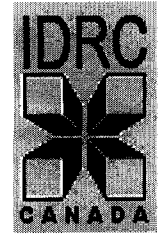




MINING POLICY RESEARCH INITIATIVES
INICIATIVA DE INVESTIGACION SOBRE POLITICAS



Mine-closure and Reclamation Bibliographic Database Project

Overview of Mine-closure and Reclamation
in the Americas
Executive Summary

by

Steve Roberts, Marcello Veiga and Carlos Peiter

- Vancouver, October 2000 -

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Abstract

The International Development Research Centre (IDRC, Canada) has been mandated by the Parliament of Canada to assist researchers and communities in the developing world to find solutions to the economic, social and environmental problems that arise as nations pursue policies intended to move their economies into the 21st Century. One area of the world economy that has seen enormous growth over the last decade is the minerals and mining sector. As domestic economies expand, the need to supply them with additional mineral resources has taken on added importance. In Latin America alone, foreign and domestic investment in the mining sector now exceeds US\$ 2 billion per year. But as new mines are developed there is a growing concern within the communities directly affected by mining that not enough has been done by their respective governments, or the mining industry to minimize the human and biophysical impact of mining. In particular, policies have yet to be developed that specifically address what is to be done when a mine has closed and it is time to reclaim the site for future productive use.

To assist those researchers who are interested in answering these important policy questions, the IDRC, through the recently created Mining Policy Research Initiative (MPRI) funded a joint research project involving the University of British Columbia, Canada, and the Centro de Tecnologia Mineral CETEM, of Brazil. The aim of this project was to establish a database of available literature on the subject of mine closure and reclamation for the Western Hemisphere that could then be used by other researchers to further the progress of their work. Though informational databases in this subject area already exist, their focus has been mainly on revealing the relatively narrow economic and biophysical issues that are commonly associated with mine reclamation. What makes this project particularly valuable is that for the first time a closure and the reclamation database has been expanded to include the important social, legal, ethical and gender issues that also need to be addressed if more holistic approaches to mine reclamation are to be found.

In addition to the database itself, an executive summary of its contents and an opinion survey has also been prepared. The summary contains a review of the material contained within the database's eleven subject headings. The opinion survey includes feedback on a variety of questions that were answered by government and industry representatives who are directly involved in administering mine reclamation programs in North and South America.

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The database was compiled using material originating from industry and academic journals, books and electronic databases. Whereas mine-closure and reclamation involves many diverse areas of study, the database sought to include material drawn from such diverse disciplines as engineering, law, economics, environmental science, ethics, and political science. Because the database is intended for use by researchers, every effort has been made to include the most up-to-date material available.

To assist the users of the database, additional supporting material has been included. This material consists of an **executive summary** covering the database's main headings, as well as the results of a **questionnaire** issued to reclamation practitioners in government and industry. The aim of the questionnaire was to gather feedback from those decision-makers that actually oversee how mine-closure and reclamation policies are pursued in the Western Hemisphere.

Some readers may be struck by the fact that the focus of this project is directly primary toward addressing the socioeconomic, rather than the environmental consequences of mine-closure. This alternative approach reflects a conscious decision on the part of the research team and

our MPRI/IDRC sponsors to have the bibliography highlight areas¹ of concern that traditionally have not received much attention. It is our belief that the future direction of research on mine-closure will be much more holistically based. No longer concerned with just environmental issues, researchers will now be struggling with the task of understanding the social and economic impacts that closure brings to a community.

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Vancouver October 3, 2000

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1. LEGAL ISSUES & INSTITUTIONAL FRAMEWORKS

1.1 Introduction

The institutional and legal frameworks that govern the practice of mine reclamation in North America have evolved significantly over the past twenty-five years in response to changing public, governmental, and industry expectations. As more is learned about the potentially negative long-term impact mining can have on the surrounding environment, an increasingly vocal public has demanded that the government create legislation designed to compel the mining industry to engage in practices that are compatible with to the needs of the environment. This section will briefly examine the regulatory and institutional structures that the Canadian and United States governments have put in place to respond to the need to reclaim previously mined areas.

