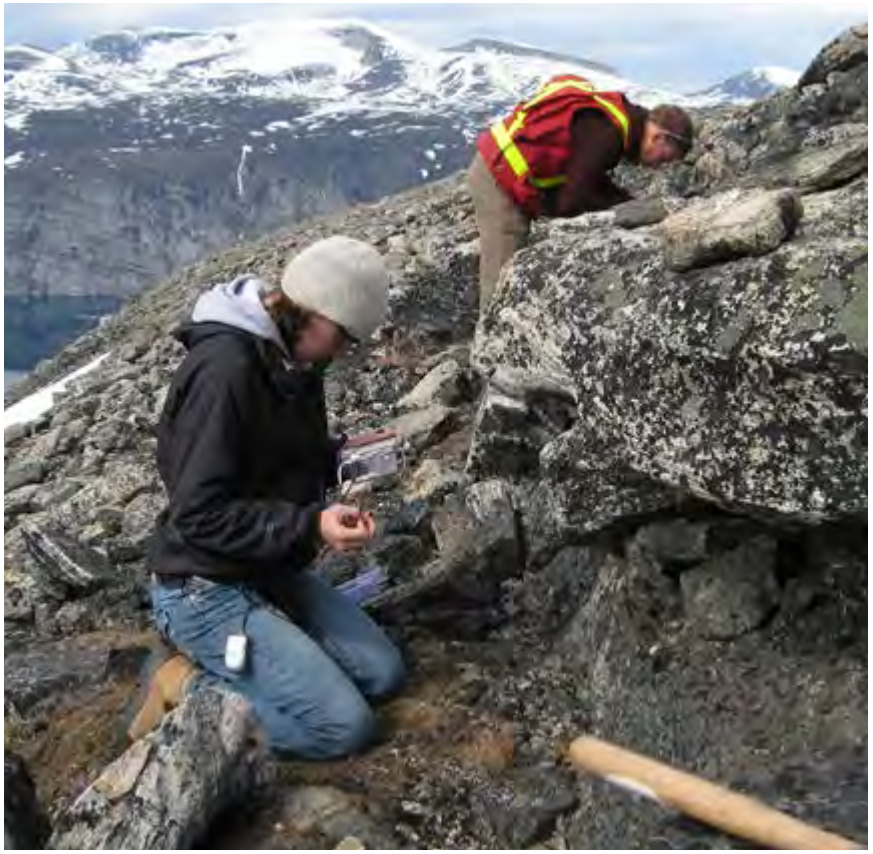
The closure plan as a document does not exist in isolation. In the development of the mine closure policy for a jurisdiction, there needs to be recognition that the plan should align with other commitments (such as those undertaken in the project Environmental and Social Impact Assessment - ESIA). The regulator should also be aware of the broader context into which the closure plan fits, such as local, district, and national targets, strategies, and plans, including national sustainable development and/or socioeconomic targets.

PLAN STRUCTURE

The required structure and contents of a closure plan should be fit for the context and purpose of the mine in question, and for the stage of mining. Largely conceptual closure planning can exist at the early planning stages of the project, although these concepts should have sufficient depth to allow adequate evaluation of their suitability. Conceptual design should not be taken as an excuse for failing to address fundamental technical issues. Further detail about issues and how these will be managed then will be discussed in increasingly more definitive versions as mine planning develops and supporting studies are undertaken.

Existing reports and referenced information should be cited. To prevent the closure plan from becoming an overly large document, only essential information not found elsewhere should be included in appendices. For instance, much of the baseline information that may be relevant for closure planning may be available in the environmental impact studies conducted for the project. Provided these reports are publically available, they can be referenced rather than included in the plan.

There is considerable variation on the structure of closure plans between jurisdictions. For ease of review, it is advisable to have a clearly defined guideline for the required organization of the closure plan. This helps to ensure that all needed elements are included and presented in a form that is easy for the reviewer to follow. A checklist for the major elements of a typical closure plan is shown on page 35.



CHECKLIST FOR THE CLOSURE PLAN TABLE OF CONTENTS		
✓	SECTION	CONTENT
	AUTHORIZATION	• corporate endorsement that the plan contents are understood and agreed with by the company director or other authorized signatory • company contact details for project and head office
	EXECUTIVE SUMMARY	• an overview of the key elements of the closure plan; this may be specified as a "plain language summary" that is aimed towards the wider stakeholder audience and avoids technical jargon
	SCOPE AND PURPOSE OF DOCUMENT	• the intended audience and purpose of the plan, as well as the stage of mine life when the plan was written
	PROJECT CONTEXT	• environmental setting, including climate data (particularly rainfall statistics), flora, fauna, soil, topography, watershed/water basin, groundwater, cultural heritage, and socio-economics of project area and surrounds • project boundary • previous and current project area and surrounding land uses • socio-environmental constraints
	PROJECT OVERVIEW	• a summary of the mine plan, including expected life of mine, mining techniques and methods, and any ancillary processes such as beneficiation • should include the expected dimensions of major project components, and dimensions of the project infrastructure that will be subject to decommissioning (detail may be provided as an appendix)
	STAKEHOLDER ENGAGEMENT	• a summary of engagement methods identifying key stakeholders (including relevant regulators) and their previous and current concerns and how planning has considered these
	CLOSURE OBLIGATIONS	• identification of all relevant legal requirements and company commitments that pertain to the operation's closure, including relevant commitments from other regulatory processes, such as the project ESIA
	NEXT LAND USE	• an overview of the post-mining land use(s) aim, closure objectives, and closure success criteria
	CLOSURE DOMAINS AND DESIGNS	• domains are landforms that share closure management requirements in common and can be treated as a common unit • section includes plans for how each domain will be managed prior to, and during, closure

CHECKLIST FOR THE CLOSURE PLAN TABLE OF CONTENTS		
✓	SECTION	CONTENT
	IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES	• all major closure issues identified for each domain, as well as any issues that bridge multiple domains; a risk-based approach can be used to identify closure issues and the key risks • clearly articulated strategies for addressing closure issues and risks • any data gaps that affect the detailed definition of these strategies should be clearly identified, and closure research plans (with timetables) defined • where closure research plans (such as field trials) have been conducted, the results should be clearly documented, along with the implications for the closure design
	CLOSURE MONITORING AND MAINTENANCE	• details of monitoring that will be undertaken, methodology, and expected monitoring durations with justifications • how monitoring will be reported and addressed (e.g., as part of maintenance)
	FINANCIAL ASSURANCE	• financial assurance requirements, closure cost assessment methods, guidelines, or legal requirements • section should provide clear documentation of the methods used in making all cost calculations, with sufficient information to permit an audit of the estimated values • calculation of financial assurance amounts, using the cost calculation amounts, should include detail on the methods, including reference to discount rates used • fiscal instruments and options or preferred securities with rationale
	DATA MANAGEMENT	• closure-relevant information management including how data will be analyzed and reported upon • reporting and information management protocols, including databases, and any database management documentation needed • data may include monitoring data, research studies and trials, as-built landform design information, site characteristics, and stakeholder engagement records
	REFERENCES	• a list of all the literature cited within the plan, presented in enough detail to allow a reader to source this material

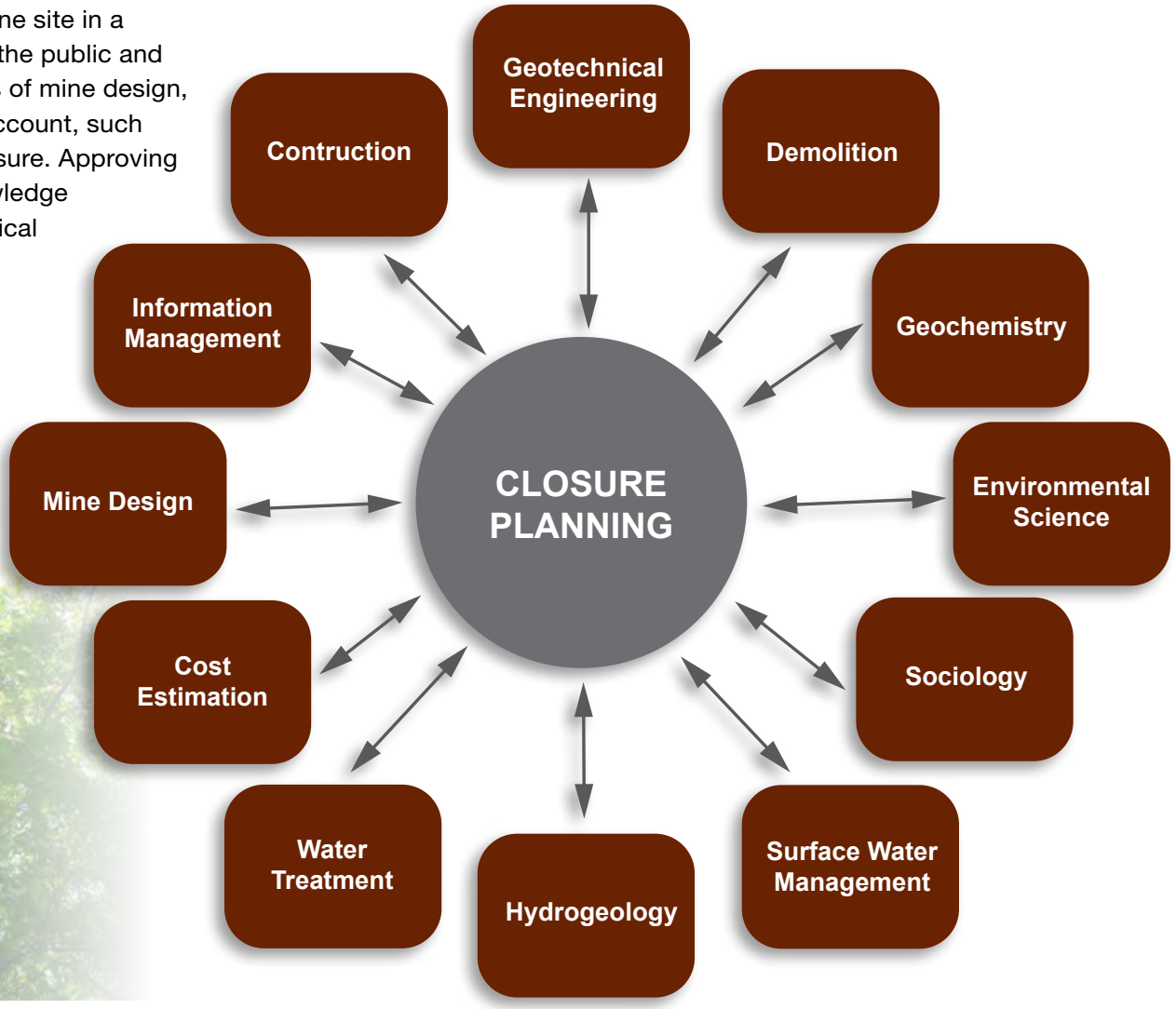
FURTHER READING

DIIS (2016). Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure Handbook Department of Industry, Innovation and Science (DIIS), Canberra, Australia.

2.2 EVALUATING TECHNICAL CONTENT – ROLE OF THE REGULATOR

A good closure plan provides a realistic and defensible approach to implementing closure of a mine site in a way that will minimize adverse effects on the public and environment. Ideally, at the earliest stages of mine design, the closure needs have been taken into account, such that the facility has been designed for closure. Approving a closure plan requires considerable knowledge of closure practices over a range of technical disciplines.

After submittal, the closure plan must be reviewed by the authorities and either approved or returned to the proponent for additional information.



REVIEWER SKILLS

Insufficient review or inadequately trained plan approvers is one of the key reasons that the jurisdiction may inherit abandoned sites or sites that have insufficient financial assurances. Equally, an overly conservative approach to plan approvals may lead to excessive approval times or to investor funds for projects being made unavailable. These may place a jurisdiction at a competitive disadvantage and discourage national and regional economic benefits otherwise expected from mining investment and activity. Potential investors need to see clear rules that are applied consistently and transparently.

This presents a clear policy challenge. As described elsewhere in this document, it is generally not desirable or practical to have regulations that are prescriptive, and that specify exactly what the closure measures should be applied. At the same time, this implies that each closure plan will be unique and present new challenges to the regulator who is tasked with reviewing a document that will cover a wide range of technical specialties. At a practical level, this implies two workable alternatives: either develop capacity or facilitate external review. Each is described below.

MANAGEMENT TYPE	DESCRIPTION	BENEFITS	DRAWBACKS
DEVELOP CAPACITY	Expertise on mine closure can be developed in the regulatory body, to provide an "in-house" team of experts that have the correct professional formation and sufficient experience to adequately review all closure plans.	• Leads to job creation • Provides a consistent team with a common approach to review the requirements of closure planning	• Depending on the funding available, it may be difficult to attract and retain such professionals, as these skill-sets are typically in high demand. • Ongoing investment in training is needed to keep skills current. • A relatively large team is needed, given the variety of topics covered in closure plans (no single professional can be expected to have full competence in all aspects of mine closure, e.g., geotechnical, water management, geochemical). • In jurisdictions with relatively few mines, it may not be possible to maintain such a team occupied solely on the evaluation of closure plans. • In jurisdictions where this approach is attempted but shortfalls occur (e.g., in experience, technical background), the team or individual professionals may be forced to make judgements in areas outside of their expertise, creating the risk of insufficient oversight, or overly conservative oversight rooted in a lack of understanding.

