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**KEY ENVIRONMENTAL, SOCIAL AND
ECONOMIC CONSIDERATIONS IN
SUSTAINABLE MINING OPERATIONS AND CLOSURE**

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ABSTRACT

This paper outlines the key environmental, social and economic issues that should be considered for sustainable mine operation and closure. The six tenets of sustainable mining are discussed, along with the need for a sustainable mine closure framework.

The closure planning process is outlined and the key issues that influence this process (including barriers to success) are discussed. The closure planning business case is put forward and it is suggested that a change in perspective for mine closure may be appropriate.

INTRODUCTION

Sustainable development is one of a range of ideas that has developed from decades of debate about how humans should best interact with each other and the biosphere. The most widely accepted definition of sustainable development is the one developed by the Brundtland Commission, which defined it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987).

More recently, the Mining Minerals and Sustainable Development (MMSD) report suggested that, in the context of the minerals industry, the goal of sustainable development should be to “maximise the contribution to the well-being of the current generation in a way that ensures an equitable distribution of its costs and benefits, without reducing the potential for future generations to meet their own needs” (International Institute for Environment and Development [IIED], 2002).

Following completion of the MMSD project, the Global Mining Initiative (GMI) established the International Council on Mining & Metals (ICMM), which has also adopted the Brundtland Commission’s definition of sustainable development. The principles of the ICMM’s framework for sustainable development are as follows:

- Implement and maintain ethical business practices and sound systems of corporate governance.
- Integrate sustainable development considerations within the corporate decision-making process.
- Uphold fundamental human rights and respect cultures, customs and values in dealing with employees and others who are affected by our activities.
- Implement risk management strategies based on valid data and sound science.
- Seek continual improvement of our health and safety performance.
- Seek continual improvement of our environmental performance.
- Contribute to conservation of biodiversity and integrated approaches to land use planning.
- Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products.
- Contribute to the social, economic and institutional development of the communities in which we operate.
- Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.

Most major mining companies are committed to continual (or continuous¹) improvement in their environmental performance. The challenge for these companies is to define where, in the short and medium term, resources can be targeted to ensure the best chance of meeting objectives such as maintaining critical natural capital, enhancing ecosystems, and contributing mineral wealth to net environmental continuity (IIED, 2002).

Through the MMSD project, five interlinked issues critical to the mining industry's response to sustainable development were identified. These are management of large volume wastes, mine closure planning, environmental legacy, environmental management systems and biodiversity. The importance of these types of issues is recognised by the Australian Mining Industry Code for Environmental Management and is expected to be addressed by the Sustainable Development Code currently being developed by the ICMM.

This paper discusses the importance of planning for mine closure and sustainable post-mining land use from the outset of mine planning.

¹ The terms "continual" and "continuous" are often used interchangeably. Although they have similar meanings, they do have different definitions. Webster's Dictionary and Thesaurus (published by Geddes and Grosset in 2002) defines continual as "unceasing, very frequent" and continuous as "joined together without interruption".

SUSTAINABLE MINING

At the 2002 United Nations World Summit on Sustainable Development held in Johannesburg, South Africa, Duma Nkosi stated that:

“While any one mine is not sustainable, mining can sustain development. Mining companies must ensure that when they finish mining, they leave behind an environment that is protected and a community that is empowered.”

So why does sustainable mining development matter? It is suggested that sustainable mining development can help achieve a broad range of savings in relation to operational, financing, transaction, closure and post-closure costs, and allows companies to contribute to the alleviation of lasting poverty and to economic development at both local and national levels (IIED, 2002; Strongman, 2002). The MMSD report also points to higher value for goodwill on the balance sheet, best practice influence on regulation, market advantages and access to ‘ethical’ investment funds (Strongman, 2002).

The foundation for sustainability planning at a mine site is provided in the six tenets of sustainable mining documented by Robertson (2004):

1. *Planning for the sustainable mining of necessary resources is a global necessity.*

The potential for mining to bring social and economic development, particularly to developing countries, should be harnessed. Mining should bring benefits that can be sustained at a national level even after mining ceases. Creating and sustaining mineral wealth can play an important role in maximising human well-being. Revenues should be distributed equitably.