1.2 North America

1.2.1 Principle Issues

What is Reclamation? The answer to this question has evolved considerably over the last thirty years. Initially reclamation was described in terms of health and safety considerations upon mine-closure (i.e., sealing of underground openings). While still concerned with these twin issues, reclamation is now also concerned with protecting and restoring land that has been affected by mining. In pursuing these objectives, Canada and the US have instituted a series of legislative initiatives designed to create procedural and enforcement mechanisms in support of specified reclamation outcomes.

In general, Canadian and US laws regulating mine reclamation and closure exhibit a number of important similarities (Champigny, 1991; Danielson & Nixon, 2000)^{2,3}. These similarities can be described using the following headings:

- **Legislation.** In both countries mine reclamation legislation has not been written as a

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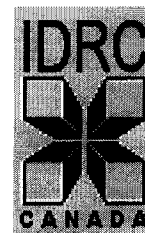
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specific act, but is part of other legislative acts governing mining. Both countries also recognize in law the involvement of other governmental departments in regulating the reclamation activities of the mining industry.

- **Procedures.** In recognition of the dynamic nature of the mining industry, both countries have adopted a regulatory framework that accepts the desirability of significant ministerial discretion. This discretion was seen as a preferable alternative to a highly centralized, “command and control” approach to mine reclamation. Under the current regulations mining companies must first submit a reclamation plan, at the level of conceptual engineering, before they are granted permission to begin mining operations. Most laws contain a simple formula for allowing the company to make amendments to the closure plan as mining operations inevitably evolve over time.
- **Enforcement.** To ensure that sufficient funds are available to carry out the closure plan, all Canadian and most US jurisdictions require companies to institute some form of financial guarantee. Whether in the form of reclamation bonds or some other financial instrument, this money is intended only to meet the objectives of the closure plan. It should be remembered that the law did not intend for these bonds to be calculated based on all of the financial obligations a company may face upon closure. As ongoing reclamation proceeds, the company is required to report (typically annually) on its progress to the appropriate government ministry. Supplementing these reports, government inspectors are required to make periodic inspections of the mine site. These inspections are intended, in part, to confirm the accuracy of the company’s report, and to identify anything that may affect the ability of the company to fulfill its reclamation obligations. In most jurisdictions there are provisions in the law for non-compliance.

1.2.2 The US Model

As an outgrowth of its unique political heritage and its long history of mining, the United States has adopted a bifurcated approach to the regulation of mine reclamation. This fact has led to a situation where in the US the laws and institutions governing coal mine reclamation are radically different from those used to reclaim “hard rock” mines. Without commenting on the underlying political reasons for these differences, it is important to recognize how dissimilar the



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1.2.2 The US Model

As an outgrowth of its unique political heritage and its long history of mining, the United States has adopted a bifurcated approach to the regulation of mine reclamation. This fact has led to a situation where in the US the laws and institutions governing coal mine reclamation are radically different from those used to reclaim “hard rock” mines. Without commenting on the underlying political reasons for these differences, it is important to recognize how dissimilar the

two systems are. When it was enacted into law in 1977, the Surface Mining Control and Reclamation Act (SMCRA) established a set of national regulations for the reclamation of coal mines. By any measure, the SMCRA is a highly proscriptive piece of environmental legislation. The regulations not only set out the precise objectives of a reclamation project, they also specify in great detail the requirements for the construction, maintenance and final reclamation of the mine site. The operation of the program is funded by a levy that is applied to the coal mining industry based on annual production.

Under the law federal authority for overseeing the provisions of the Act may be delegated to the level of state government if it can be demonstrated that state laws are at least as stringent as the federal regulation. Even in those cases where the state government has assumed responsibility for administering coal mine reclamation, SMCRA still grants the federal agency the right to monitor the way the state operates its program. If a state fails to meet its legal obligations under the Act, the federal agency retains the power to revoke the state's legal authority and resume control.