MANAGEMENT TYPE	DESCRIPTION	BENEFITS	DRAWBACKS
FACILITATE EXTERNAL REVIEW	Jurisdictions can establish mechanisms to facilitate external review, usually accomplished by contracting groups of experienced professionals or consulting companies with the needed areas of expertise. This approach may be called a review board, review panel, or qualified third-party review.	• Ensures technical reviewers are experts in the various aspects of mine closure • Allows the maintenance of a smaller regulatory staff	• A regulator with a good overall understanding of mine closure is still needed to assign the review and evaluate the results, but there is no need for the regulator to have expert-level knowledge of every aspect of closure. • A funding mechanism is needed to pay for the reviewers • Specific regulatory mechanisms are required. • Effort is required to ensure consistency in review and requirements between disciplines and mine projects. • Availability of competent reviewers may be limited in smaller economies. It may be necessary to bring in reviewers from outside the jurisdiction, and possibly deal with language issues • Depending on the size of the company it may be challenging to find third party reviewers that are truly independent and not conflicted because of past association with the company.

Clearly, there are advantages to the use of external reviewers to supplement in-house knowledge. However, addressing the funding issue is critical to this, especially in developing economies. The budget for reviewers may simply be part of the funding that the review agency receives from the government, or the mining company may directly fund the third party review. This may be in the form of an application fee ("user pay"), which is administered by the regulator, or another mechanism. As not all closure plans are equal in complexity, consideration should be given to tying this funding to the size and complexity of the project.

REJECTING CLOSURE PLANS

When a closure plan fails to adequately address the needs of closure, the reviewer may need to reject a plan, typically requesting modifications or improvements to the plan. Careful legislative design is needed around the rejection process. The reason or reasons for the rejection must be clear and cannot be arbitrary or unfounded. And the proponent will need an adequate period of time to address the issues that lead to a rejection and provide an improved plan.

The framework around this period of time needs to take into account the fact that, during the period of addressing comments, the operating mining project may be without an approved plan, and potentially without financial assurance (or without sufficient financial assurance) in place. This may continue for an extended period if the plan is rejected more than once. This delay may place the governing body at risk if a sudden closure or bankruptcy occurs. History shows that the mines that are most challenged to present adequate closure plans are also those that are most at risk of unexpected closure. One mechanism to at least partially deal with this is for the company to be required to maintain a minimum financial assurance based on the most recent approved estimate of closure costs, with that assurance amount updated as necessary once the approvals are finalized.

2.3 POST-CLOSURE LAND USE

Many closure practitioners argue that selecting post-closure land use is the single most important decision in developing a closure plan, as all closure and reclamation activities will be defined based on the next use of the land. With the evolution of modern concepts around sustainable development, it may not be sufficient to simply attempt to return the land to the pre-mining conditions, nor is that always the most practical goal. Therefore, care should be taken to avoid simplistic policy that simply advocates (or prescribes) a return to pre-mining land use.

Policy should promote a focus on post-closure land use that starts in the early planning stage of the mine and continues through operation as part of a dynamic and evolving closure plan that captures regulatory constraints, community input, economic aspects, and needs for post-mining stewardship.

CHECKLIST: POST-CLOSURE LAND USE POLICY REQUIREMENTS		
✓	BE SURE TO...	BECAUSE...
	INVOLVE STAKEHOLDERS	• In modern practice, the vision of post-closure land use is determined not only by the operator, but also by many groups of stakeholders that have expressed interest in the surrounding areas. Closure policy can help ensure early consultation and engagement between key stakeholders with a focus on defining an acceptable land use or (more commonly) a range of land uses. Finding a common ground that is technically achievable, economically practical, and widely accepted by all the parties presents challenges and opportunities.
	ALIGN WITH ALL LEVELS OF PLANNING	• Ideally, the post-closure land use is developed in a way that considers and aligns with landscape level planning, watershed level and basin level planning, and ecosystem services protection and enhancement.
	START EARLY	• Target post-closure land uses will influence, and be influenced by, all aspects of closure planning (e.g., landform design, access, revegetation).
	BE ADAPTABLE	• While policy needs to encourage the definition of post-closure land use during the planning stage of closure, it should not restrict the evolution of the planned approach in response to changing community expectations or the appearance of innovative approaches. A clear framework that fosters innovation, clarity, and realistic goals assists regulatory bodies, and also the ultimate land users (communities and the environment).

For policy guidance on post-closure land use, the following topics will need to be considered, and developed in line with the goals and aspirations of the jurisdiction:

- protection of health and safety of the public and future users
- remediation and reclamation objectives
- geomorphic landform design that integrates the area into the surrounding environment
- environmental stewardship and ecosystems biodiversity
- preventing or minimizing off site impacts to water or air quality
- traditional land use and community expectations
- land tenure (or land ownership after the mine closure)
- relinquishment aspects as discussed elsewhere in this document

POSSIBLE POST-CLOSURE LAND USES

While by no means an exhaustive list, the following gives some idea of the types of post-closure land uses that have been adopted or planned for other mine sites:

- forestry
- agriculture
- fish farms and aquaculture farms
- recreational areas, botanical gardens, and parks
- heritage and tourism attractions
- educational, sports, and leisure facilities
- wildlife habitat areas and ecological preservation areas

2.4 PROMOTING PHYSICAL AND CHEMICAL STABILITY – THE TECHNOLOGY OF CLOSURE

> ***It is imperative that closure policy focus on ensuring that all closure plans fully and adequately address both the physical and chemical stability of the site and off-site impacts, with closure measures identified where necessary to ensure that reasonable long-term stability standards are met for both.***

The technical content of a closure plan is critical. The probability of successful implementation of the closure plan is directly related to the quality of the technical design behind the closure measures. No amount of policy and regulation will compensate for technically insufficient closure measures.

The technical measures needed to promote long-term physical and chemical stability are drawn from a wide range of practice areas, and can range from earthworks and geotechnical engineering to stabilize slopes and provide access control, to the design, testing and operation of sophisticated water treatment plants. Evaluating the range of options available, and assessing the adequacy of the technical measures selected by the proponent, requires considerable professional knowledge and judgement.

This document cannot provide a complete overview of all of the technological approaches to assure physical and chemical stability of closed mine sites. There is a wide range of published literature on the topic which can be referred to by the interested reader. However, the checklist on the next page identifies the principal areas of interest for chemical and physical stability that should be addressed as appropriate in the closure plan. Additional resources are identified in Appendix A of the Checklist.

PHYSICAL AND CHEMICAL STABILITY CHECKLIST FOR MINE CLOSURE

DOES THE MINE CLOSURE PLAN CONSIDER...?		
✓	**ASPECT**	**CONSIDERATIONS**
	MINE WASTE MANAGEMENT	• Closure measures are specific to the types of mine waste that will remain on site. • Closure objectives should be defined for each facility. • Design criteria are measurable and are generally more stringent for closure condition than operations due to the long time period.
	DESIGNING TAILINGS MANAGEMENT FACILITIES FOR CLOSURE	• Design the tailings facility for closure, and include closure considerations in the selection of tailings management options. • Ensure that all common failure modes for physical stability are considered in evaluating the long-term design of the dam: overtopping, slope instability, seismic effects, tailings liquefaction, wave erosion, runoff erosion, wind erosion. • Evaluate consequences of future dam failure. Where consequences are high, ensure best design and operation practices are in place: qualified review boards and engineers of record; operation, maintenances and surveillance plans; emergency preparedness plans. • Evaluate long-term chemical stability of tailings and dams. Predict contact water quality, and ensure that impacts on surface and/or groundwater will be within acceptable limits. Evaluate approaches to prevent, minimize, or treat impacted water.
	DESIGNING WASTE ROCK FACILITIES FOR CLOSURE	• Overall stability typically governed by the strength of the soil foundation at the toe of the dump. • In seismic regions, design should consider long return period earthquakes and effects of rock weathering. • Consider closure needs and desired final landform at the time of waste placement. • Characterize potential impacts on contact water, with approaches to prevent, mitigate and/or treat impacted waters as needed. • Low grade and unused ore stockpiles to be treated similarly to waste rock facilities if present at closure.
	DESIGNING FOR CLOSURE FOR OTHER MINE WASTES	• Other common types of mine waste include slag, heap leach waste, process residues, and uranium tailings. – **Slag** is usually chemically stable, but still requires characterization. – **Heap leach waste** may need to be drained or flushed (although flushing is not always appropriate in dry climates). The estimated time to drain down and plan for the management of residual discharges should be addressed in the closure plan. – **Process residues** vary and will need individual characterization and planning. – **Uranium tailings** require special treatment.
	WATER MANAGEMENT	• Develop plan with an understanding of baseline conditions. • Risk-based planning should take into account contaminant sources (mine wastes), transport mechanisms (surface water, groundwater), and potential receptors (human, environmental).

DOES THE MINE CLOSURE PLAN CONSIDER...?		
✓	ASPECT	CONSIDERATIONS
	MINE DRAINAGE	• Water impacted by contact with mine waste (acidity, metals) can be one of the greatest ongoing liabilities after closure. • Early stages of the closure plan should include geochemical characterization of mine wastes, identification of potential issues, and control strategies. • First priority in closure planning should be the prevention of impacted drainage, followed by mitigation, and if neither is sufficient, treatment (see below). • Evaluate watershed dynamics upstream and downstream of facilities, including constraints and influences on flows (culvert failure, natural dam bursts).
	PIT LAKES	• Typically have steep sides, great depths, and large volumes. • Need credible predictions of long-term water quality. Poor water quality can present many closure challenges, including off-site impacts and death or damage due to ingestion. • Consider safety risks (eg, highwall falls, drowning). • Pit lakes may offer opportunities for benefits: new ecosystems, water supply/storage, new development opportunities, recreation, aquaculture, energy generation.
	WATER TREATMENT	• May be needed if site water or water discharges fail to meet closure criteria. • Generally incompatible with relinquishment of mine if long term, and is challenging to cost accurately. • Should be avoided where practical. If needed, should consider range of possible technologies—active and passive treatment, hybrid methods. • Benefits are an opportunity for continued employment, economic development, and promotion of continual site presence with associated benefits to ongoing site-wide monitoring and maintenance.

The design of closure measures will take into account economic conditions. From the point of view of the proponent, closure design is shaped by a desire to attain the closure objectives in the most cost-effective way possible, considering both the capital expenditures needed to attain the closure and the operating expenditures needed (if any) in the period after implementation of the principal closure works.

Where long term operating expenditures are needed for the closed site, the financial burden (and potential liability) implied by any needed operating expenditures can greatly exceed the capital expenditures. The desire to control or eliminate this cost and associated liability is often expressly stated as the desire for “walk-away” closure solutions.

2.5 DESIGN CRITERIA AND PLANNING HORIZONS

DEVELOPING CRITERIA

One of the fundamental needs for both regulators and mine closure designers is to decide on acceptable criteria. Criteria should provide the designer with answers to questions such as:

"What is acceptable water quality for my site's discharge?"

"What factor of safety is acceptable for the stability of waste rock dumps? Or tailings dams?"

"What design storm should I consider for my water channels?"

There are no universal answers to these questions, as the criteria are tied to what needs to be achieved—something that can vary not only between sites, but also between different installations on the same site. The development of criteria for mine closure is further complicated by the very long planning horizons, as discussed later in this section.

TYPES OF CRITERIA

Closure criteria may be developed through either a "risk-based" or an "objectives-based" approach. Both approaches have been used by jurisdictions around the world and provide different benefits. These two approaches are not mutually exclusive and can be combined. In both cases, the criteria are tailored to the site needs.

- **Risk-Based Design Criteria—** In the risk-based approach, the risks posed by the facility are identified first. Measures to control the risks are then identified and evaluated in terms of their effectiveness and risk reduction potential. The risk-based approach is introduced well in the *International Council on Mining & Metals* toolkit (ICMM 2008), which forms part of a practical framework for closure planning throughout the mining life cycle.

- **Objectives-Based Design Criteria—**In the objectives-based approach, closure objectives are defined and criteria are established. Closure measures are then developed to meet these criteria. An example and clear description of the objectives based approach can be found in the *Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories (MVLWB/AANDC 2013).* Criteria are a direct result of the objectives that have been agreed upon. The objectives-based approach to developing criteria should not be confused with prescriptive criteria, where universal criteria are applied to all sites without regard to site-specific conditions. The prescriptive approach is generally not advisable.

PLANNING HORIZONS

When developing criteria for mine closure, the issue of the planning horizon (the period of time accounted for by a plan) must be understood. In most engineering applications, a relatively limited design life is normally assumed, rarely in excess of 50 years. However, in the case of mine closure, it is clear that, conceptually, the closure works are expected to last a very long time: concepts such as "in perpetuity" or "until the next ice age" are commonly seen in mine closure literature.

At some point in the development of the closure plan, it may be necessary to state a "design life" for closure. There is relatively little agreement about what constitutes an appropriate design life for closure, and considerable variation in the understanding of the concept. However, the planning horizon can have a tremendous impact on closure costs, liability, landform design, and community expectations. Considerations of planning horizons also inevitably link to considerations of global climate change, which are discussed in the following section of the Checklist.

In talking about planning horizons for mine closure, it can be useful to separate the discussion into three concepts:

- the design life of the overall closure system
- the design life of a specific closure component (e.g. concrete used in a spillway)
- the recurrence interval of a design event (e.g. a 1:200- or 1:1,000-year storm)

It is possible that all three of these can be different for a single closure plan. For example, a closure period of 1,000 years may have been selected as the design life for the site closure. On the other hand, the design storm used to size water diversion studies may be the 1:200-year, 24-hour storm, based on an analysis that shows that if the design storm flow is exceeded, the overflow of the diversion system will have acceptable consequences. At the same time, a concrete structure needed for some aspect of closure may be constructed with concrete that has a design life of 50 years, with the understanding that this structure will need to be periodically renovated throughout the design life of the overall system.

