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MINE CLOSURE, SUSTAINABLE DEVELOPMENT & CORPORATE SOCIAL RESPONSIBILITY: AN EMERGING PARADIGM IN MINE PLANNING

Mining faces distinctive challenges in the future. The concept of closure and decommissioning now involves the entire mining industry. As a consequence, it is essential to recognize in the mine planning process that a commitment to mitigating the environmental effects of a project is a fundamental component, and a closure plan is an important aspect of the mining project. Mining companies must be committed to seeking out the cleanest, most environmentally sound mining techniques. It is now clear that reclamation planning, environmental planning, ecological planning, and sustainable development are approaches which take an increasingly broader view of the impacts of an industrial operation both in spatial and temporal dimensions. It is thus essential that mine planners recognize that a commitment to mitigating the environmental effects of a project is a fundamental component.

While environmental issues are considered and accounted for during the operation and after the closure, the mineral extraction based economy of the region is not easily replaced. Clearly, mineral development is only a bridge between the present and future generations through which the foundations for a new economic base needs to be fostered. The new operating paradigm has shifted from a “do no harm” approach to a “demonstrated positive development” benefit imperative. A mine and its local community are inextricably linked. The two will thrive together or fail but rarely will one thrive without the other for any length of time. The quest for truly sustainable mines is unattainable with understanding how to ensure sustainable development of the local community. It is a new emerging concept for all mine planning endeavors worldwide. Mining companies need to enhance their ability to earn the right to enter a mining region and extract its resources with social responsibility.

***Keywords:* sustainable development, mine planning, social responsibility, mitigating the environmental effects.**

Introduction

Experience in the last century has shown that environmental standards have risen steadily. Changing conditions, such as higher production from fewer mines, increasing depth of workings, the extraction of lower grade deposits, increasing costs in heap leach pile detoxification and rinsing, tailings dam closure, growing recognition of the health and safety, and environmental aspects, have had a profound influence on the planning and design of mines.

As a truly global industry and one with unenviable reputation in many circles, mining faces distinctive challenges in the future... Industry and governments all over the world is now focusing on thorough and reliable assessments of these impacts, as well as identification and evaluation of possible response, all in the context of

widely differing social and economic settings. In the U.S., in addition to the Surface Mining Control and Reclamation Act of 1977 (SMCRA), mine owners and operators are faced with a myriad of environmental laws and regulations with consequences which can reach far beyond those imposed by SMCRA. The civil and criminal enforcement actions mandated in those laws compel owners and operators to be accountable for the preservation of the environmental impacts of these conditions could become the responsibility of lending institutions as well. In order to protect all entities involved, it is important that mine planners maintain a thorough understanding of the environmental issues, the adequacy of their plan relative to current laws, and the ramifications of pending laws and regulations.

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Current Environmental Issues

Land damages that cited against surface mining are mainly due to the destruction of surface topographies and of soil conditions that existed before mining commenced. Often, this potential productivity of the soil for plant growth is greatly reduced after mining. Soils that are disrupted by these operations are often chemically active, and toxic, thereby becoming a source for water pollution. Also, if the overburden is a massive rock formation, huge blocks of rock occur in the graded spoil which makes it difficult for the smooth passage of farm machinery. Much larger areas are also affected by the unconsolidated spoil heaps and voids because these conditions affect drainage patterns. Here, the natural processes of erosion and sedimentation are accelerated, moving large volumes of soil into receiving streams.

The Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87, 95th Congress) represents a significant effort on the part of the Federal Government to establish a nationwide program to protect society and the environment from the adverse effects of surface mining operations. The Act of 1977 requires that reclamation plans must include the following:

- historical and existing land use;
- capability of land to support a variety of uses before and after mining;
- proposed use of land after reclamation;
- relationship of proposed use to existing land use policies.