2. *Sustainability of the economic and social benefits stimulated by the active mining period is an objective of sustainability and succession planning for a mine site.*

Though mining is only a temporary use of the land, the benefits of local and regional development stimulated by mine development can be sustained well beyond the life of the mining operations (Robertson, 2004). Mining companies, communities and governments now have the knowledge to ensure that the economic and social benefits arising from mining projects are not missed and that negative legacies do not occur. However, this requires early, concrete and pro-active stakeholder involvement (Sheldon *et al.*, 2002): see Tenet 5.

3. *Determination of the potential impacts and the optimisation of mine development, operation and reclamation to minimise these impacts, is a requirement of responsible stewardship.*

Mining is invasive and can change or impact on various physical, chemical and biological components and processes present at the mine site (Robertson, 2004). Integrated mine planning should address conversion of the resource into long-term sustainable capital while minimising short and long-term impacts on the natural and social environments.

4. *Planning and provisioning for post-mining sustainable land use management and custodial succession are necessary.*

Mining is generally one of a succession of uses for a piece of land and a mining company is simply a custodian in a succession of custodians or landholders (Robertson, 2004). Consequently, careful planning and provisioning is required to ensure smooth and effective custodial transfer of land.

5. *Involvement of all stakeholders in the planning, execution and succession processes is necessary.*

Planning and provision for sustainable management of the environmental, social and economic issues associated with mining requires input and commitment from all stakeholders throughout the life of a project (Robertson, 2004).

For a mine to close successfully, a trilateral process of consultation and problem solving that involves the mining company, government(s) and communities is required (Sheldon *et al.*, 2002).

6. *Achieving a consensus decision on the mine plan requires both a platform for the exchange of technical and social information and viewpoints (to achieve universal and comprehensive understanding) and an accounting (decision making) procedure that allows for all evaluation bases.*

The environmental, social and economic impacts of mine development may be described by a number of indicator values. The list of values considered by each stakeholder, and their respective value bases, varies between stakeholders and stakeholder groups. Consideration of all stakeholder concerns and valuations is required when selecting appropriate mine development, operation, rehabilitation and sustainable post-mining land uses (Robertson, 2004).

Sustainability is a pragmatic pursuit, not an ideological exercise, which is about increasing opportunities, not limiting them (Strongman, 2002).

PLANNING THE CLOSURE OF A MINE

Moving towards Post-mining Sustainable Land Use Planning

Mine closure has become an increasingly complex process. A century ago, closing a mine involved simply boarding up the adit and walking away. This practice is still followed in some places today!

During the 1980s and 1990s, there was a global trend towards “designing for closure” that saw planning for closure being incorporated into mine planning right from the initial environmental impact assessment and permitting phase. However, most closure planning was (and remains) “regulator driven”. In addition, closure planning tended to be addressed in general terms only, with little detailed consideration until close to site closure.

Progressively, more mines began to develop mine closure plans earlier in the life of a project. Although a significant improvement on simple mine abandonment, the use of

“Mine Closure Plans” suggests a short term planning perspective that appears shortsighted to the succeeding landholder or custodian (Robertson and Shaw, 1999). Mine “closure” may signify the end of the mine’s operating life but it is also the start of a new chapter in the life of the community (Strongman, 2000).

Most companies now recognise that mine closure not only needs to involve rehabilitation, but increasingly needs to address on-going environmental and socio-economic issues. This has precipitated a move to “mine completion” rather than mine closure. However, the use of the term “completion” indicates a status of completeness and a job well done, which may not be appropriate when a site requires sustained or perpetual care and maintenance.

Mine closure is now being seen not simply as the end of mining, but rather as one step in a larger process of environmental recovery for ecosystems and social renewal for communities (Sheldon *et al.*, 2002). Consequently, there is now a move towards planning for sustainable post-mining land use(s). This requires a sustainable mine closure framework and a post-mining sustainable land use plan, rather than a closure or completion plan.