WHY IS THERE NO CONSENSUS ON DESIGN LIFE FOR CLOSURE?

Part of the problem arises from the tension between the limits on what we can reasonably design based on engineering experience and the self-evident reality that a closed mine can be expected to remain for the indefinite future, until geological processes over thousands or tens of thousands of years completely reshape the area.

Key issues include:

- **Limits of Engineering Practice**
  - There are very few engineering experiences available with which to meaningfully evaluate design periods greater than about 100 to 200 years.
  - Closure periods of over 10,000 years are beyond the reach of what we can meaningfully analyze with models calibrated against real world experience.
  - In periods of time of the order of 10,000 years, one can quite reasonably expect geological processes and significant climate change will have an impact on any closure design, especially taking as context that the last major period of glaciation (or ice age) ended about 11,000 years ago.
- **Human Institutions —** Relatively few human institutions have lasted more than a few hundred years.

Further Reading Logsdon (2013). What does “perpetual” management and treatment mean? Toward a framework for determining an appropriate period-of-performance for management of reactive, sulfide-bearing mine waste. IMWA 2013 Golden, Colorado p. 53–58.

Best Practice: Jurisdictional mandates for design life should ideally take into account both the limits of engineering practice and of our institutions. One of the more practical formulations balancing the limits of engineering practices with very long design lives was developed for the US Uranium Mill Tailings Radiation Control Act of 1978, which required closure measures to be effective “for up to 1,000 years to the extent reasonably achievable and, in any case, for at least 200 years”. According to Logsdon (2013), the EPA guideline was formulated to cover the ”periods over which climatological and geomorphic processes could reasonably be predicted, given current knowledge of earth sciences and engineering.” The 200-year period can be seen as being reasonably within reach of analytical or predictive engineering approaches, while the 1,000-year span enters into the realm of qualitative evaluations (Logsdon 2013).

2.6 FACTORING IN CLIMATE CHANGE

Given the long design period associated with mine closure, and concern about climate change, it is reasonable that the regulator should ask the proponent if climate change has been considered in the closure design.

Two key questions that must be considered by mine closure regulators are "How does climate change affect mine closure?" and "How can we deal with climate change in closure plans and policy?" Some guidance on these two questions is provided below.

HOW DOES CLIMATE CHANGE AFFECT MINE CLOSURE?

The development of closure designs is closely linked to the physical climate in which the mine site is located. Water management, dust generation, and reclamation needs are all quite different in arid and wet climates. Water management in particular is a key component of most mine closure planning: water can affect physical stability through erosion, or dissolve and transport potential contaminants either on the surface or underground, as well as affect revegetation strategies and outcomes.

As discussed in Design Criteria and Planning Horizons (Section 2.5), the climatic history of a site (usually represented by data ranging from a few years to at most a hundred years) is used to make statistical predictions about the probability, frequency, and magnitude of future climatic events. These predictions are all based on the assumption that the site's climatic history represents the site future. With short duration datasets and especially with climate change, this assumption may not be true.

What might be the results of climate change?

- **Rainfall patterns can change** with sites becoming drier or wetter than they have been historically. Equally, sites may experience greater rainfall variability, with extended dry seasons and wet seasons featuring higher rainfall than previously. The frequency of large storm events may change, with storm events becoming more frequent and and/or intense. Greater duration or intensity rainfall can increase a number of risks, including risk of dam or water management system failure.

- **Drier climates** may challenge re-establishing vegetation and reclaiming terrain with the mean climate of arid areas possibly becoming drier.

- **Temperatures may rise.** Predicted increases are greater at higher latitudes. The extent and thickness of permafrost (permanently frozen ground) is expected to decrease, while higher evaporation rates may benefit closure water balances with less water to treat or manage.

- **Sea levels may rise**, affecting sites located close to the coast and coastal waterways, both through erosion and inundation.

HOW CAN WE DEAL WITH CLIMATE CHANGE IN CLOSURE PLANS AND POLICY?

Current climate models all predict significant changes in the global climate, including increased variability (IPCC 2007). However, there is considerable uncertainty regarding how much change will occur, and little consensus on design practices to account for climate change.

There are two common approaches for regulators to assess if climate change has been fully accounted for in closure planning:

MANAGEMENT TYPE	DESCRIPTION	BENEFITS	DRAWBACKS
ADAPTIVE MANAGEMENT	• Closure measures are designed to the best of our current knowledge with design criteria that are focused on accommodating long-term conditions and extreme events (such as the 1-in-1,000-year storm event). • A strategic plan using adaptive management is needed to monitor changes in climate, and adapt closure planning as needed. This may require modifying designs after construction or repairing structures after extreme events.	• Simplicity—adapting to changes may be easier than trying to predict them. • The approach may reduce the risk of overly conservative designs.	• The approach may require an owner/manager that is providing ongoing oversight, evaluating conditions, and has the resources to carry out repairs and design modifications to better suit the changing climatic conditions. • Who is liable for the site if conditions change outside the planned envelope?
PREDICTIVE MANAGEMENT	• Closure planners use climate models to predict future conditions at the site. • Normally, the models are run for different climate scenarios to understand a range of possibilities. A precautionary approach would use the more conservative model outputs in planning. • Conditions under climate change are considered in the design. This consideration may mean planning, including landform designing, to more conservative criteria, or simply evaluating the impacts of the changes and their likely change in risk.	• Allows for design to meet a modelled future condition. • Does not require the same level of ongoing authority to implement changes.	• Accuracy of predictions may be poor. • If predictions are wrong, who is responsible for potential repairs or maintenance that may need to be implemented?

When evaluating climate change impacts for mine closure, consideration should be given to the aspects of the mine that will be affected differently from the surrounding natural terrain. For instance, the performance of a soil cover to reduce infiltration to mine waste could be impacted, and should be evaluated. But climate change could be expected to affect vegetation at both a reclaimed site and the surrounding natural terrain equally. It would not be reasonable to design a site closure to be more resistant in closure to climate change than the surrounding natural terrain.

2.7 SOCIO-ECONOMIC ASPECTS OF MINE CLOSURE

Mines, and the communities around them, often develop interdependent relationships. During mining operations, mines can benefit communities, through both employment opportunities and other benefits such as improved education, training, and health care. These benefits may be particularly marked for women and other otherwise less privileged groups. However, where the mine is a significant component of the economy, mine closure can have devastating local and even regional economic impacts for decades after closure. It is also true that the impact of a mine closing is greater in a developing economy than it is in developed economies where there are greater alternative employment opportunities as well as a more robust social safety net.

> ***The challenge of closure policy for social perspectives is to manage the effect of both the operation and the closure of the mine on the changing local and regional societal landscape.***

2.7.1. STAKEHOLDER ENGAGEMENT

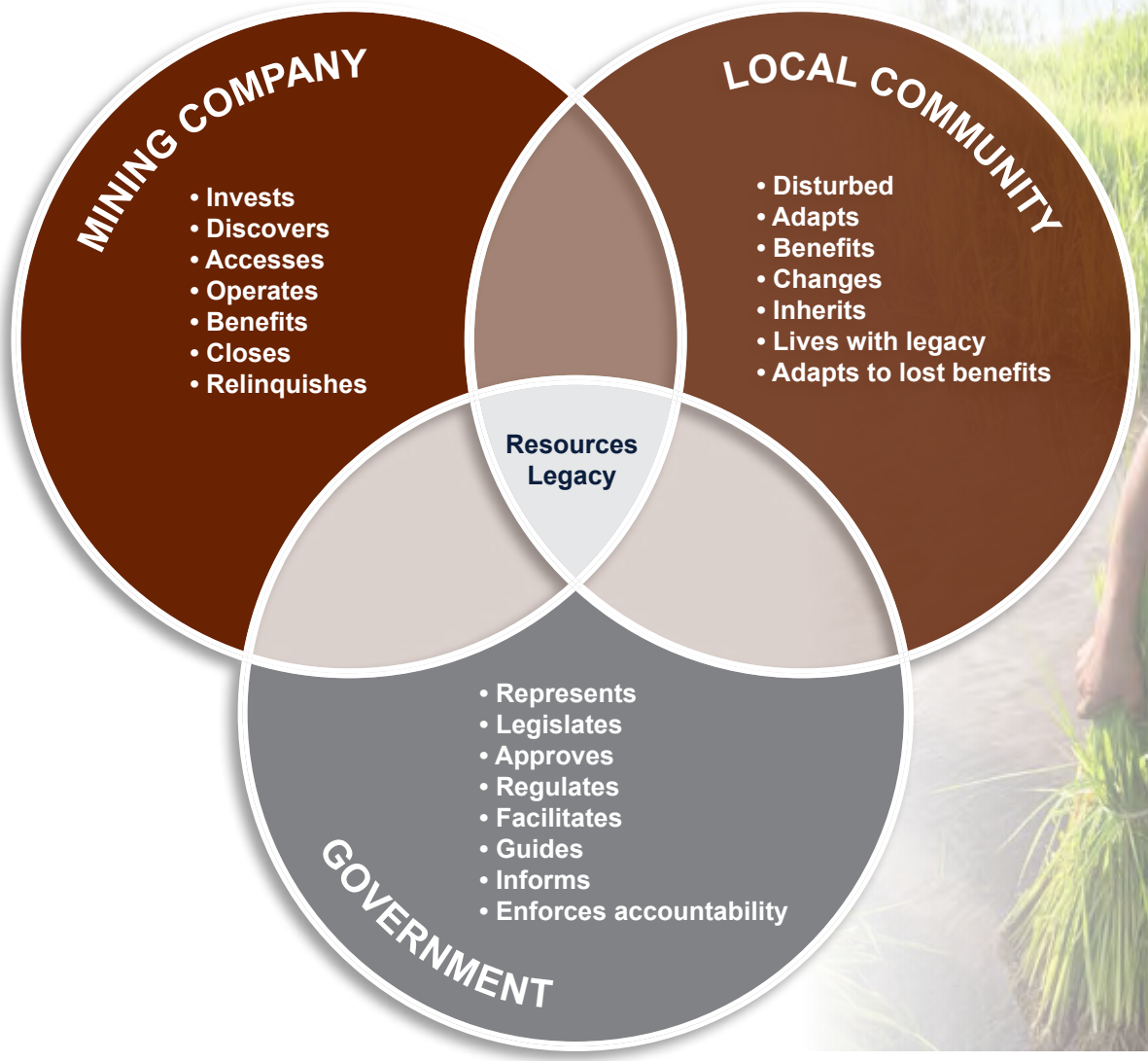
- **Stakeholders** are parties (other than the mining company) who have a vested interest in the mine closure. Stakeholders should be considered as closure planning partners as they can help with identifying potential risks and their solutions.
- **Engagement** means that stakeholders are informed about closure planning and have opportunities to provide input. Meaningful stakeholder engagement is not an end in itself; rather, it is about both mining company and stakeholders speaking and being heard in turn. Stakeholders are invited to participate in the process so that it is about giving information to stakeholders about mining company views as much as receiving stakeholder thoughts in return.

Policy must direct that stakeholder input is key to any closure planning and must be included for planning to be effective. Engagement begins with identifying stakeholders and then matures into a mutually beneficial strategic activity.

Stakeholders may include the following broad groups:

- Government (local, regional, and national)
- Company, Joint Venture or Operator
- Communities existing nearby, or migrating toward the project
- Employees/workers
- Local businesses
- Lenders/development agencies
- Decommissioning subcontractors
- Industry organizations
- Insurance/bond/third party guarantee providers
- Civil Society/NGOs
- Volunteer and local non-profit organizations
- Elected officials
- First Nations or indigenous communities in the project area

Stakeholder Engagement Recognizes Stakeholders as Key Participants in the Closure Planning Process (after Lacy and Bennett 2015)



Mine closure regulation should guide closure planning to recognize that stakeholder groups and their views can change over time. There also may not be uniform agreement between groups or even within a specific stakeholder group. Engagement with stakeholders does not mean agreement with stakeholder views. However, it does mean their views are acknowledged and considered in planning.

Policy should require that minority and disadvantaged subgroups also be considered separately in community engagement programmes as they both play a critical role in the social dynamics of any community. For instance, more vulnerable and least resilient community members may include women, girls and boys, old people, disabled people, less privileged groups in the community, and any religious or ethnic minorities.

The significant role that women play in decision making, particularly in indigenous societies, is very important when working with communities. Equally, women may often have less social influence when mining occurs and may also have less access to the opportunities generated by mining, where mining employment and income are often largely captured by men. Women's participation in engagement often facilitates more broad based and lasting community outcomes as women may raise concerns more directed toward family welfare. Engagement should ensure that both women and men from different social groups are consulted. One way to accommodate more vulnerable groups and women in particular is to plan engagement activities at times where women and other potentially marginalized groups can attend, or to set up meetings exclusively for those groups.