In addition, compliance is also required with those regulations that are generally separate (non-SMCRA) from compliance with mine permit requirements. These regulations are commonly mandated by State and Federal environmental protection agencies and are usually enforced separately from SMCRA (Hanlon, 1995):

- Clean Water act (CWA)
- Resource Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
- Toxic Substance Control Act (TSCA)
- Safe Drinking Water Act (SDWA)
- Clean Air Act (CAA)

The regulatory framework under which industry is mandated gets more complicated every day. Agencies such as the EPA, OSM, and the State mining agencies have increased scrutiny of

all facets of mining and processing operations to the point that mining companies can no longer react in passive manner (Marcus, 1990). As a capital-intensive industry, mining cannot tolerate much political risk and must, therefore, conduct its operations in a socially responsive manner.

In the non-coal mining sector, principally gold, and base-metal sulfides, mining activities, comprising the mining and milling of ores to produce concentrate, disturb the environment in several ways. Tailings disposal may contaminate water with toxic substances and acid mine water and tailings water affect the pH of receiving watercourses. Tailing dams are potentially dangerous structures. Water pollution is the single most important type of environmental damage caused by mining activities. Due to serious water pollution concerns, a combination new forces of public, special interest groups, and government, is creating a competitive environment that threatens the viability of a prospective mine. An increasingly litigious and adversarial climate obstructive to development mandate the search for ways to anticipate, mitigate, and resolve environmental conflicts in order to facilitate appropriate and environmentally sound economic development. Environmentalists are interested in any mining activity that will cause change to the natural environment. The most common environmental concern is the potential impact to water quality. However, the destruction of habitats directly by removal of ore and waste rock, or through the placement of tailings and waste rock, are also a common concern.

Planning and regulatory authorities now insist that far greater attention be paid to the likely effects of mine closure; the program for mine decommissioning, site rehabilitation and restoration now forms an integral part of the permit application. There are other reasons that justify the application of a closure plan. First, planning for closure during all stages of mining operation results in a large cost saving. Second, the regulatory environment now requires a closure plan, and third, legislation mandating long-term liability forces mine owners to consider the post-closure environmental impacts of mining. These stipulations impose retroactive liability to mine owner in the Unites States (Lima and Wathern, 1999). The environmental implications must be fully considered in the environmental impact assessment (EIA) and described in the environ-

mental impact statement. If the consequences of a mining development can be foreseen at the planning and design stages, any detrimental effects can be minimized at the outset (Ricks, 1995).

It is thus essential that mine planners recognize that a commitment to mitigating the environmental effects of a project is a fundamental component. In general, the mines that would draw the attention of the environmental community are the large projects that involve the proc-

essing and long term storage of hundreds of millions of tons of ore, tailings, and waste rocks. These large scale, low grade ore operations, which have become the preferred method to extract both precious and base metals in the last 50 or so years, represent a significant departure in the magnitude in their physical effects, and in the knowledge about the resource itself and the potential resources that could be affected, from the pick and shovel mining of previous century

Planning for Mine Closure

A closure plan is an important aspect of a mining project. This implies that closure issues should be incorporated into the EIA process at the earliest possible stage. In the past, many mining companies have approached mine closure as a casual event. Generally, the main goal of the closure plan is to determine the optimum method of operating and rehabilitating a mine site. Environmental concerns include liability considerations about existing and closed operations, the need for quantification of measures to achieve compliance, and closure plans. "Closure is de-

finied as the activity of a mining company related to the shutdown and reclamation of mining projects in a cost-effective manner" (Licari, 1997). Closure involves the removal of structures and buildings, and other infrastructure, and initiation of reclamation on the yet un-reclaimed portions of the mine (Taggart and Kieth, 1997). In the closure and post-closure Phase, structures are removed and ground surfaces are re-contoured and re-vegetated. Underground mines may be plugged and other measures for the control of acid mine drainage are initiated (Murray, 1997).

Table 1. Issues to be covered in mine closure plan

End of processing, deposition, or use;
Drain-down, treatment, and release of process water;
Construction of containment structures;
Plugging of drill holes, adits, or drifts;
Detoxification of process equipment;
Machinery salvage;
Removal of buildings, pipelines, and structures;
Final reclamation and revegetation.