Business Case

Mine closure is a complex task that involves significant potential environmental, social and safety risks. Effective planning for mine closure and sustainable post-closure land use(s) will:

- Provide a structured and comprehensive approach to decommissioning, rehabilitation and closure that ensures that no issues are overlooked or addressed inadequately.
- Ensure that the end result of the closure process is the product of long term thought, scientific investigation and trial, thereby minimising the risk of on-the-run planning, costly mistakes and insufficient timeframes.
- Maintain continuity of approach and ensure that all appropriate site personnel are involved in the planning and decision-making process.
- Save money by reducing final remediation costs and effort. Some mines have incurred high closure costs due to the failure to identify and mitigate conditions that require costly remediation at site closure. Planning for closure allows the most cost-effective measures to be designed and incorporated into the mine plan (Brodie *et al.*, 1992).
- Ensure that adequate funds are available, and give validity and credibility to closure provisions. Early estimation allows companies to define and control areas of high risk and cost.
- Ensure that rehabilitation and closure issues are taken into account when modifying site operations and infrastructure, thus ensuring that closure plans and cost estimates are kept up-to-date.

- Improve company profile and reputation. In turn, a good environmental track record assists in ensuring the availability of natural resources for future operations and reduces the future risk of stricter regulation.
- Help determine the viability of future projects and provide immense value in due diligence issues.
- Reduce the potential for long term financial and other liabilities for companies and for government if a company abandons a mine site.
- Provide certainty to stakeholders, and reduce tensions and conflicts with local communities.
- Reduce the risk of economic and social collapse, especially for communities in remote locations.

As Reinhardt (1999) observes:

“Managers need to consider environmental problems as business issues. They should make environmental investments for the same reasons that they make other investments: because they expect them to deliver positive returns or reduce risks”.

Key Issues

Currently, mine closure planning tends to focus only on the environmental aspects of closure. However, integrating economic activity with environmental integrity, social concerns and effective governance systems is a necessary step in transforming mining investment into sustainable development (IIED, 2003).

A range of closure scenarios should be considered, including planned closure (which occurs when site operations cease due to known or predicted economic or operational factors, such as depletion of the ore body), unplanned closure (which occurs when site operations suddenly cease due to financial constraints, non-conformance with regulatory requirements and/or other unexpected issues) and temporary closure (which is otherwise known as “care and maintenance” and is usually required for operations that have temporarily ceased operations due to an unfavourable economy or other reasons) (The Chamber of Minerals and Energy of Western Australia Inc [CME], 2000; Australian and New Zealand Minerals and Energy Council [ANZMEC] and Minerals Council of Australia [MCA], 2000).

Issues and considerations that influence planning for sustainable mine closure and post-mining land use include those outlined below.

- It is important to identify all legal obligations and other requirements relevant to mine closure early in the mine planning process, and to ensure that this list is kept up-to-date through the life of the project. Often, sites are aware of their project-specific obligations (as defined through environmental approvals, licence requirements and tenement conditions) and industry guidelines, but are not as familiar with legal requirements. Lack of awareness of these requirements could result in inadequate closure planning.

- In general, mining companies recognise the need to understand the impacts, both beneficial and adverse, that their operations have on the natural and social environment. However, it is equally important to understand how these impacts will change as a result of site closure. Regular review of a site's impacts and appropriate risk assessments assist in this regard. These need to consider on-site and off-site impacts. The combined effects of multiple projects in a project area (i.e. cumulative impacts) must also be considered in any regional post-mining sustainable land use plan development (Robertson *et al.*, 1998).
- It is important to ensure that the rehabilitation and closure measures are effective over the long-term. This requires that the mining company look far into the future, in the order of several decades and possibly centuries, to identify those processes and forces that will act upon the mine components remaining after closure. The company must then design and implement closure works that minimise or eliminate significant long-term risks, or if deterioration is inevitable, identify and provide for the necessary long-term maintenance (Brodie *et al.*, 1992).
- Experience has demonstrated that while individual technical issues may be adequately addressed in closure planning, what is often incomplete is the technical understanding of overall long-term system performance. The development of a sound understanding of the natural and man-made physical, chemical and biological systems operating at a site is critical to the definition of closure works and the willingness of succeeding landholders to accept responsibility and liability for the site (Brodie *et al.*, 1992; Robertson *et al.*, 1998).
- Post-mining land use must reflect the needs, priorities and values of the local community. However, the diverse nature of communities means that reaching alignment can be difficult.
- Effective stakeholder involvement is essential for successful planning and implementation of mine closure. However, stakeholder engagement is an inherently political process and may require a substantial contribution from the mining company to develop the capacities and resources of stakeholder groups and communities (Sheehy and Dickie, 2002).
- Stakeholder legitimacy is a continuing concern and it is critical that those who purport to speak on behalf of particular groups or interests are able to demonstrate a clear mandate from those they claim to represent. In addition, all stakeholders need to demonstrate the highest standards of ethics, transparency and accountability. Not all stakeholders will behave well at all times, but it is critical that the industry demonstrates leadership and commitment, and adopts high standards (Sheehy and Dickie, 2002).
- It is increasingly becoming clear that the socio-economic impacts of mine closure and the impact on workers, their families, communities and the local economy must be addressed as part of closure planning. Where possible, avoid the creation of a culture of dependence (Carter, 2000; McGuire, 2003). However, it is recognised that, in many cases (particularly in remote areas), it is impossible for the mining community not to become dependent on the income, employment, infrastructure and facilities (including transportation networks, telecommunications, water and sanitation services) provided through the mine.