Engagement should capture stakeholder ideas and concerns by being:

- early, with identifying of stakeholders in exploration phases
- frequent, permitting stakeholder views and project changes to be captured
- honest, developing trust for the engagement to be meaningful
- transparent, so that parties do not feel excluded or prejudiced against
- bias aware (e.g., ethnicity, gender) and aware of existing social dynamics
- equitable, addressing prior or novel social discriminations and privileges

Closure-oriented engagement should occur during all of the following key phases:

a) **Planning mines**—discussing anticipated mine life, principal closure measures, post-closure land use. Much of this information should be captured during ESIA activities as part of planning and approval work.

b) **Mines under construction**—especially disruptive to communities previously unaffected by mining. Updates on any material changes to closure strategies or post-closure land use as a result of more definitive closure planning.

c) **Operating mines**—regular updates on mine life (including relevant mine plan changes).

d) **Closing/closed mines**—critical phases of mine life for ongoing engagement with the workforce and communities. Engagement should provide regular updates on the progression of closure activities, and later the results of post-closure monitoring.

Early in the mine life, it can be difficult to get stakeholders interested in engaging on closure. However, there are important benefits to early engagement that make the effort worthwhile. In particular, early engagement can help with end land use planning, and shaping realistic reclamation research programs.

Case Study: *Argyle Diamond Mine, Australia. Participation Agreement*

The Argyle Diamond mine is situated on Barramundi Gap, a site of particular cultural significance to both Miriuwung and Gija women.

As part of closure planning, Argyle Diamonds held an options identification workshop with Traditional Owners, which generated several preferred closure options, and stakeholder engagement has been a critical element of the pre-feasibility study. Argyle Diamonds has also committed to provide training on land management and reclamation. The mine site includes significant infrastructure, including the airstrip and the Argyle Village. Traditional Owners will have an opportunity to submit a business plan to maintain and use infrastructure after closure.

Ongoing engagement related to closure has been sensitive to the fact that that the initial community engagement about the development of the mine, and the community agreement signed at the time, gave insufficient regard to the fact that the mine was on a site of particular significance to women. For two decades after the mine commenced, senior Traditional Owners attempted to renegotiate the relationship between the mine and the local community to give due regard to the site's significance to women.

Further Reading

DIIS (2016). Leading Practice Sustainable Development Program for the Mining Industry – Community Engagement and Development. Department of Industry, Innovation and Science (DIIS), Canberra, Australia.

Government of Canada (2015) Corporate Social Responsibility CSR Checklist for Canadian Mining Companies Working Abroad. NRCan.

Oxfam (2016). Gender and the Extractive Industries: Putting Gender on the Corporate Agenda. Gender and the Extractive Industries. Oxfam.

World Bank Multistakeholder Initiative (2010) Towards Sustainable Decommissioning and Closure of Oil Fields and Mines: A Toolkit to Assist Government Agencies. Version 3.0, Toolkit 5, Stakeholder Engagement and Continuous Improvement.

2.7.2. TRANSITIONING ECONOMIES

Mining is a temporary land use. The duration of a mine's operations may range from a few years to several decades, and can be expected in many cases to cause socio-economic changes. In the case of longer mining durations, the changes brought about by mining activities can result in major shifts in economic activity across an entire generation, resulting in cultural changes. Closure of the mine can initiate significant transition for both the economy and the society, and the resulting impacts will be heavily influenced by what capacity (material and social) has been created during mining operations, as well as the condition that the land is left in. Mitigation must be managed through regulation underpinned by sound policies. Incorporating social impact assessment and socio-economic dimensions is central to closure planning processes.

Potential Socio-Economic Impacts of Closure and Possible Mitigation Strategies

IMPACT	PROPOSED MITIGATION
Land use change Substantial transformation of the landscape by surface mining, which may inhibit restoration of previous land uses, or cause permanent changes in possible land use.	• Plan around landscape transformation and even include it in strategic design. • Examples: pit lakes for aquaculture, modification of steep terrain to provide more arable land.
Unemployment – Serious and lasting impact on regional socio-economics following mine closure. – Loss of direct and indirect employment opportunity. – Deterioration in job quality and income with less technical, well-paid roles. – Unemployment often occurs simultaneously with loss of municipal services such as transport services, schools, and health clinics.	• Education, particularly training teachers, and supporting women's organizations, especially economic development of women, can assist with building community-wide resilience and capacity to change. • Micro-development and local job creation is a typical way to build resilience in post-closure societies. However, it can take many years for these benefits to take effect and their contribution to overall employment may be small in terms of economic growth at larger geographic scales. Subsidization may also prolong the time taken for these economies to realize and adapt to post-mining market conditions. • Consideration should be given to measures that support a larger private sector, including jurisdiction-owned enterprises, as these industries may provide greater employment capacity.
Migration – Workers who have migrated into the area and may not feel an ongoing sense of place and desire to remain following mine closure. – Loss of population as they migrate to other areas with greater employment prospects. – Locals who become accustomed to economic benefits of mining may choose to leave and seek other opportunities when benefits end.	• Policy may choose to continue to support, or even develop, migration or transportation, increasing employment opportunities.

Policy for closure should ideally promote that closure plans:

- consider previous and current local, social, and economic conditions and build upon relationships with stakeholders (particularly local communities) when planning for future local and regional economies
- allow enough time for adequate transition strategy development for local economies/workers from operation to closure/post-closure conditions; this time may be longer and the assistance may need be greater for less resilient society members

Policy That Contributes to a Successful Next Use of Mined Lands (after McCullough et al. 2009)

CONDITION	DESCRIPTION
Sustained community involvement	Includes an inclusive stakeholder process. Early and regular dialogue with all relevant stakeholder groups.
Site reuse vision	Creation of site reuse vision is achieved through meetings, visioning sessions, and workshops involving local communities. Vision minimizes risks, but also maximizes opportunities for next use benefit.
Reuse process oversight	Form an advisory committee to oversee the development and identification of key individuals responsible for reuse development and stakeholder communication. Rationalization of social assets and infrastructure.
Coordination with regulatory agencies	Reuse options will be governed by regulations. Information flow and advice between regulatory authorities and the development group are essential for a successful outcome. Alignment of completion and land use criteria to strategic regional development aspirations.

- include the involvement of both women and men from all sections of the community in economic activities to help foster more resilient communities and increase the possibilities for enhancing the skills base in the community, improving incomes and reducing poverty

- consider differences in the gender and socioeconomic status of local community members in early studies of local economies; otherwise, standalone studies to better understand the ramifications of transitioning economies for different genders should be considered

Most post-closure benefit tends to be available from mines that are closed near urban centres or in rural areas where there is a high demand for land. Closure of remote mining operations, regardless of the state of regional development, tends to demonstrate less contribution toward next land use socioeconomic opportunity.

During the implementation of closure and monitoring activities, there may be opportunities to ameliorate the reduction of employment opportunities by promoting local procurement for the closure works. This can be done by a number of mechanisms. For instance, with proper anticipation of closure, local skills development can begin early, ensuring that local professionals are available with the right skills for closure activities such as maintenance, monitoring, and water treatment plant operation. Similarly, preference for local procurement, which should be established as a practice in operations, should be continued through the closure and post-closure stages.

Case Study: *El Chifón del Diablo mine, Lota, Chile – Negative Impacts*

The closure of El Chifón del Diablo mine in Lota, Chile, is a classic example of long-lasting negative and unintended consequences following closure. The underground coal mine operated between 1857 and 1997, with multiple changes of ownership, the final one being to the state-owned company Enacar. The final closure took place before the implementation of modern mine closure practices in Chile, with dramatic negative consequences for the town of Lota, which depended completely on the mine. More than a decade after closure, the once-thriving town of Lota maintained some of the highest rates of poverty and unemployment in the economy. In the two decades since closure of the mine, projects have been launched to try and capitalize on the mining history of the district and develop former mine works as a tourist attraction. Despite these efforts, the negative impacts of the closure persist.

Case Study: *Island Copper Mine, Canada – A positive legacy*

This large open pit copper mine operated for 25 years and ceased operations at the end of 1995. The closure involved a number of technical innovations, including meromictic pit flooding. From a community standpoint, the closure of the mine was carefully planned in advance, based on the expected life of the mine. The mine owners took into account the sustainability of the nearby community of Port Hardy, which had housed most of the mine staff. They promoted alternative post-closure uses of the site, including wood processing and aquaculture. Workers benefitted from retraining opportunities, which resulted in successful working transitions for many of the workers.

Case Study: *Island Misima, Papua New Guinea (PNG)*

The Misima Gold Mine commenced commercial operation in 1989, with the end of open pit mining in 2001, closure of the operation 2004, and relinquishment in 2012. The entire site has now been revegetated and rehabilitated. Following closure, the basic services and infrastructure, provided by both the mine and the PNG government, have declined significantly, due to limited funding and the effect of the distance between Misima and Alotau. Other than work related to the current monitoring of environmental reclamation, there have been no major economic developments on Misima to replace the mining-derived income. As a result, the Boiyo people are now trying to put back together how their lives used to be 20 years ago before the mine came, which was largely subsistence farming and cash cropping.

Further Reading

McCullough, C. D.; Hunt, D. & Evans, L. H. (2009). Sustainable development of open pit mines: creating beneficial end uses for pit lakes. In, *Mine Pit Lakes: Characteristics, Predictive Modeling, and Sustainability* Chap. 22. Castendyk, D. & Eary, T. Society for Mining, Metallurgy, and Exploration (SME), Colorado, USA, 249-268p.

ESCAP (2003). *Policies, Regulatory Regimes and Management Practices for Investment Promotion and Sustainable Development of Mineral Resources Sector in Economies in Transition and Developing Countries of East and South-east Asia*. Energy for Sustainable Development in Asia and the Pacific (ESCAP), United Nations.

2.8 IDENTIFY CLOSURE MANAGEMENT AND MONITORING REQUIREMENTS

Successful closure and post closure will require both management and monitoring effort, and closure policy should ensure that this effort is properly dimensioned.

Management is needed to ensure that all needed efforts are carried out and documented appropriately. Monitoring and reporting of closure progress is a key part of closure planning: it is the mechanism by which the effectiveness of the mine closure is demonstrated. Monitoring should have clear objectives that meet the needs of the closed site and should use standard methods where possible. The use of standard methods is preferred to allow easy interpretation and acceptance of the results by third parties. Those third parties could include both regulators and the community.

Mine closure policy should ensure that effective progress toward closure objectives is demonstrably made by:

- monitoring closure works against agreed-upon closure milestones expressed as criteria to be met at a specified time
- assessing the efficacy of closure works (progressive and final) throughout the life of mine
- reacting to changes flexibly (adaptive management) and addressing issues in a timely and cost-effective way
- providing sufficient post-closure monitoring until all closure criteria are met and relinquishment is formalized

Some common closure risks, such as mine drainage issues, can continue or even develop many years after a site has been closed.

Closure policy should realistically address the time it may take for some closure risks to manifest themselves, with monitoring methods and management oriented towards such delayed risks. The duration of the monitoring period should be addressed on the basis of site-specific risks, rather than adopting a blanket duration of 5 or 10 years, which is likely to be excessive in some cases and insufficient in others.

MANAGEMENT AND MONITORING AIMS

Policy should ensure that in the closure and post closure period, the management and monitoring will:

- evaluate the success of closure measures
- validate model predictions (for example, validating the predictions of how long it will take for pits to refill with water after closure)
- gauge stakeholder attitudes, such as satisfaction with completion of the closure works

Monitoring policy should also require clear social objectives and frameworks that include as appropriate gender-sensitive indicators with data that are separated by gender.

Further Reading

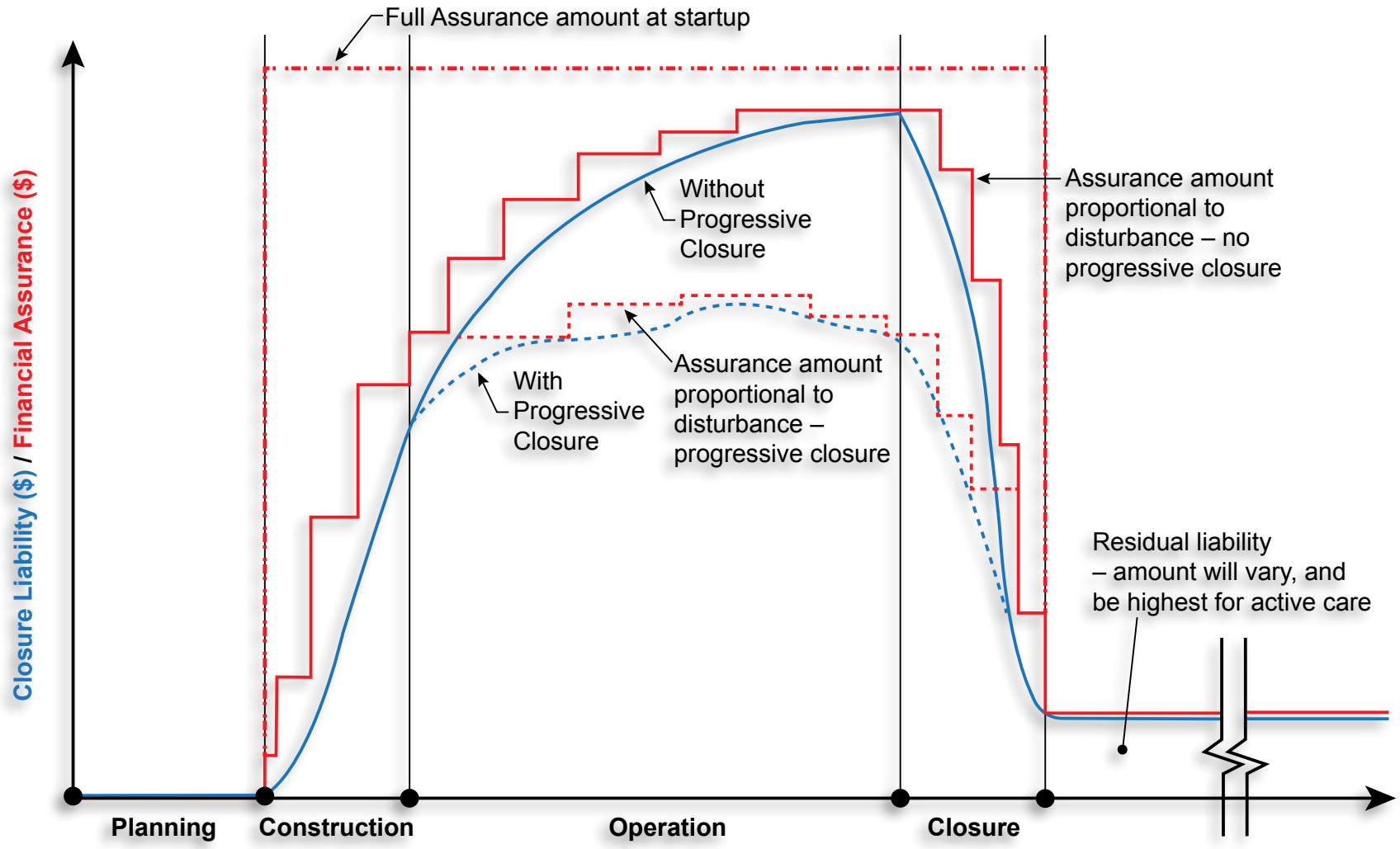
DIIS (2016). Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation. Department of Industry, Innovation and Science (DIIS), Canberra, Australia.