A closure plan must consider long-term physical and chemical stability and land issues associated with the components left behind at the project site because of mining and mineral processing operations. A closure plan must identify a

variety of data with respect to the mine and the environment, particularly as these relate to the mining areas that will require decommissioning. Some of the issues to be covered in a closure plan are listed in Table 1.

Long-term Environmental Liability & Closure

Ideally, every mining company wishes to move on once the job of decommissioning, cleansing and rehabilitation of the mine site is complete. However, it is becoming clear that the mining industry is expected to do a great deal more in terms of long term monitoring, measurement and reporting of performance. Today, many permits for mining require 30 to 40 years of active participation in post-closure monitoring and follow up actions. The time required to

complete this work varies widely from site to site. However, the question as to when works are completed creates a great deal of uncertainty (Lima and Wathern, 1999) and creates conflict of interests.

Closure represents a discrete point in time. Because economically viable mineral deposits are finite, all mines will eventually cease extraction and close. This perception is implicit in the expectation that closure is merely a formality for

mines, assuming that proper environmental control was exercised during operations (Greef, 1993; Anon 1993 (a)). The assumption or expectation that mine closure releases the owner from long-term environmental liability is inconsistent with the 'polluter-pays-principle'. Commenting on the closure of a mine near Faro, Yukon Territory, White (1996) states that: "Closure is not an open and shut case. It is a process of reconciliation for, at any point in time, [mining] costs that may represent the price of past failures that were not seen [as failures] at the time. White's observation introduces two fundamental issues that must be addressed prior to permanent closure. First, mine owners will be held financially accountable for the failures of environmental management during operations regardless of cause. Second, mine closure is not simply a phase of the mining cycle but is inextricably linked to environmental liability.

The 'polluter-pays-principle' introduces the concept of site responsibility following permanent closure. Legislated liabilities and economic necessities compel mine owners to reconsider the conventional view of closure. The liability issue at, and following closure, is not unique. In fact legislated long-term liability is commonplace for mineral producing nations. The regulatory environment defines the constraints placed on mines following closure. Pertinent constraints include long-term liability provisions, scope of liability, and the duration of liability.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) is the most notorious environmental liability statute in the world. CERCLA and subsequent amendments, commonly referred to as Superfund, were enacted to force potentially responsible parties (PRPs) that cause or have caused contamination of soil, air, or water to pay for clean-up efforts. CERCLA establishes strict liability for the site, which means that no evidence of wrongdoing is necessary for enforcement action against PRPs. In general, the government, acting through the Environmental Protection Agency (EPA), establishes a 'joint and several liability' claim against one or more of the PRPs. 'Joint and several' means that any one of the PRPs is responsible for the costs of clean up. It is then up to the affected PRP to seek reimbursement from other PRPs through legal action. This statute applies to all industrial facilities that generate hazardous wastes, including mining

operations (Cowan, 1997). According to Cowan (1997) typical mining problems that result in CERCLA enforcement include:

- Acid mine drainage;
- Trace metal releases from tailings impoundments;
- Contaminated soils; and
- Radioactive mine wastes.

CERCLA enforcement action in the United States is not limited to historical operations. In a study of mine sites on the National Priorities List (NPL) Housman and Hoffman (1992) found that of the 52 mine sites listed, 12 were active. In their estimation only half of the 52 sites represented 'historical mining practices'. It is important to bear in mind that these 52 sites are estimated to cost the U.S. mining industry 21 billion dollars in clean-up costs. These costs do not include the costs of legal action (Housman and Hoffman, 1992). Indeed, legal costs in the form of class-action lawsuits may dwarf the actual expenditure for site clean-up (Kumamoto and Henley, 1996). Thus, in the United States of America a mine site is never closed from a liability standpoint.

To indicate potential impacts all aspects of mine closure are interfaced with principal resources susceptible to impact, while identifying the respective emissions and effects by which impacts are produced. These are appropriately addressed by an environmental risk assessment. A risk assessment quantifies the perceived risk posed to defined "receptors" by a proposed action. A risk assessment normally consists of four distinct steps:

- hazard identification;
- exposure assessment;
- toxicity assessment (receptor dose-response);
- risk characterization.