Consequently, closure of the site has significant impacts on the well-being of the community. This is exacerbated in developing countries where alternative economic activity may be more limited, and where local government and communities lack the resources to develop a process that would provide suitable alternatives (Sheldon *et al.*, 2002).

- Careful consideration should be given to fiscal provisions and sharing the benefits from the mine so that they result in long term benefits to the community, not simply short term consumption (Strongman, 2000). For example, the “Future Generations Fund” and other programmes established in relation to the closure of the Ok Tedi Mine in Papua New Guinea protect benefits for use by subsequent generations (Strongman, 2000; Anon, 2004).
- There can be socio-economic benefits in transferring important social or productive assets and infrastructure to government, the community or a non-government organisation. However, simply “handing over” these services rarely works unless the organisation is set up to manage the services and facilities. Therefore, it is important to establish a relationship and consult with these parties to ensure that any transfer is successful.
- The costs of mine closure vary greatly and are influenced by such factors as the location and size of the mine, its age, the type of mining conducted and mineral extracted, the volume of waste produced, environmental characteristics and history of environmental management. Actual closure costs tend to be underestimated, but this can be difficult to identify as the scope of the work, exclusions and assumptions used to develop the cost estimate are often not clearly and comprehensively documented. It is important to have clarity about costs (Sheldon *et al.*, 2002).
- Cost estimates for closure works should be updated regularly. Rather than merely updating cost estimates based on old closure plans, it is important to take into account the latest available data and technology, current legal and other requirements, any changes in the community and industry, and any changes in site operations.
- Poor experience with closure plan implementation has resulted in reluctance by the potential new custodians or landholders to accept transfer of the site (Robertson *et al.*, 1998; Robertson and Shaw, 1999). This particularly applies to sites where there is significant risk of physical instability (eg. where waste dump slopes could fail) or chemical mobility (eg. leaching of contaminants).
- The procedures and processes involved in mine closure and transfer of land can be complex, particularly where the final closure criteria and custodial transfer mechanism(s) evolve from the combined input and interaction of various government departments, community groups, non-government agencies and other parties. It is important that sufficient time be allowed to clearly define these processes, especially when dealing with groups that have not been through this process before and where administrative procedures are unclear or absent.
- Improved governance requires clearer definition of roles and responsibilities, and new mechanisms to deliver on commitments to sustainability. By taking

leadership in improving standards and governance, the mining industry can only do itself good (Sheehy and Dickie, 2002).

DEVELOPING A CLOSURE PLAN

There are many issues and aspects to consider in developing a sustainable closure and post-mining land use plan, and this paper does not attempt to list them all. Instead, the authors wish to present three key messages relating to the way in which such planning could be conducted. These are as follows:

- “Start at the start”.
- “Know what you’re trying to achieve”.
- “Be systematic”.

Start at the Start

Planning for progressive rehabilitation and the development of sustainable post-mining land use(s) should be an integral part of overall mine planning. An initial mine closure plan can influence decisions about key technology and waste disposal options before mining commences, enabling rehabilitation and aspects of post-mining land use development to be built into operational activities at a lower cost over the overall mine life (Sheldon *et al.*, 2002). In some instances, an early understanding of the cost of closure, the development of a sustainable post-mining land use and/or any resultant environmental liabilities will result in changes to the mine plan or may even prevent a project from going ahead.