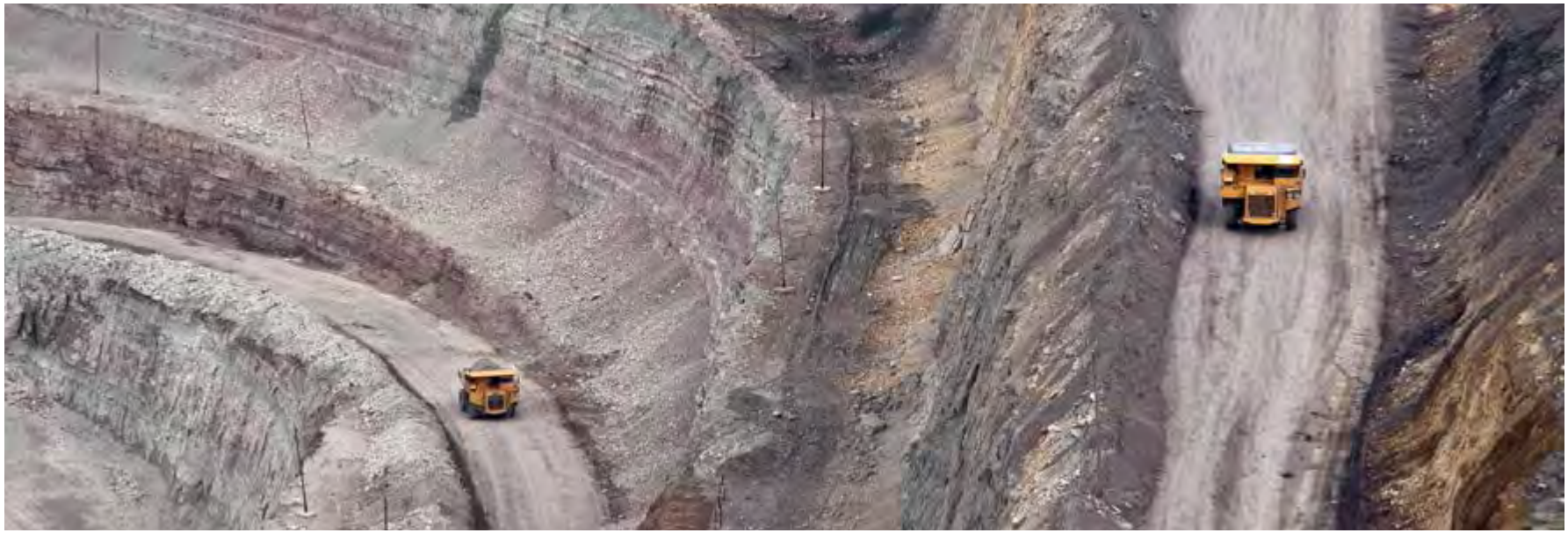
2.9 DEVELOP CLOSURE FINANCING POLICY

Historically, many mines were simply abandoned when they ceased to be economically viable. Currently, there are tens of thousands of abandoned mines around the world. This has left a legacy of hazards to public safety, environmental damage, and sterilization of land. The liability associated with the safe closure of these orphaned or abandoned mines has generally fallen back to the public through the jurisdictional authority. The cost to close an individual mine site may run from tens of thousands to over a billion dollars, depending on the characteristics of the mine.

To ensure that governments have the funds to properly close mine sites in case of abandonment, many jurisdictions now require that proponents of new mines post some form of financial assurance as a prior condition to being granted approval to construct and operate the mine, as well as for operators of existing mines to ensure that they have the necessary assurance in place. The purpose of the financial assurance is to ensure that, if the mine operator fails to adequately close the mine and reclaim the mining lands, then there will be adequate funding in place that the jurisdiction can use to undertake the closure and reclaim the land. The financial assurance also acts as a strong incentive for mine operators to properly close their mines using their own forces at the end of mine life.

At a given mine, the cost liability to close and reclaim the site will vary over the mine life cycle as illustrated schematically on the following page.


Full Assurance amount at startup
Closure Liability ($) / Financial Assurance ($)
Without Progressive Closure
Assurance amount proportional to disturbance – no progressive closure
With Progressive Closure
Assurance amount proportional to disturbance – progressive closure
Residual liability – amount will vary, and be highest for active care
Planning
Construction
Operation
Closure
STAGE OF MINE LIFE



- Prior to the development of the mine, the closure liability will be zero.

- As the mine is being developed, the liability will increase considerably, reflecting the costs that would be incurred to demolish the buildings, remove equipment and reclaim infrastructure, as well as address disturbances created by early works such as pre stripping and pit development.

- During operations, the liability will increase further as waste rock piles grow, tailings management facilities are filled, and open pits and underground workings are expanded over time.

- The peak liability will normally occur at the end of operations, just before closure begins.

The liability can be reduced somewhat during the operating period by undertaking progressive closure measures. Progressive closure measures could include, for example, covering and revegetating parts of a waste rock dump as they become inactive. The implementation of closure measures will significantly reduce the liability. If a “walk-away” condition can be achieved, then the post-closure liability would be zero; however, it is more likely that there will still be some residual liability related to the passive care requirements for post-closure monitoring and maintenance.

Most closure plans include a schedule for post-closure monitoring, aimed at verifying that adequate environmental conditions have been achieved with respect to the physical stability of the site, surface water quality, groundwater quality, health and diversity of biota, and other closure objectives.

At some sites, it will be necessary for active care to continue during closure. For example, active care may include the need for post-closure water treatment, as discussed elsewhere in this document. In an active care scenario, the residual liability will be larger and it may extend for many years into the future.

Different jurisdictions use different methods to calculate the amount of financial assurance required. In some locations, the amount is simply based on the land area disturbed by the mine. More commonly, however, the financial assurance must meet or exceed the estimated full cost to implement closure and reclamation.

The simplest approach is to require that, prior to commencing development, the mine proponent provide a financial assurance amount that is equal to the maximum liability expected over the life of the mine. A more reasonable policy framework is one that allows mine proponents to build up the financial assurance in several stages, "keeping ahead" of the increasing liability as the mine develops. As the mine closure measures are satisfactorily implemented, the liability is reduced and a proportionate amount of the financial assurance is released back to the proponent.

COMMON CHARACTERISTICS OF FINANCIAL ASSURANCE

The rules for calculating financial assurance amounts tend to vary among mining jurisdictions. However, the following are fairly common assumptions used in the development of policy:

- It is assumed that the financial assurance would be used if the mining company abandons the mine; therefore, the cost

assumes that the closure work will be carried out by a third party contractor rather than by the mine using its own personnel and equipment.

- The salvage value of equipment and the scrap value of materials is not normally considered, as the condition of potentially reusable equipment is difficult to estimate with accuracy, and scrap metal markets tend to fluctuate considerably over time.

- Some costs that would accrue to a mining company for internal accounting purposes, such as employee severance costs, taxes, and financing costs, would not apply to a government that is assuming the site after abandonment. These costs are, therefore, excluded from financial assurance calculations.

- It is assumed that the mine could be abandoned at any time without prior notice. For this reason, in some jurisdictions future costs to implement closure cannot be discounted to the present using net present value simply because closure could "occur tomorrow."

- Costs that occur after closure (such as post-closure monitoring, care, and maintenance) can be discounted to the time of closure (but not to the present).

- Closure costs are normally considered in terms of present value, incorporating the planned closure date (mine life), and a defined discount rate to account for the time value of money. The discount rate selected will have a tremendous impact on the present dollar amount of the financial assurance.

  As aresult, the mechanism used to select and adjust the discount rate should be transparent, fair, and clearly defined. A good practice used in economies such as Chile and Peru is to tie the discount rate to an internationally recognized long term interest rate, based on the published rates at the month of plan submission to the approving authority.

Historically, financial assurance funds have often proven insufficient to actually implement closure, with the estimated amount being significantly less than the actual needs. As a result, a number of jurisdictions now require an independent audit of closure cost estimates, at the discretion of the regulator. Mechanisms for funding this are described in the section on the role of the regulator in evaluating the technical content of closure plans.

Once the amount of the financial assurance has been set, it is necessary to decide on the form it will take. There are numerous financial instruments and approaches implemented worldwide to provide jurisdictions with financial assurance. These include:

- **Irrevocable letters of credit—**These are held by a reputable bank who would pay the jurisdiction in the event that the closure obligations were not met. The mining company pays the bank an annual fee (typically between 0.5% and 1.5% of the face value of the line of credit, depending on the creditworthiness of the mining company).

- **Corporate guarantees—**These have been allowed for large "blue ribbon" mining companies that can demonstrate their financial soundness (by means of a credit rating by independent bond rating companies). In one jurisdiction, the companies are required to post other forms of financial assurance as they near the end of the project life or if their bond rating falls below a threshold.

- **Trust funds—**A mining company will transfer money into a trust fund progressively during the life of mine to accumulate enough money to fully cover the costs of closure. Trust funds may leave the jurisdiction vulnerable at the start-up or early stages of a mine's life.

- **Cash deposits—**These offer the highest level of security; however, it can be very difficult for new mining ventures to make a large cash deposit at the start of a project, just when they are trying to finance its capital cost.

A more in depth discussion of financial assurance options is provided by the ICMM (2005 – see reference links in Appendix A).

Governments that implement a financial assurance requirement need to plan on managing large sums of money, easily greater than one billion dollars. These funds will eventually need to be paid out, either to mining companies in recognition of the completion of closure measures, or to undertake the closure of sites which have been abandoned. Depending on the financial instruments that will be used, governments need to consider if financial assurance funds should be segregated from general revenues.

Case Study: *Closure Costing, South Africa*

An estimated 6,000 abandoned mines in South Africa impose a significant burden on the national environment. South Africa now has closure laws in place with financial assurance requirements to prevent the generation of additional abandoned mines. Mining companies are liable for any residual, or even latent, environmental impacts (such as AMD years after closing) that may arise even after a closure certificate has been granted.

The total costs of closure activities as described in closure plans are determined through project-specific cost estimates developed based on individual closure activities. The financial provision is annually reviewed and assessed by closure cost estimator experts and audited by an independent auditor. The costs for closure activities include costs for:

– progressive closure costs (during operation)
– mine closure at the end of mine life
– a risk-based provision for latent and residual impacts including ongoing landform maintenance and water treatment

3 PHASE 3: DEVELOPING POLICY FOR MANAGING CLOSURE

Purpose:

The purpose of Phase 3 is to address the policy needs for the over-arching management of closure within a jurisdiction, covering key transversal issues that need to be addressed in closure policy beyond the needs specific to the closure plans (addressed in Phase 2).

Steps:

3.1 Address Relinquishment Pathways
Define how the jurisdictions will face the challenge of providing a mechanism to allow mined lands to be returned to the jurisdiction or third parties.

3.2 Temporary and Sudden Closure
Provide clear policy to address events of temporary and sudden closure, which are not uncommon due to the cyclical nature of mine commodity prices.

3.3 Identify Key Aspects of Abandoned Sites Policy
While mine closure policy is designed to avoid the generation of abandoned sites, most mining jurisdictions have abandoned sites that must be addressed. In this step, the key elements of abandoned site policy are identified.

3.4 Manage Expectations
Considerable expectations can develop around mine closure and mine closure policy. Expectations on all sides need to be managed to ensure that the sector can develop sustainably in the jurisdiction.