Hazard identification involves the characterization of potential contaminants, their relative mobility, and relative toxicity and identifies target contaminants of concern. The exposure assessment consists of a conceptual model of contaminant fate and transport, and modeling of potential exposure for a specific event. The toxicity assessment identifies the dosage of target contaminants at a point of exposure to potential receptors and compares this exposure to known toxicological information. Finally, the risk characterization summarizes the overall environmental risk. Toxicity management is by no

means unique to the mining industry. For the mining industry, however, the issue of toxicity management and associated decision making is more complex than many other product industries. Much remains to be learned about the movement of metals through the environment and their possible short and long-term effects at various concentrations. Absolute elimination of

risk may not only be difficult to define in the case of metal species but would also prove prohibitively expensive. Finding the acceptable balance through risk assessment requires understanding, not only by those in the industry, but those influence society's decision through the media.

Corporate Social Responsibility & Social Dimension of Mine Planning

While major advances have been made in the environmental planning and post-mining rehabilitation of mining communities, the most serious issues facing the mining industry in recent years have been social and community acceptance of mining. The growing awareness of the complex issues of ecosystem stability has brought to the forefront the need for greater understanding and control of the factors that affect not only the physical environment but also all other aspects that can checkmate the long term development potential.

The management of social issues poses a key challenge for many mining companies operating in underdeveloped countries. Identifying and addressing these issues early on in the mine planning process and managing them actively throughout the life of a project can increase the likelihood of project success. It is a new and emerging concept for all mine planning endeavors worldwide.

The new operating paradigm has shifted from a "do no harm" approach to a demonstrated positive development benefit imperative. No longer are companies obligated to "do no harm", they need to demonstrate positive benefits and engage directly in corporate and social investment to ensure that the host communities, particularly those indirectly and negatively affected by their operations, receive direct and immediate benefits rather than wait for a possible "trickle down" effects from government from the receipts of taxes and royalties.

Strong emphasis is needed on gathering of socioeconomic data at the front end of the planning process, and a lack of social information can pose a risk for a mining company. Initial public consultations should commence at the scoping stage, and frequently, in a culturally appropriate and socially relevant way. Community ownership in building solutions for mitigation measures should be advanced as often as possible. It is essential for the mining company to ac-

knowledge that social impacts extends beyond the footprint overlays and may include direct and indirect impacts.

The idea of social responsibilities supposes that the mining companies have not only economic and legal obligations to society which extends beyond these obligations. One important aspect of corporate social responsibilities is how large multi-national mining companies relate to the local communities in which they operate. Good corporate citizens are active citizens who understand and take responsibility for their impacts on society around them. Corporate social responsibility provides an opportunity for mining companies to respond to public concerns and to leverage technological and organizational innovation for their competitive advantages.

Mining and corporate social responsibility regimes have developed embryonic pluralistic independent local community groups. Emergence of local communities as the other stakeholder in the trinity of mining development is very common... Thus, large scale mining development cannot operate on a daily basis without contributing tangibly to development pursuits.

Mining companies need to enhance their capacity to earn the right to enter a region and extract its resources responsibly. Mine Planning must display foresight and vision of a changing world, through leadership and direction. The social license to operate is extra-legal and abstract. Recognition and acceptance of a company's contribution to the community in which it operates, while moving beyond meeting basic legal requirements.

The concept of sustainable development – the development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs [WCED, 1987] – is widely accepted as essential for incorporation in planning and development by governmental agencies and industrial sectors, mining being no exception [MMSD, 2002]. The

concepts that are embodied in the definition of sustainable development are noble, simple and easy to understand and are the very reasons for the unifying appeal it has endured over the last two decades. Implications of sustainability and sustainable development for mineral industry which deals with non-renewable energy and mineral resources need to be understood before one can proceed to apply them. Several countries [e.g. Australia, Canada, etc.] and several international agencies have developed, following the WCED's sustainable development definition, specific definitions and elaborations with regard to the sustainable development of the mineral resources.