An overview of the closure planning process throughout the life of a mining project is provided as Figure 1. This figure demonstrates that, at the exploration, conceptual or pre-feasibility phases of a mining project, there is a high level of uncertainty in relation to project design. However, it is possible to identify broad objectives for closure, to establish a baseline for financial provisioning and to identify (in general terms) those environmental, social, economic and governance issues relevant to site closure (CME, 2000). There is limited stakeholder consultation, most of which will focus on internal stakeholders. The outcomes of the above are captured in a Conceptual Closure Plan.

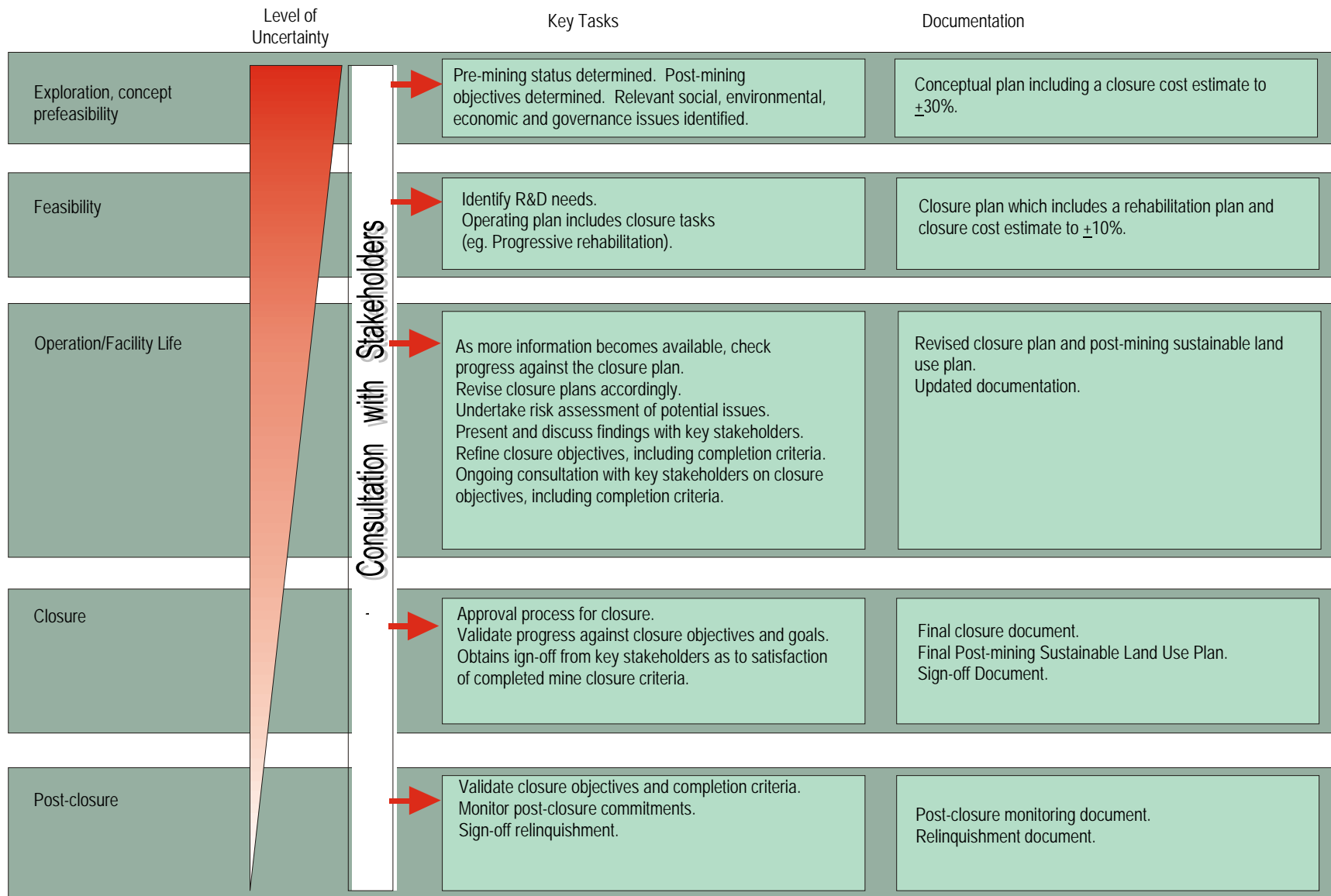


Figure 1
Closure Planning Overview

Source: Modified from BHPBilliton

During the feasibility phase, work is conducted to more clearly define the scope and estimated cost of the decommissioning, rehabilitation and closure works likely to be required. However, the scope of work is still relatively broad and the closure costs still have some level of uncertainty. A better understanding of the relevant environmental, social, economic and governance issues has usually developed by this stage of a project, and can be used to identify research and development (R&D) needs. Stakeholder consultation continues to be targeted, but often includes key regulators and landholders. The findings of this work are documented in a closure plan. Plans for sudden or temporary closure should also be addressed in this plan at a conceptual level.