Outputs:

- a position for the jurisdiction on how relinquishment will be addressed
- a policy approach for temporary and sudden closure
- an approach for abandoned sites, if required
- a plan for managing policy expectations

3.1 RELINQUISHMENT – WHEN IS IT OVER?

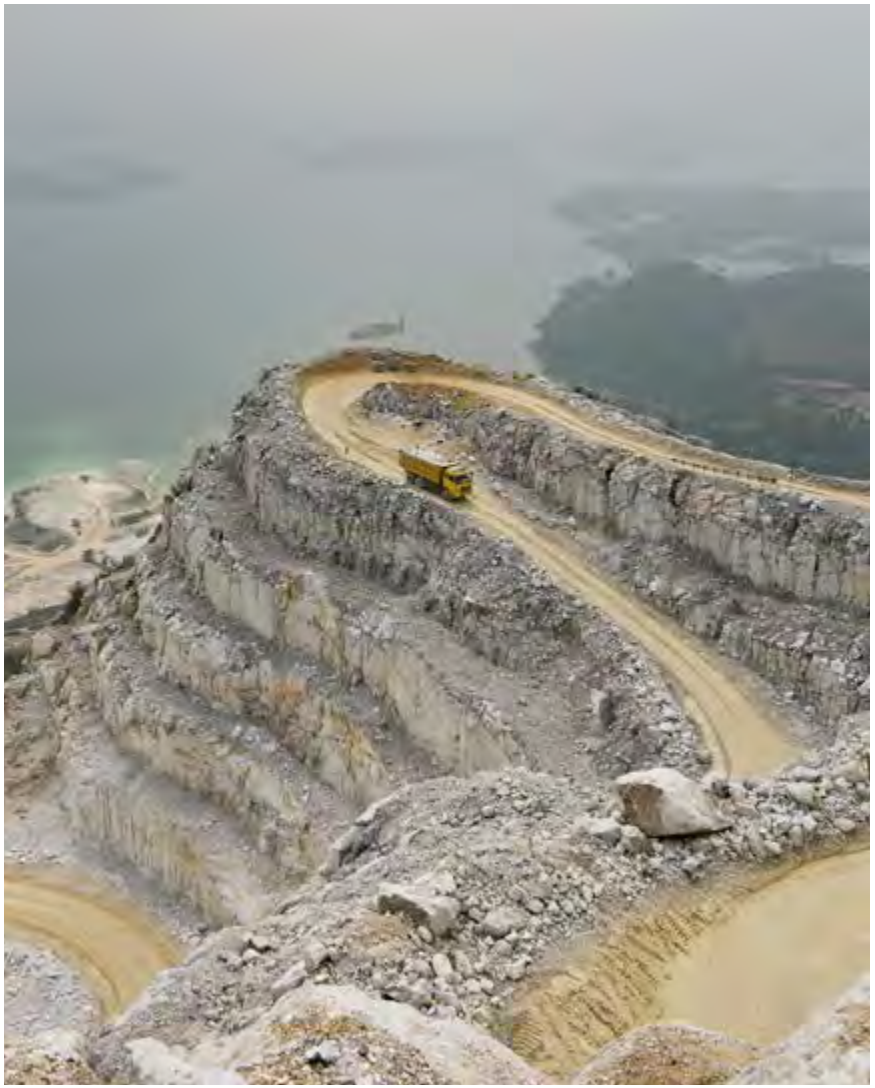
Many jurisdictions have provisions in mining regulations that permit mining companies to return satisfactorily closed mining lands to the next owner, often the government. If lands were returned, the mining company would cease to be responsible for future liabilities associated with the property. Consequently, the future maintenance of the properties would then become a responsibility of the next owner, often the public through government.

Regulators should provide mining companies with a pathway to final relinquishment of mine sites, including:

- a mechanism for return of sites (or portions thereof) to jurisdiction or third parties
- recognition of transfer of liabilities to third parties if the property ownership and/or rights are transferred
- a mechanism for quantifying residual liabilities (e.g., monitoring, maintenance, water treatment) and providing the final owner with funds to address those liabilities

While the potential to relinquish is recognized in a number of jurisdictions, there are very few examples where a closed mine has been relinquished. This failure to relinquish can be attributed to the following:

- "moving goalposts" as society's (and consequently regulators) expectations of mining sustainability change (typically increasing) over time, leaving the company often unable to reactively plan and execute. This can be an outcome of "polluter pays" legislation



- underestimation of the true post closure monitoring and maintenance duration

- unclear relinquishment requirements. These may arise from insufficient planning

Currently, most mining properties that have been properly closed remain in the hands of mining companies and under a state post closure management or "care and maintenance." This is an undesirable outcome for companies because it leaves them with unresolved liabilities for land that may have little or no remaining commercial value. Further, the lack of a clear relinquishment pathway may discourage companies from investing in closure if there is no potential for the site to be returned. It also means that the properties are not returned to beneficial next use (which could include resumed exploration and mining activities).

The difficulties that governments encounter in facilitating the return of completed mining properties is understandable. However, the alternative to a structured relinquishment is that the mining company may eventually go into default, leaving the jurisdiction to assume responsibility, and activating the financial security for, the site. It is, therefore, in the public interest for the jurisdiction to accept relinquished properties on proper terms and with appropriate funding put in place by the mining company.

Out of the public interest, governments will place conservative conditions on the relinquishment of former mining lands. Although in most jurisdictions regulations and guidelines still require development, conditions that apply to returning closed mining properties to the government should include the following provisions:

- A risk assessment should be undertaken to evaluate potential long return period events (such as earthquakes or floods) that could disrupt the closed mine in terms of their probability of occurrence, probable consequence, and cost to repair.

- A final environmental audit must be carried out that demonstrates that the property has been closed as per the agreed plan's closure criteria.

When a government accepts a mining property's relinquishment, it is also making a commitment that the next owner will undertake long-term responsibility for the management of that property. Management of a relinquished mine site typically requires careful programming as well as significant ongoing funding. The National Orphaned/Abandoned Mines Initiative (NOAMI 2016) describes a framework that has been put in place in the province of Saskatchewan, Canada, which has accepted the relinquishment of several mining properties in return for contributions by mining companies into several government held funds. One fund, the Monitoring and Maintenance Fund, is segregated for each individual site and reflects the predicted costs for future monitoring and maintenance. A second fund, the Unforeseen Events Fund, is a common trust fund for all relinquished mines. The Unforeseen Events Fund is designed to grow in value over time until it will eventually cover all unforeseen risks to the pool of properties. Mining companies are still required to have an agreed upon amount of financial assurance in place, at least until the Unforeseen Events Fund is fully funded. In that sense, the relinquishment is still somewhat incomplete.

- A post closure management plan should be developed, describing any ongoing activities, and providing relevant historical site information.

- Requirements for long-term or in-perpetuity monitoring and maintenance after closure must be identified and costed.

- The mining company would have to provide the government with sufficient funds to cover the costs of future care of the property.

3.2 TEMPORARY AND SUDDEN CLOSURE

Mining activity is typically cyclical, with the market prices for mined materials subject to alternating cycles of high and low commodity prices. When prices are lower in the market, some mines will become uneconomic and their owners may seek to cease operation. This event may be sudden relative to previously planned closure and reclamation works. Sudden closure may also occur when unforeseen influences such as geopolitical unrest, corporate strategy revision, or technical incidents render the current operation unviable.

- **Sudden closure** is when the mine closes permanently ahead of the originally planned closure date.

- **Temporary closure** is when mine operations are suspended, but the site is maintained with the intent that operations will resume when market conditions improve.

Temporary closure may lead to permanent closure, or mines may be re-opened after years or even decades of inactivity, potentially with improved closure outcomes resulting from better policy and regulation and internal company performance expectations.

During temporary closure, the operation enters a care and maintenance phase, where infrastructure, plant, and equipment remain intact and are maintained in anticipation of production recommencing.

During this time, staffing is minimal and company activities should be directed primarily toward:

- ensuring the site remains in compliance with all permits, regulations and other commitments
- reducing liability upon mine restart through infrastructure maintenance and repair
- managing safety and environmental risks not addressed by a more strategic closure planning process
- continuing site monitoring as required by regulations.

POLICY NEEDS

Regulatory policy should ensure that there is a framework for handling temporary and sudden closure as a fundamental component of mine closure planning, including:

- The closure plan in place should specifically address the possibility of sudden closure, including identification of key risks, and care and maintenance activities to manage these periods of closure.

- Financial assurance should be sufficient to cover outstanding obligations at any point in the mine life, such that the site can be adequately moved from care and maintenance to final closure if an abandonment occurs during temporary closure.

- During temporary closure, there should be regular site inspections, and a mechanism to increase financial assurance if existing risks increase or new risks present.

- Within a defined period after the onset of temporary closure, there should be a temporary closure plan submitted to the regulatory authority, describing temporary closure activities and documenting needed inspection and maintenance activities.

- There should be assurance that appropriate care and maintenance is in place.

- Groups that will have special needs in facing the challenges of sudden or temporary closure should be identified, including more vulnerable groups, such as women and minorities.

In design of the policy, care should be given to provide adequate protection of the public interest without unduly punishing a temporary closure and forcing the mining company to initiate final closure prematurely. In general, the pressure to close should be limited as long as the mining company is taking full responsibility for the inoperative site, including:

- remaining in full compliance with applicable permits and legislation
- all care and maintenance obligations
- conducting any applicable progressive reclamation
- maintaining the full required financial assurance amount to carry out final closure.

From a regulatory point of view, the site in temporary closure can be treated similarly to an operating site. There can be a concern that "perpetual temporary closure" can be used as a way of avoiding closure responsibilities. However, a statute that seeks to avoid the risk of this by setting limits on the duration of temporary closure may avoid the risk of perpetual temporary closure but could force premature closure of sites during an extended commodity price downturn.

The socio-economic impacts of temporary and sudden closure have historically been difficult to manage. Ideally, it is desirable to mitigate the following key impacts:

- social impacts from withdrawal of company-sponsored activities
- economic impacts at regional or national jurisdictions
- socio-economic effects on dependent economies such as employees and independent local service and goods providers

An emphasis in policy should be made on managing impacts to developing regional communities where there is a high dependency on the mining operation. Where the communities are highly dependent on the activities of a single mine, some impacts of an unexpected closure will be unavoidable.

Further Reading

Fawcett, M. (2016). Redbank Copper Mine – a legacy mine case study. CRC Care: Dealing with Derelict Mines 2016. 6–8 December. Singleton, NSW, Australia.

3.3 ABANDONED SITES

Virtually all mining jurisdictions have a legacy of abandoned sites, even in wealthy nations with more developed mining policy and regulation. At these sites, the original owner has relinquished responsibility without meeting agreed closure standards. These sites may:

- present ongoing risks to the community and the natural environment
- cause financial liability to be borne by taxpayers
- allow hazards to remain unmanaged following abandonment of the site due to high remediation costs and lack of funding to address abandoned sites.

Mine closure policy as addressed in the Checklist has been designed to avoid creating abandoned sites in the future. A robust mine closure regulatory framework with appropriate financial assurance requirements is one of the best tools available to a jurisdiction to prevent future creation of orphaned or abandoned sites.

Where abandoned sites exist, mine closure regulation may improve management of the sites by prioritizing needed remediation works. The following are key elements of successful policy for abandoned sites.

ESTABLISHING A JURISDICTIONAL REGISTRY OF ABANDONED SITES

A registry of abandoned sites is a powerful tool for management. A full and updateable registry provides understanding of the size of the problem, its geographic distribution, and a basis for evaluating and prioritizing sites.

In developing the registry:

- Ensure that there is a common definition of what constitutes an abandoned mine site.
- Catalog current information and collect new information about each abandoned site using a common format.
- Complete inspections to collect information about the area affected, including structures remaining, discharges, proximity to human and environmental receptors, and impacts observed.
- Train site inspectors in the identification of hazards, both for updating the registry, and ensuring that they are not exposed to unnecessary risks during site investigations.

Registry development typically starts with a desktop study, compiling documented information and interviewing people with site knowledge to outline the known extent of the issue. This initial step can result in a simple list of sites with basic details such as location and commodity.

This can then be followed up with a program of inspections and audits to provide further detail on each site. If the available information permits, remediation cost estimates can be based on site inspections. Additional specialist studies will be needed to fully understand remediation costs for complex sites.

Many mining jurisdictions have advanced the development of registries for abandoned sites, including Peru, Chile (see case study on page 81), and a number of provinces within Canada.

DEVELOPING CRITERIA TO PRIORITIZE REMEDIATION OF THE SITES

The abundance and complexity of abandoned mine issues often outstrips the capacity of the jurisdiction to address all sites immediately. In this case, it is advisable to prioritize, with at least the two following considerations taken into account:

- Remediation work priority is given to the greatest risks to the health and safety of the public and environment.

- Consideration of the greatest cost-benefit result should also direct closure works. For instance, risks posed by abandoned mine openings such as shafts or adits can be considerable (with loss of life) but can be addressed economically and quickly. Alternatively, risks posed by a failing mine waste disposal facility may be much greater, but the cost and complexity of remediation may also be greater.

Many small issues can be addressed immediately while the more complex design and funding problems are being addressed in parallel.

DETERMINING THE COST OF ABANDONED SITE REMEDIATION

The cost of remediating an individual site varies greatly as a result of varying complexity of the issues being faced. Sites have been remediated with costs that range from a few thousand US dollars to budgets in excess of a billion.

While engineering studies are usually needed to characterize the costs of remediation with high confidence, information collected during abandoned sites database development can be used as a starting point for estimates. These estimates are then refined as priorities are set.

Remediation costs will be determined in part by the remediation standard chosen. For example, requiring that remediation measures for an abandoned site be subject to a full environmental and social impact assessment may delay or prevent clean-up altogether. If needed, consideration should be given to allowing more flexible and practical approaches. Doing something is generally better than doing nothing.

FINANCING THE REMEDIATION OF ABANDONED SITES

Financing remediation of abandoned sites can be challenging. While funds most often come from government sources, other mechanisms may be available, either in conjunction with government funding or in place of it.