Mineral industry does practice a large number of sustainable practices, some rather unique, for extending the life of deposits. The significant progress in addressing the environmental, health and safety and local community development is also an indication that several aspects of sustain-

ability are being addressed. An outgrowth of the MMSD project is the ICMM sustainable development framework to which major mining companies around the world have subscribed. The sustainable development framework is a set of ten principles of operation [ICMM, 2003] supported by both a public reporting of the results on each of the principles and an independent third party verification of the reported results.

As an industrial and economic activity, mining has to cease due to either the physical depletion of the reserves or the economic viability of the operation. While environmental issues are considered and accounted for during the operation and after the closure, the mineral extraction based economy of the region is not easily replaced. Clearly, mineral development is only a bridge between the present and future generations through which the foundations for a new economic base needs to be fostered.

Conclusions

Mining is changing because of increased liabilities, permitting, and cost associated with environmental and safety compliances. More productive and economic alternatives, larger efficient equipment and automation are also changing the mining industry.

In the past, where post-closure planning requirements have been minimal or did not exist, some companies have avoided their obligations for site clean-up by manipulation of ownership and liabilities to other companies.

Today most countries require the approval of reclamation and closure plans prior to issuing a mining permit. Environmental concerns include liability considerations about existing and closed operations, the need for quantification of measures to achieve compliance, and closure plans. Mining companies now must investigate three aspects of closure planning: the indicative mine closure plan and its predictive impacts, and the implementation cost for bonding.

In many respects the mine closure objectives of the industry today are not unlike those of the regulatory agencies. Mine operators need to eliminate future liabilities where possible in order to obtain a release from planning and discharge permit conditions, so that their interests in the site can be disposed of quickly. Investors are asking companies to provide evidence that environmental requirements will be met. Publicly traded companies are being asked to disclose the

total environmental liabilities to shareholders. Mine closure is not simply a phase of the mining cycle but is inextricably linked to environmental liability.

Many of the environmental problems associated with mining are manageable, and are being managed with state-of-the-art technology and on the basis of today's scientific knowledge. The necessity to prepare reclamation and closure plans early cannot be over emphasized. Closure plan provides methods and techniques for rehabilitation of areas impacted by mining. The best way to create a successful mine closure is to undertake it progressively during mining operation. Contemporaneous reclamation, for example, will provide valuable information for ultimate reclamation success.

The economic success of mining company will increasingly depend on the fully integrated mine planning and feedback mechanism. In many mining areas, potentially profitable mineral projects, however, can be at risk because local people do not trust their government and mining companies on many issues. Mining projects will continue to be vulnerable to potential failures, delays, and higher costs. This suggests that mine planners need to be aware of the global challenges they face from issues of mine closures, corporate social responsibility, and sustainable development. Integrating all aspects of mining from exploration through closure, mine

plans can be developed based on the social aspect of mining, within the context of corporate social responsibility and sustainability. Mine

planning approaches must display foresight and a vision of a changing world.

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СУКУМАР БАНДОПАДХАЙЯ

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**ЗАКРЫТИЕ ПРЕДПРИЯТИЙ ГОРНОДОБЫВАЮЩЕЙ ПРОМЫШЛЕННОСТИ,
УСТОЙЧИВОЕ РАЗВИТИЕ И КОРПОРАТИВНАЯ СОЦИАЛЬНАЯ ОТВЕТСТВЕН-
НОСТЬ: НОВЫЕ ПАРАДИГМЫ В ПЛАНИРОВАНИИ ГОРНЫХ РАБОТ**

Горнодобывающая отрасль столкнется в будущем с рядом специфических проблем. В настоящее время концепция закрытия и вывода из эксплуатации объектов касается всей горнодобывающей промышленности. Как следствие при планировании горной добычи основным условием является обязательства по смягчению воздействий на окружающую среду, а план закрытия является важным аспектом проекта добычи. Горнодобывающие компании должны быть приверженцами поиска чистых, самых экологически безопасных методов добычи. Теперь ясно, что планирование рекультивации, экологическое планирование, планирование окружающей среды и устойчивое развитие являются подходами по смягчению последствий промышленной эксплуатации недр, получившей широкое распространение, как в пространственном, так и во временном измерениях. Таким образом, при планировании горных работ важно принимать обязательства по смягчению воздействий на окружающую среду и в проекте они является основной составляющей.