As the project moves through the construction and operation phases, the closure plan is reviewed and updated on a regular basis to address changes in technology, work practices, project design and operations, regulatory and other requirements, and other aspects. The stakeholder consultation programme expands, and objectives and criteria for the preferred sustainable post-closure land uses are refined. In addition, further work is conducted on planning for sudden or temporary closure. The outcome of this process is a series of updated closure plans.

As the project approaches planned closure, further review and refinement of the detailed scope of work and cost estimate occurs. This includes clear definition and documentation of the approvals process for site closure to ensure that timely sign-off from key stakeholders can be obtained. At this point, the sustainable post-mining land use plan should be finalised in consultation with all stakeholders.

Following completion of the final decommissioning, rehabilitation and closure works, a post-closure monitoring report is used to assess progress against commitments and actions required for relinquishment or transfer of the land to the next custodian or landholder. This demonstrates the importance of placing mining in a much longer timeframe that is needed just to operate the mine (Strongman, 2000).

Know What You're Trying to Achieve

A site's mine closure policy needs to clearly define a company's intention in relation to the development of sustainable post-mining land use(s) and to provide a framework for objectives and actions. The policy and related strategies should reflect corporate objectives and business imperatives, but should also take into account community values, needs and objectives. Consequently, consultation with internal and external stakeholders is a necessary step in policy and strategy development and review.

A closure policy should clearly state desired outcomes or aspirations to guide decision-making by mine planners and operators, but should be flexible enough to adapt to changing conditions. This process guides individual decisions taken during mine life to ensure they are always oriented towards, and give due consideration of, closure objectives.

It is important that a company establish and document the closure standards that it is aiming to fulfil, and that these are both acceptable to stakeholders and achievable. A set of indicators that allows the company to track progress in meeting its closure objectives and standards is also required. Regular assessment of these indicators allows the company to measure progress and redirect effort and resources, if required.

Be Systematic

The suggested content of mine closure plans catering for various stages in the life of a project has been well documented (see, for example, ANZMEC and MCA, 2000; CME, 2000; Koontz and Lacy, 2002; Sheldon *et al.*, 2002). More recently, effort has been made to develop systems for mine rehabilitation and closure. A good example of this is the Progressive Mine Rehabilitation System described by Lacy and Koontz (2003), which is based on the objectives and principles outlined in the Strategic Framework for Mine Closure (ANZMEC and MCA, 2000).

It is logical to apply a systems approach to mine closure and post-mining sustainable land use planning, particularly as it ensures regular review and continual improvement (Figure 2). A systems approach also ensures that critical factors such as allocation of accountabilities, assessing competency and providing training, auditing and review, and the provision of adequate human and other resources are accounted for up to and following site closure.

Records management is another critical component of closure planning that is often overlooked. It is generally recognised that databases developed during the operation of a mine site are required to validate targets for relinquishment and to confirm when closure criteria have been achieved. However, attention is not always paid to identifying what information should be provided to the new custodians or landholders, and in what format.

Another critical issue is, who owns and is responsible for the system once mine closure has occurred? It is necessary to ensure that accountabilities are identified and adequate resources are allocated to support the system once the mining operation and resultant cashflow has ceased.

CONCLUSION

Sustainability is not an all-or-nothing, one-size-fits-all proposition. In relation to sustainable mine closure, it is equally likely that there will be no one model to suit every situation. However, a wealth of information, experience and expertise is available to guide companies and organisations towards sustainability.

There is a growing body of evidence that sustainable mining development and closure, when implemented well, can provide net benefits both to the community and the investor (Strongman, 2002). However, constantly changing circumstances (such as changes in regulatory requirements, stakeholder interests and values, environmental standards and custodial transfer requirements) can result in long term changes in requirements for mine closure (Robertson *et al.*, 1998). Consequently, it is important that mining companies position themselves to manage change.