- Remediation of abandoned sites can be through an “off-set,” which requires the proponent remediate abandoned mine sites as part compensation for future land disturbance. In this approach, there needs to be a clear mechanism for site liability transfer and monitoring requirements after the site has been remediated.

- Another approach is to put “Good Samaritan” provisions into mineral policies, allowing third parties to remediate a site without assuming liability. In some cases the third party may profit from the cleanup, either in terms of land use or reputational benefits, including licence to operate.

- Other innovative funding combinations are possible, such as multi-way partnerships between various levels of government and communities, private industry, and research institutes. The key role of policy is to remove obstructions to such partnerships and to address issues of liability clearly.

Case Study: *Giant Mine, Northwest Territories, Canada*

Giant Mine is one of the best known abandoned sites in Canada. Current best estimates of the site closure cost are in the order of $1 billion Canadian, and the site will require monitoring, maintenance, and water treatment in perpetuity. This gold mine operated for around 50 years and produced approximately seven million ounces of gold before declaring bankruptcy and becoming abandoned in 1999. Arsenic is one of the greatest concerns with the site, as there is about 237,000 tonnes of arsenic trioxide stored underground in 14 chambers at the site. This material was produced as a byproduct of refractory ore roasting, and if uncontrolled would present significant risks to human health and the environment. Closure measures are now being undertaken by the Canadian federal government under the Contaminated Sites Program.

Photograph: *https://www.aadnc-aandc.gc.ca/eng/1100100027395/1100100027396*

Case Study: *Britannia Mine, British Columbia, Canada*

This large copper mine complex operated for about 70 years, closing in 1974. About 5 million m^3 per year of acidic mine water drained from the high level workings into Britannia Creek and Howe Sound. Prior to remediation, this flow represented one of the largest point sources of heavy metal pollution in North America. A private–public partnership approach was used to reduce the flows to the extent possible; however, the requirement remains to treat large volumes of ARD. The province of British Columbia hired a private company to finance, design, build, and operate a large capacity high density sludge treatment system for 20 years, starting in 2006. The province owns the treatment facility and pays a fee for the volume of water treated to meet standards.

Photograph: *http://www.partnershipsbc.ca*

Case Study: ***Evaluation of Abandoned and Orphaned Sites, Chile***

A nationwide inventory of abandoned and orphaned sites in the economy was developed with a process that started in the mid-2000s. To prioritize the sites in terms of remediation needs and those that presented the greatest risk, a risk evaluation process was developed by the Chilean mining authority in partnership with an international development agency (BGR, Germany). A simplified risk evaluation methodology was developed to assess and rank the sites, and staff trained in application of the methodology. A guide outlining remediation approaches was also developed to support closure of the abandoned sites. Between 2008 and 2014, 492 abandoned mine sites were identified and assessed.

Photograph: *Bjorn Weeks*

3.4 MANAGING EXPECTATIONS

Managing expectations is not an easy task for the regulator. Regulations can be developed to address public expectations in harmony with international practice, but both the expectations and practices may evolve over time.Considerable expectations can develop on the part of many stakeholders around mine closure and mine closure policy. Expectations on all sides need to be managed to ensure that the sector can develop sustainably in the jurisdiction.

- On the industry side, smaller or mid-sized operators that have not been exposed to modern regulatory regimes around closure in other jurisdictions may expect exemptions to bonding requirements, or special considerations, which are generally not justified as small operators have historically been common sources of abandoned sites. However, requirements for smaller operators must be balanced against their role in meeting development goals for the jurisdiction.
- On the community side, there may be unreasonable expectations around the continuity of employment opportunities that the mine owner can provide after the end of productive mining.
- On the regulator side, it will be important to realize that closure plans and all engineering works—inherently carry some level of risk. As such, it is not reasonable to expect that properly implemented closure plans will be able to reduce risk to zero prior to the relinquishment of bond amounts. Rather, there should be a reasonable threshold of residual risk that is acceptable and that takes into account the benefits the mining operations have provided over the life of the mine.

Honest, open engagement and discussion throughout the planning, development and implementation of both closure policy and closure plans is one of the best tools available to manage expectations on the part of all stakeholders.

4 PHASE 4: IMPLEMENTING THE CLOSURE POLICY

Purpose:

To describe the process to put into practice mine closure policy, including aspects for transitioning from any existing regulatory regime to the new one.

Steps:

4.1 Prepare to Implement New Mine Closure Policy

Develop a strategy to transition from any existing mine closure regulations to the new policies.

Develop an implementation plan, establishing clear roles and responsibilities for the new policy implementation, including schedule and budget. Consider pilot programs.

4.2 Evaluate Policy Effectiveness and Update as Required

Monitor and evaluate the implementation of closure policy, and ensure that mechanisms are in place to facilitate updates to the policy, if needed.

Outputs:

- implementation plan
- monitoring and evaluation plan

4.1 PREPARING TO IMPLEMENT NEW CLOSURE POLICY

Once the Checklist has been applied to a jurisdiction, gaps in the existing closure legislation identified, and preparations are undertaken to address those gaps, the question remains how to transition from the current regulatory regime to the desired one. The following checklist provides a starting point for developing an implementation plan:

THE IMPLEMENTATION CHECKLIST		
✓	DO YOU HAVE A PLAN TO...?	TAKE THIS INTO ACCOUNT:
	CONSULT	• Prior to drafting new legislation, it is advisable to consult early with key stakeholders. These could include representatives of mining companies (both local and international, if possible), other government agencies within the jurisdiction that may have an interest in mine closure, NGOs, and representatives from communities that are impacted by mining.
	COMMUNICATE AHEAD OF TIME	• As policy is developed, or once a draft policy has been prepared, it is advisable to communicate it with stakeholders. It is particularly advisable to communicate the draft regulation with the mining companies that will be most affected by it. This provides a chance to receive and address concerns prior to formalizing the measures—potentially both improving policy and building trust. • Workshops, conference presentations, and high-level meetings can all be used to communicate to mining companies and their consultants the nature of upcoming changes to closure regulations, and the timing of those changes.
	ESTABLISH TIMELINES	• Prior to developing new regulations or implementing policy guidelines, it is advisable to establish and communicate timelines. This will allow all stakeholders to plan. This is especially important for regulations that will require lead times for compliance. For instance, sufficient time to prepare a closure plan or to develop cost estimates to support financial assurance amounts.
	RUN A PILOT PROJECT	• It can be very useful for the project task force to run a pilot project to test out as many aspects of the new closure policy as possible. One way to do this is to identify an industry partner, and develop—prior to implementation of the new regulations—a closure plan or closure plan update for one of its properties, applying, to the extent possible, the new guidelines. This should include developing all aspects of the plan, including closure costs. • The pilot project will have benefits for the mining company, including early understanding of the new closure policy, and an opportunity to introduce early optimizations in the process. For the regulator, it provides experience with developing and reviewing all aspects of the closure plan under the new policy, including the communication of requirements to mining companies.
	OFFER A TRANSITION PERIOD FOR FINANCIAL ASSURANCE	• If financial assurance has never been required previously in the jurisdiction, or major changes are planned, a transition period is advisable. Mines that are currently operating without financial assurance should have a period to adapt to the new regime, and not have a significant financial burden implemented from one year to another. The experience in Chile offers one example of how to implement an orderly transition from no bonding requirement to full bonding (see Case Study in this section).

THE IMPLEMENTATION CHECKLIST		
✓	DO YOU HAVE A PLAN TO...?	TAKE THIS INTO ACCOUNT:
	CLARIFY INTERACTIONS WITH EXISTING REGULATIONS AND DEVELOPMENT POLICY TARGETS AND GOALS	• New closure regulations rarely enter into a legal vacuum. Often there will be interactions with existing regulations—either previous regulations that are being supplemented or superseded by the new legislation, or other laws that cover similar topics (for instance, environmental assessments frequently address closure to some degree). It is important that the authorities involved review these interactions, and identify and resolve potential conflicts prior to implementing the new legislation. Failure to do so can lead to confusion, contradictory requirements, and difficulties with compliance. It is also important to ensure that new closure policy is coherent with the development policy targets and goals of the economy, especially for emerging economies that are interacting with the World Bank, International Monetary Fund, or other development banks.
	EVALUATE ADMINISTRATIVE RESOURCES NEEDED	• A careful review is necessary of the administrative resources that will be needed on the regulator side to deal with the new law. If closure plans are being required for the first time, how many will be coming in for review over what time period? How many reviewers will be needed? Are the resources in place to provide adequate technical review? Will all plans be coming on the same date, or is there a mechanism to distribute them through the year? Are the appropriate institutions in place to administer financial assurance instruments?
	PROVIDE MECHANISMS FOR FEEDBACK AND IMPROVEMENT	• The perfect policy and legal framework for mine closure has not yet been developed (although imperfect policy is preferable to no policy). The chances are that in the course of implementation, errors and areas for improvement will be identified. The best framework is one that provides a mechanism to collect feedback, and allows for future modifications to incorporate lessons learned.

Case Study: *Chile — The Transitory Regime*

In 2012, Chile adopted a new closure law that required for the first time the posting of financial assurance by the mining companies. The implementation of this closure law included a two-year "transitory regime" designed to provide a smooth transition from the existing closure law (which was focused on identifying measures for the physical stability of closed mines) to a far more sophisticated law that outlined a risk-based framework for addressing physical and chemical stability, as well as mechanisms for financial assurance and relinquishment of the closed mines. Many of the considerations in the implementation checklist (outlined above) were used by Chile in the implementation of the closure law, including consultation with industry, communicating in anticipation, establishing timelines, and preparing a clearly defined mechanism to gradually transition over a number years from no financial assurance to having all mines fully bonded. By the end of 2014, at least 150 closure plans were submitted to the authorities for mines in the economy that had production rates of more than 10,000 t/mo.

4.2 EVALUATING THE EFFECTIVENESS OF CLOSURE POLICY

Once the new closure policy has been developed and implemented according to plan, how do you know that it is working? While no policy is perfect, here are some key indicators that the policy is working well:

THE POLICY EFFECTIVENESS CHECKLIST			
✓	ARE THERE ISSUES WITH...?	TAKE THIS INTO ACCOUNT:	POSSIBLE SOLUTIONS
	REVIEW TIMES	• The organization responsible for reviewing closure plans needs adequate resources for the number of plans to be reviewed.	• Add resources to the department. • Facilitate third party review for part or all of the closure plan.
	NON-SUBMISSION OF PLANS	• Non-compliance in the form of mining companies not providing the required closure plans can have various roots, and the causes should be evaluated on a site-by-site basis. It may be due to timeframes that are too tight, lack of qualified resources, lack of clarity around due dates, or unclear regulations.	• Clarify requirements, re-evaluate timelines, review compliance motivations (i.e., punishments for on-compliance should be greater than the cost of compliance).
	COMPANIES FAILING TO PROVIDE FINANCIAL ASSURANCE AMOUNTS	• This non-compliance needs to be evaluated on a case-by-case basis. It may be due to overly restrictive options for financial instruments, or insufficient motivation to incur the cost of financial assurance.	• Evaluate on case-by-case basis.
	INSUFFICIENT FINANCIAL ASSURANCE AMOUNTS	• Financial assurance amounts may be insufficient if cost estimates are not sufficiently conservative. Alternatively, over-long implementation periods can result in sites being under-bonded while the full financial assurance period is built up.	• Re-evaluate mechanisms for reviewing cost estimates, implementation periods.
	COMMUNITIES	• A wide range of problems can occur for communities.	• Require that measures be taken during the life of the mine to strengthen community leadership and decision-making capacity and build community resilience so that a community is better prepared to cope with the loss of jobs, services and taxes when mines are closed. • Review the adequacy of stakeholder involvement requirements.
	GENERATION OF NEW ABANDONED SITES	• Once the new closure policy is in place, abandonment of a site through bankruptcy of the owner should result in a smooth transition to the regulator for the implementation of the closure plan with all resources in place. If new unfunded liabilities are generated, then mine closure policy has failed.	• The generation of new, unfunded abandoned sites should not occur under adequate policy. If it does, a complete policy overhaul should be undertaken (return to Phase 1 with a task force specifically focused on addressing policy failures).

FINAL CONSIDERATIONS

Establishing practical and effective mine closure policy is not a simple undertaking. Many jurisdictions struggle to find the right balance between fostering beneficial development and addressing the technical complexity involved in proper mine closure, while providing adequate representation for the concerns of stakeholders.

Working through this Checklist should provide governments with a tool to assess and improve their current mine closure policy. While the first step of the Checklist helps users to identify gaps, the core of the process is improving (or developing) closure policy. This Checklist distills closure policy experience from many regions, extracting broadly applicable learnings and considerations.

Getting closure policy right is a challenge. While this document lays out a roadmap to move forward efficiently, it is realistic to expect that more than one round of policy development and implementation will be needed. Many jurisdictions with advanced closure policy have gone through more than one policy iteration to get to their current state.

Listed on page 89 are some key indicators that would show policy development is on the right track.

	INDICATORS THAT POLICY IS ON TRACK
✓	• Current policy is understood, and gaps identified with a plan to address them
✓	• All mines are required to have a closure plan in place
✓	• The requirements for the closure plan as a document and policy instrument are clear
✓	• Adequate review of the plans can be provided on behalf of the jurisdiction
✓	• Clear policy is in place for financial assurance, with instruments that are fair and appropriate
✓	• There is clear policy for how the impacts of closure on communities should be managed
✓	• There is a pathway to relinquishment for properly closed mines
✓	• Policy addresses the realities of temporary and sudden closure
✓	• There is good policy for the management of abandoned mine sites
✓	• New policy is compatible with the existing legal framework

APPENDIX A: INTERNATIONAL STANDARDS AND GUIDELINES

This Checklist provides an overview of key issues to be addressed by mine closure policy for all APEC economies. In this short document it has not been possible to present in detail all the aspects of mine closure that the interested reader should be familiar with. Fortunately, there is extensive complementary literature available, much of it freely available on the Internet.