В то время, как вопросы экологического характера рассматриваются и учитываются как во время работы, так и после закрытия предприятий, то найти замену добыче полезных ископаемых, которая лежит в основе экономики региона, нелегко. Очевидно, что разработка месторождений полезных ископаемых всего лишь связующее звено между настоящим и будущими поколениями, посредством которого должны быть заложены основы новой экономики. Акценты новой парадигмы производства сместились с "не навреди" на "демонстрирование позитивного развития", т.е. императив выгоды. Предприятия горной промышленности и их местная инфраструктура неразрывно связаны между собой. Совместно они могут процветать или нет, но редко одно без другого успешно развивается в течение длительного времени. Стремление к устойчивому развитию горного производства недостижимо без понимания как обеспечить устойчивое развитие местной инфраструктуры. Эта новая концепция касается всех проектов горного производства во всем мире. Горнодобывающим компаниям необходимо усилить социальную ответственность для того, чтобы иметь право заниматься добычей природных ресурсов в районах, богатых ими.

Ключевые слова: устойчивое развитие, проектирование предприятий горнодобывающей промышленности, социальная ответственность, смягчение воздействия на окружающую среду.

СУКУМАР БАНДОПАДХАЙЯ

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**ЗАКРИТТЯ ПІДПРИЄМСТВ ГІРНИЧОДОБУВНОЇ ПРОМИСЛОВОСТІ,
СТАЛІЙ РОЗВИТОК І КОРПОРАТИВНА СОЦІАЛЬНА ВІДПОВІДАЛЬНІСТЬ:
НОВІ ПАРАДИГМИ В ПЛАНУВАННІ ГІРНИЧИХ РОБІТ**

Гірничодобувна галузь зіткнеться в майбутньому з рядом специфічних проблем. Зараз концепція закриття і виводу з експлуатації об'єктів стосується всієї гірничодобувної промисловості. Як наслідок при плануванні гірничого видобутку основною умовою є зобов'язання з пом'якшення впливу на довкілля, а план закриття є важливим аспектом проекту видобутку. Гірничодобувні підприємства повинні бути прихильниками пошуку чистих, найбільш екологічних методів видобутку. Планування рекультивації, екологічне планування, планування довкілля і сталий розвиток є підходами з пом'якшення наслідків промислової експлуатації надр, яка отримала широке розповсюдження, як в просторовому, так і в часовому вимірах. Таким чином, при плануванні гірничих робіт важливо приймати обов'язки з пом'якшення впливу на довкілля і в проекті вони є основною складовою.

В той час, як питання екологічного характеру розглядаються і враховуються як під час роботи, так і після закриття підприємства, то знайти заміну видобутку корисних копалин, який лежить в основі економіки регіону, нелегко. Очевидно, що розробка родовищ корисних копалин всього лише ланка, що пов'язує сучасне і майбутні покоління, за допомогою якої повинні бути закладені основи нової економіки. Акценти нової парадигми виробництва змістилися з «не нашкодь» до «демонстрування позитивного розвитку», тобто імператив зиску. Підприємства гірничої промисловості і їхня місцева інфраструктура безперервно пов'язані між собою. Разом вони можуть процвітати або ні, але рідко одне без одного успішно розвиваються протягом довгого часу. Прагнення до сталого розвитку гірничого виробництва недосяжне без забезпечення стійкого розвитку місцевої інфраструктури. Ця нова концепція стосується всіх проектів гірничого виробництва у всьому світі. Гірничодобувним компаніям необхідно посилити соціальну відповідальність для того, щоб мати право займатися видобутком природних ресурсів в районах, що багаті ними.

Ключові слова: сталий розвиток, проектування підприємств гірничодобувної промисловості, соціальна відповідальність, пом'якшення впливу на довкілля.