While the SMCRA is generally regarded by government and industry as a highly successful program, there are aspects to the Act that limit its usefulness as a model for other jurisdictions. In terms of cost, the Act is expensive to administer. Because most US coal production is consumed by local power plants, the added costs of the program can be readily passed on from the company to the consumer. For a commodity whose price is set in a global market place (i.e., copper or gold) such added costs of production must instead be borne internally by the company. As commodity prices fall, this may threaten the ability of some companies to remain profitable. The Act may also not be appropriate for situations that call for the application of individual discretion on the part of mine inspectors.

In contrast to the strict federal laws written to control coal mine reclamation, the laws for hard rock and sand and gravel reclamation are vastly different. In the US the legal responsibility for establishing laws to regulate the non-coal mine industry rests squarely at the state level. Based on the vagaries of local politics, some states initiated well-conceived reclamation laws while others chose not to enact any reclamation legislation. The result has been to create a patchwork of laws that vary greatly in terms of the demands each state places on the

requirement of the industry to reclaim mined land.

In the absence of any powerful state laws specifically written to address the need to reclaim mined land, there are still several federal statutes that, while not directly related to mine reclamation, will influence to some extent the impact post-mine lands have on the surrounding environment. Experience has shown that a well managed mine that obeys strict environmental guidelines during the course of its operational life will, upon closure, be easier to reclaim. Thus US federal regulations on air and water quality and the handling of toxic waste have made a positive, indirect contribution to mine reclamation.

Operating in a global marketplace, mining companies must actively control their costs of production if they are to remain competitive. Taken in this light, the mining industry in the US has continued to fight a rear guard action against those who advocate for increased regulation of the industry. The more proactive members of the mining community have in fact taken it upon themselves the task of adopting a more sustainable approach to mine reclamation. By voluntarily raising the bar on reclamation, the industry hopes to forestall efforts by environmentalists to pressure the federal government into introducing national mine reclamation legislation similar to that found in the SMCRA.

If a national program of non-coal mine reclamation legislation were to be put into place, it would have to overcome the difficult problem of how to deal with the great diversity that is the mining industry. Hard rock mining, sand and gravel operations, placer mines and artisanal mining are fundamentally different in terms of mining methods, products they produce, the scale of their operations, degree of environmental effects and the scope of their reclamation requirements. This would suggest that governments are faced with the choice of either instituting a series of reclamation laws tailored to the demands of each subset of the mining sector, or adopt a unitary system that attempts to address the problem of reclamation using a single blunt instrument. Currently in the US, only the state of Arizona maintains a unitary system for issuing reclamation permits. All other US states have adopted, to various degrees, multiple permitting systems based on the type of mining operation that is seeking the reclamation permit.

1.2.3 The Canadian Model

Under the Canadian federal system, responsibility for mining falls within the exclusive domain of the provinces. Therefore with respect to mining, there is nothing in Canadian mining law that is comparable to the SMCRA. The situation in Canada is similar to the US in the sense that like the states, each province is responsible for developing policies and regulations governing how mined lands are to be reclaimed within their jurisdiction. Historically, the laws have been written in a way that government inspectors are awarded a high degree of discretion in terms of how they interpret the regulations (B.C. Ministry of Employment and Investment, 1997)⁴.

Like in the United States, Canadian Federal laws also play an important indirect role in how mines are reclaimed. The *Canadian Environmental Assessment Act* (CEAA), the *Canadian Environmental Protection Act* (CEPA) and the *Fisheries Act* can substantially affect not only the way mines are operated, but on occasion these laws have been applied to direct how mined lands are to be reclaimed

As part of the ongoing discussions over the redistribution of political power in Canada, the federal and provincial governments have agreed on the need to pursue a process that would lead to a streamlining of the existing regulations governing the mining sector (Natural Resources Canada, 1996)⁵. Consensus between the parties to change the existing legal statutes was reached on the following points:

1. The need to create opportunities for increased regulatory efficiency and effectiveness in meeting environmental protection objectives.
2. The need for better communication and cooperation within and between governments, industry, environmental groups and First Nation's peoples.
3. The need for better coordination within and between jurisdictions.
4. The need to clarify responsibilities and requirements for Environmental Assessments (EA), fish habitat compensation, and the permitting phases.
5. The need for relevant and easily accessible information.
6. The need for greater transparency in decision-making.