Some of the key resources for the interested reader on various related topics are presented below.

FOR GENERAL GUIDANCE ON CLOSURE PLANNING

Australian Government (2016) Mine Closure – Leading Practice Sustainable Development Program for the Mining Industry: A broad introduction to mine closure and current leading practices from an Australian perspective.
https://industry.gov.au/resource/Documents/LPSDP/guideLPSD.pdf

ANZMEC (2000) Strategic Framework for Mine Closure: The objective of the Strategic Framework for Mine Closure is to encourage the development of comprehensive Closure Plans that return all mine sites to viable, and wherever practicable, self-sustaining ecosystems, and that these plans are adequately financed, implemented, and monitored within all jurisdictions.
http://www.sernageomin.cl/pdf/mineria/cierrefaena/DocumentosRelacionados/Strategic-Framework-Mine-Closure.pdf

ICMM (2008) Planning for Integrated Mine Closure – A Toolkit: A mining industry document that provides a broadly conceived life-cycle and risk-based approach to closure planning. https://www.icmm.com/website/publications/pdfs/310.pdf.

IFC (2007). Environmental, Health and Safety Guidelines:
http://www.ifc.org/wps/wcm/connect/9aef2880488559a983acd36a6515bb18/2%2BOccupational%2Bhealth%2Band%2Bsafety.pdf?MOD=AJPERES

Mining Association of Canada (2008) Towards Sustainable Mining – Mine Closure Framework: An example of an industry-led initiative to articulate the commitment of member companies to to promote responsible mine closure.
http://mining.ca/sites/default/files/documents/TSM_Mine_Closure_Framework.pdf

NOAMI (2010) Policy Framework in Canada for mine closure and management of long term liabilities – a guidance document: This document provides an overview of how mine closure liabilities were addressed in jurisdictions across Canada. While now out of date, it provides a useful overview of the national experience with closure planning, cost estimating, and financial assurance.
http://www.abandoned-mines.org/pdfs/PolicyFrameworkCanforMinClosureandMgmtLiabilities.pdf

NOAMI (2016) Orphaned and Abandoned Mines: Risk Identification, Cost Estimation and Long Term Management: This document describes the long-term liabilities and risks that pertain to mine sites after closure. It describes a framework for institutional control that has been established by the province of Saskatchewan, Canada, to manage mine sites that have been relinquished.
http://www.abandoned-mines.org/wp/wp-content/uploads/2017/02/Risk_Cost_Management_A.pdf

FOR MORE INFORMATION ABOUT MINING POLICY FRAMEWORKS

World Bank Multistakeholder Initiative (2010) Towards Sustainable Decommissioning and Closure of Oil Fields and Mines: A Toolkit to Assist Government Agencies. Version 3.0: This document provides a policy-oriented series of toolkits related to closure for both oil fields and mines. The document includes toolkits for policy/regulatory frameworks, environmental/social best practices, financial assurance, monitoring/enforcement, and stakeholder engagement.
http://siteresources.worldbank.org/EXTOGMC/Resources/336929-1258667423902/decommission_toolkit3_full.pdf

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) (2013) The IGF Mining Policy Framework: Mining and Sustainable Development: This document lays out a framework which provides a comprehensive model for policy that will allow mining to make its maximum contribution to the sustainable development of developing countries. Touches on all relevant aspects of policy, including closure ("Post-mining transition"). http://igfmining.org/wp-content/uploads/2017/02/MPF-English-Oct-2013.pdf

FOR MORE INFORMATION ABOUT CHEMICAL STABILITY

The GARD (Global Acid Rock Drainage) Guide: A comprehensive guide to acid rock drainage issues, including characterization and design of closure measures. http://www.gardguide.com/

Australian Government (2016) Leading Practice Sustainable Development Program for the Mining Industry: AMD prevention: Leading practice AMD management and AMD planning for closure for the Australian mining industry operating in Australia and overseas.
https://industry.gov.au/resource/Documents/LPSDP/LPSDP-AcidHandbook.pdf

FOR MORE INFORMATION ABOUT FINANCIAL ASSURANCE

World Bank (2008) Guidance Notes for the Implementation of Financial Surety for Mine Closure: A report developed to help governments make decisions with respect to financial assurance policy.
http://siteresources.worldbank.org/INTOGMC/Resources/financial_surety_mine.pdf

ICMM (2005) Financial Assurance for Mine Closure and Reclamation: A detailed overview of financial assurance as applied to mine closure.
http://www.icmm.com/website/publications/pdfs/282.pdf

FOR THE LONG-TERM STABILITY OF DAMS

CDA (2014) Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams: A bulletin providing additional explanation of the Canadian Dam Association Dam Safety Guidelines.

FOR TECHNICAL GUIDANCE ON SUBSIDENCE AND UNDERGROUND MINES

Center for Science in Public Participation (2002) Technical Report on Underground Hard-Rock Mining: Subsidence and Hydrologic Environmental Impacts: A good technical primer on the issues associated with the subsidence of underground mines.
http://www.csp2.org/files/reports/Subsidence%20and%20Hydrologic%20Environmental%20Impacts.pdf

FOR MORE INFORMATION ABOUT THE RECLAMATION OF MINED LANDS

Australian Government (2016) Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry: A broad introduction to the rehabilitation (reclamation) of mined lands, including planning, implementation, monitoring, and success criteria.
https://industry.gov.au/resource/Documents/LPSDP/LPSDP-MineRehabilitationHandbook.pdf

FOR MORE ABOUT GENDER AND SOCIAL ISSUES IN MINING

World Bank (2009) Gender Dimensions of the Extractives Industry: Mining for Equity.
http://siteresources.worldbank.org/EXTOGMC/Resources/eifd8_gender_equity.pdf

CSRM (2007) Estimating Socio-Economic Impacts of Mine Closure (Research Paper No.8): Provides a method of estimating and quantifying the socio-economic impacts of mine closure.
http://www.csrm.uq.edu.au/docs/SEIA%20for%20Mine%20Closure_Final%20Draft.pdf

LEADING EXAMPLES OF CLOSURE POLICY

MVLWB/AANDC (2013) Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories: A clear and comprehensive guideline for the preparation of closure plans from a relatively small jurisdiction, which incorporates many of the leading aspects of closure practice.
http://www.lands.gov.nt.ca/sites/lands/files/resources/2013_mvlwb-aandc_guidelines_for_closure_and_reclamation.pdf

Chilean Ministry of Mines (Law 20.551) Regulating the Closure of Mine Sites and Installations (in Spanish): The 2011 mine closure law marked Chile's transition to modern closure law, addressing physical and chemical stability of mine site and the need for financial assurance. The regulation includes several notable models, including the development of a transition period from the previous law to the new one. Numerous related policy guides are also available from the national mining service (SERNAGEOMIN) related to this law, including ones that detail the approach to presenting closure plans, calculating the financial assurance amount, and evaluating closure risks.

Government of Western Australia Department of Mines and Petroleum (2017) Mining Rehabilitation Fund – Guidance: The Mining Rehabilitation Fund (MRF) Act of 2012 and associated regulations of 2013 provided an example approach to funding the closure and rehabilitation of abandoned mines, where all mine operations in the jurisdiction contribute to a pooled fund.
http://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-382.pdf

FOR MORE ON MINING AND CLIMATE CHANGE

MEND (2011) Climate Change and Acid Rock Drainage – Risks for the Canadian Mining Sector (MEND Report 1.61.7): Presents a high level overview of the potential impacts of climate change on acid rock drainage. While focused on the Canadian mining sector, the observations are broadly applicable.
http://mend-nedem.org/wp-content/uploads/2013/01/1.61.7.pdf

ICMM (2013) Adapting to a Changing Climate: Implications for the Mining and Metals Industry: Presents an industry view of the potential implications of climate change on all aspects of mining, including closure issues. https://www.icmm.com/website/publications/pdfs/5173.pdf

IPCC (2007). Fourth Assessment Report and Climate Change: A fundamental reference document by the Intergovernmental Panel on Climate Change on climate change, not just for mining applications. https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

FOR IDEAS ON WHAT TO DO WITH SITES POST-CLOSURE

Georgina Pearman (2009) 101 Things to do with a Hole in the Ground: An engaging look in book form of post-closure mine site uses from projects around the world.

APPENDIX B: GLOSSARY – COMMON MINE CLOSURE TERMS

AMD (Acid Mine Drainage) – A common environmental problem at mine sites, where exposed waste material contains materials such as sulphides that react with water and oxygen, generating acidic runoff water.

ARD (Acid Rock Drainage) – See AMD (synonyms).

Biodiversity – The diversity of flora and fauna within an ecosystem. This may be at species or higher levels of consideration, such as ecological community types.

Closure Plan – The plan for how a mine site will be managed at the end of its productive life, including the activities that will be carried out to achieve closure goals. The plan should be developed prior to the start of operations and updated periodically throughout the mine life, with increasing detail in the last years of operation.

Co-disposal – Disposing of two waste streams together; commonly used to describe the disposal of tailings with waste rock, where the waste rock provides structural strength and stability, and tailings in the void space reduce permeability of the co-disposed deposit.

Cycloned Tailings – A process where a cyclone is used to separate tailings into a fine and a coarse fraction. Typically done to provide a construction material (coarse sand) for the tailings dam.

Heap/Dump Leach – A type of commodity extraction process, where ore is piled over a liner and collection system and irrigated with chemicals to extract the mineral of interest by a leaching process. Once the extraction has been completed, the “spent” heap leach material is a mine waste product.

Filtered Tailings – Tailings that have been reduced to a very low water content by the use of a mechanical filtering process.

Financial Assurance – This is a requirement in many jurisdictions for the mining company to provide some form of guarantee to the jurisdiction that sufficient funds will be available to implement all of the required closure works at the site. The intent is to ensure that if the mining company should abandon the site for any reason, the jurisdiction will have the funds to implement the required closure works. Financial assurance may take a variety of forms, including a letter of credit, a trust fund, an insurance policy, cash deposit (normally only used for very small operations), or third-party guarantee.

Mine Closure – A wide range of activities undertaken to prepare the mine site for the period after the completion of active mining. This may include activities to stabilize facilities, demolition, and removal of buildings and other infrastructure, reclamation of mined lands, and others.

Mine Life – The expected or actual length of time that the mine will operate productively. It is a function of the rate of extraction and processing, as well as the economically available ore material in the ground. The estimate of the remaining mine life will typically fluctuate throughout the operation of the mine, conditioned by variations in the markets, cost of extraction, process modifications, and improved knowledge of the subsurface conditions throughout operations.

Mine Reclamation – Once of many mine closure activities, which is generally understood to include the establishment of sustainable ecosystems or alternative vegetation, depending on the desired post-operational use.

Mine Rehabilitation – Term commonly used interchangeably with “Mine Closure”.

Mine Waste – Any waste product generated by mining operations. Commonly used to refer the highest volume wastes generated, including waste rock, tailings, and heap leach material.

Opportunity – The product of the likelihood of a benefit multiplied by the magnitude of the benefit.

Orphaned or Abandoned Site – A mine site where there is no clear owner or responsible party. Often created by the bankruptcy or dissolution of the company that formally owned the mine. Historically, this has resulted in sites where no closure measures have been undertaken, and a variety of physical or environmental issues can persist.

Post-closure – General term referring to the period of time after the completion of all works needed to implement the closure of the site. Sometimes used to refer only to a period of monitoring and maintenance, but may include a period in which ongoing activity (such as the operation of a water treatment plant) is needed.

Progressive Closure – Mine closure activities undertaken during operation of the mine. Often used to reduce closure work needed at end of mine life, when cash flow from the mine is at its lowest point. Progressive closure in parallel with mine operation may also make use of operational activities (e.g., waste handling) to achieve zero or low cost closure outcomes.

Relinquishment – The end of site ownership by the mine and responsibility for the site. Usually implies the transition of ownership to the jurisdictional authority or a third party, and the completion of all obligations outlined in the closure plan to the satisfaction of the authorities.

Risk – Product of the probability of a hazard causing an impact multiplied by the consequences of the impact.

Social Sustainability – The ability of a society to continue over the long term with social structures (education, employment, health care, community relations) intact or evolving in a positive direction.

Sub-aqueous Disposal – The disposal of mine waste underwater, which reduces the contact of oxygen with the underwater waste, and is a well-known practice for disposal of mine waste. Commonly used for tailings, where the tailings surface is flooded with water, and waste rock (especially where waste rock is disposed of in the bottom of a pit, and the pit flooded).

Tailings – A common by-product generated by many mining operations, consisting of fine-grained crushed rock (usually sand or silt-sized products) that has been treated physically or with a chemical to mobilize the commodity(ies) of interest. Tailings usually are generated with entrained process water which may be partially removed by any number of thickening processes.

Waste Rock – Rock that is excavated in the process of accessing valuable ore. This refers to the rock that has no economic value to the mine. The rock is normally stored in piles on the ground surface, and may be used in the construction of other mine facilities, such as tailings dams. Waste rock may be chemically inert, or may be reactive with the potential to generate acidic or metal drainages when exposed to precipitation.

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MINE CLOSURE

Checklist for Governments