In order to achieve sustainability, a change in perspective from mine closure planning to planning for post-mining sustainable land use is appropriate.

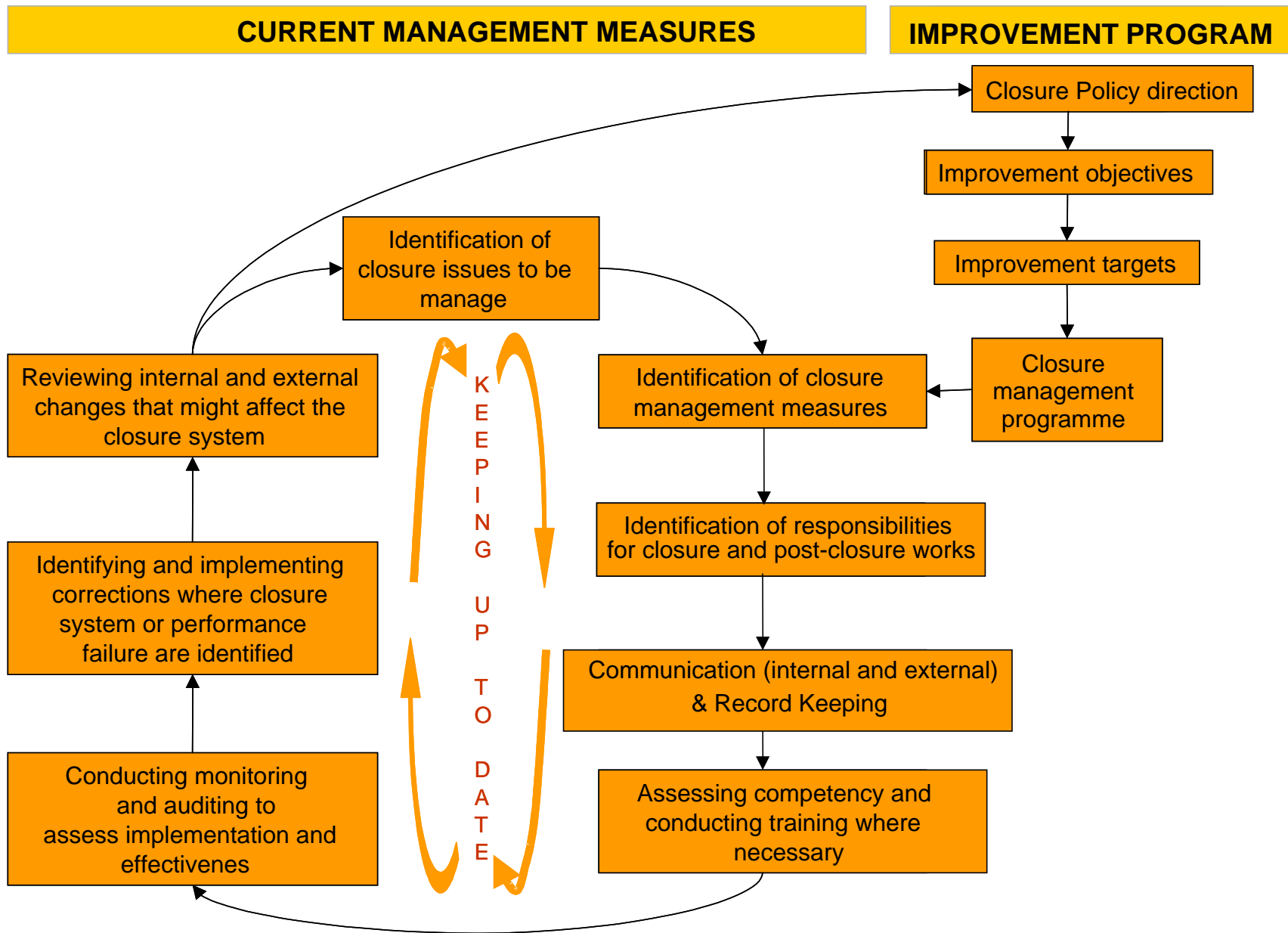


Figure 2
Suggested Closure Management System

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