⁴ B.C. Ministry of Employment and Investment (1997). Health, Safety and Reclamation Code for Mines in British Columbia, Victoria, BC, Canada. ISBN 0-7726-3150-6

7. The need to acknowledge the role of non-regulatory approaches (environmental performance agreements, memorandum of understanding, codes of practice, guidelines, etc) in achieving environmental management objectives.

These changes reflect an ongoing evolution away from top-down, centrally administered and adversarial approaches to resource management to approaches that rely more on the need to form cooperative partnerships between government and industry. The Ontario Government in particular has demonstrated a willingness to re-write its reclamation laws in order to lessen the financial burden closure bonds have had on company balance sheets.

1.2.4 Abandoned Mine Lands

In both Canada and the US there has been an ongoing attempt to deal with the problem of reclaiming abandoned mined lands (AML). Mineral and surface title laws are inherently complex, and as such they present one of the more difficult institutional problems for addressing AML reclamation. Identification of former owners of AMLs is lengthy and expensive, and even if they can be identified these parties may be incapable of funding the required cleanup. Other problems include the need to possibly fund the cleanup into the foreseeable future (due to the lack of an appropriate walk away solution) and the threat of future liability imposed on third parties that attempt to cleanup sites. Under existing laws in both countries, liability for toxic releases is considered to be both retroactive and without limit. This means that the present owner of the property is responsible for the site in perpetuity, even if that owner was not involved in the original operation of the mine. The effect of the law has been to make third party cleanup of AMLs a very risky proposition. Due to this unintended aspect of the law, discussions between the various levels of government and the industry are ongoing over how best to amend the regulations to include a “good Samaritan” clause.

1.2.5 Future Trends

While predicting the future is inherently difficult, we can, with some measure of confidence, speculate on where the future of reclamation regulations are headed by looking back at the regulatory path that has so far been traveled. Beginning with its initial concern for issues of

⁵ Natural Resources Canada (1996). The Minerals and Metals Policy of the Government of Canada. <http://www.nrcan.gc.ca/mms/sdev/policy-e.htm>

human health and safety, the regulations have over time evolved to the point where almost an equal emphasis is now placed on the preservation of environmental values. This evolution has come about in response to heightened public awareness and concern over issues relating to the environment. It would seem unlikely that in the near or medium term this trend will be reversed.

While acknowledging that the current emphasis on environmental protection is likely to continue, recent changes in the political climate in Canada and the US suggests that other important changes are coming. In an effort to combat high government deficits, both countries have adopted a series of fiscal measures aimed at reducing their direct involvement in the economy. In Canada⁶ the result of this policy has lead to a gradual move away from a centralized regulatory regime to one that provides the industry with much more discretion over the ways and means it uses to meet the government's broad policy objectives. As a result of these changes to the legislation it is likely that in the future the job of government inspectors will change from a proactive to a reactive role.

While the potential exists for some industry players to cut corners in an effort to increase their relative competitive advantage, in general the large companies have, at least publicly, committed themselves to the principle of environmental stewardship. What is more problematic is how medium and small mining companies will respond to the less restrictive regulations.

It is somewhat more difficult to predict the future course of US mine reclamation regulations. While the SMCRA is widely seen as a highly effective piece of legislation, it is unlikely that it will be used as a model for future regulations governing hard rock mine reclamation. The SMCRA is expensive to administer and unlike the US coal industry, these costs cannot easily be passed on to the consumer. In addition there are important differences in the today's political climate that make replication of the SMCRA highly improbable. What is a more likely scenario is in the future there will be a continuation of the existing incremental approach taken

⁶ Ontario and to a lesser extent British Columbia have initiated a series of changes to the existing regulations in the hope of not only reducing their costs for overseeing the industry, but also to remove some of the perceived barriers to the economic competitiveness of the mining sector.

by the states to strengthen their reclamation legislation. This means that in the US there will continue to be a patchwork of laws of varying effectiveness and severity governing how hard rock mines will be reclaimed. In the absence of any standardized laws that are specifically written to address reclamation, the emphasis will remain with the mining industry to develop and follow best management practices if the existing situation is to substantially improve.

One area where future change is bound to occur is in legislation intended to address the ongoing problem of AML. There is little utility in creating laws that limit pollution from existing mine sites if nothing is done to address pollution from historic mined areas. How and when these laws will take effect remains a source of much speculation, but this is an issue that must eventually be addressed.

1.3 Latin America

In the Latin American countries studied⁷ under this project, the government institutions that are most closely linked to mine-closure and reclamation⁸ are the agencies responsible for the environment and/or mining. The formulation of policies and regulations are generally held at the federal level while the control and auditing of these policies may be the responsibility of the federal, state and/or local governments, depending on the characteristics of the project.

While the mining acts of Latin American countries typically contain specific references to the recovery of degraded areas, it is in the complementary regulations that the more general tools for environmental management and evaluation are found. Alternative legal frameworks for managing mine reclamation are found in Argentina, Ecuador and Peru. In Mexico, the regulation for system evaluation and environmental management is contained in the regulations governing mine development.

Bolivia is the only country in Latin America that has a specific regulation for the environmental management of mine-closure and reclamation procedures. The regulations provide specific

⁷ Argentina, Bolivia, Brazil, Chile, Ecuador, Peru and Mexico.

technical guidance for how the reclamation is to be accomplished once mining operations cease. To help ensure that the intent of the law is carried out, mining companies are required to develop a closure plan beginning from initial exploration. As in North America, these closure plans must address the objectives for the closure and reclamation, specify a program for closure (tailings control, physical and chemical stabilization of tailings, reclamation of the area and of superficial drainage, control of erosion), and address post-closure actions (control and monitoring).

In Peru the government has produced for industry a manual for mine-closure and reclamation. However, use of this manual is considered voluntary.

It should be noted that the Chilean Government is currently engaged in a process that would see different aspects of the mine-closure procedures in order to create a more holistic set of rules and regulations for the mine industry. At this point COCHILCO has been commissioned by the Minister of Mines of Chile to carry out investigations on mine-closure, abandoned sites and mining towns to establish liabilities and technical, social and political guidelines for the matter. This project has been observed by other North and Latin American governments with potential to use the recommendations as a basis for future regulations in these countries.

⁸ In Portuguese and Spanish the term reclamation does not exist. In English the term reclamation has been used as a synonym of rehabilitation and restoration. In fact, rehabilitation connotes a situation in which a degraded site is returned to a former level of biophysical productivity and reclamation process brings a degraded site to a situation comparable, better or different, but acceptable by regulators.

2. ECONOMIC ASPECTS OF MINE-CLOSURE

2.1 Introduction

The objective of mine-closure and reclamation is to provide long-term stabilization of the geochemical and geotechnical conditions of the disturbed mined areas to protect public health and safety, and to minimize and prevent any additional or on-going environmental degradation. Mine-closure is, typically, required at a time when the operation is no longer economically viable, when cash flow is often severely restricted or negative, and when the value of assets is below the expenditures required to achieve the regulatory and environmental objective of mine-closure. The objective of securing mine-closure funding at an early stage is to mitigate against the risk that an enterprise may either be unwilling or unable to undertake mine-closure due to lack of funding.

2.2 North America

In North America, as in many other parts of the world, governments attempt to manage environmental issues in mining through a number of ways. One such way is through economic and financial instruments designed to make mining companies internalize their environmental costs. These instruments may take the form of taxes, credits, rebates subsidies, penalties, etc. One of the advantages of using these instruments is that they encourage the industry to innovate in order to achieve the government's policy goals. The alternative is to have the government impose a system of command and control that is both difficult to establish and expensive to maintain.

In the absence of other regulatory requirements, accounting provisions are preferred by the mining industry to address mine-closure liabilities. This accounting transaction allows a company to make non-cash provisions for future mine-closure costs. However, this does not result in any actual cash flow for the purpose of accumulating closure funds. Unless the company has chosen to set aside actual funds for closure, when the project approaches the closure date, closure liabilities are likely to exceed the company's tangible book value. Any attempts to raise additional cash through the sale of mine assets is unlikely to raise sufficient funds to meet the closure requirements.

At this point the company may be driven to declare bankruptcy rather than attempt to raise additional financing to cover their reclamation liability. Declaring bankruptcy serves to externalize the costs associated with mine-closure by passing on the liability to the government. With limited resources specifically budgeted for mine reclamation, government funding may well be inadequate to address the immediate and long-term environmental and safety impacts.

To avoid the problems described in the above scenario, Canadian and US mining companies are not allowed to rely on accounting accruals alone to cover the costs associated with mine-closure. Instead the government requires that companies secure the necessary funding by providing guarantees for mine-closure funds prior to mine construction and operation. While these and other regulatory requirements have resulted in greatly increased costs to the industry, experience has shown that ultimately it is much more expensive to plan for reclamation during closure.

2.2.1 Financial Assurances

One form of economic instrument that is most effective when used in combination with permitting, environmental assessment, inspection and enforcement is financial assurance. Typically, financial assurance devices are designed to ensure that the normal costs associated with mine-closure and reclamation are paid for by the mine owner or their designated agent. These devices are usually not designed to safeguard against costs that are associated with catastrophic events. Nor are these devices intended to cover costs resulting from long-term post-closure monitoring and maintenance of the site. Financial assurance assumes that costs of reclaiming mined lands are ultimately the responsibility of the mine owner.

An effective financial assurance program consists of three parts: permitting, inspection and enforcement, and the financial assurance itself.

2.2.2 Permitting

In setting the level of financial assurance, the permitting process plays an important role for several reasons. First, the permit can be used to identify the required standards for

reclamation and environmental performance for the mine. The permit also requires that the company produce a detailed mine plan. This plan will be used as the basis for calculating the amount of financial assurance that is required to achieve the objectives of the mine plan. Finally, the permit serves as an important legal device for ensuring that the company fulfills its reclamation commitments.

2.2.3 Inspection and Enforcement

A key element for ensuring the success of a financial assurance program is a rigorous system of inspection and enforcement. Ongoing inspections require communication between the regulator and the company, with the goal of identifying small problems before they grow into major ones. Inspection and enforcement, when conducted early on, helps to mitigate against those problems that inevitably occur when reclamation planning is left until mining has ceased and the cash flow available to the company is at its lowest.

The enforcement capacity of the regulator must be clearly and explicitly defined. All parties, including the provider of the financial assurance provisions should be aware of the implications for the financial assurance in case of permit violations or bankruptcy that may cause the regulator to seize assets or close the mine.

2.2.4 Financial Assurance Mechanisms

Many different mechanisms are available to miners to cover financial assurance. These include bonding systems, trust funds, insurance plans (available from only a small number of providers and provide limited coverage)

Difference mechanisms can be described as either being “hard” or “soft” depending on how rigid the financing requirements are.

Type of Security

HARD

Irrevocable Letter of Credit - an agreement between the company and the bank whereby the bank will provide cash funds to the regulator if the company defaults.

Performance Bond - a surety bond issued by an insurance company in which the insurer is responsible for all claims up to an agreed limit.

Trust Fund - a fund that operates in a similar fashion to a pension fund with regular contributions being invested by a fund manager.

Insurance Policy - a special form of performance bond.

Parent Company Guarantee - the parent company guarantees to indemnify the government in the event of company default.

Pledging of Assets - the company's assets are pledged to the government.

SOFT

(adapted from UNEP, 1998)¹

It is the typical practice of regulators to accept one or more types of security. The issues surrounding the type, nature, and conditions of guarantees are critical if the financial assurance is to function as the regulators intend. Experience has shown, particularly in the US, that when major closure problems occur the result is almost always some form of negotiation between the regulator and the mine owner. Typically the mine owner is trapped for cash and is seeking to scale back on his reclamation commitments. The direction these negotiations take largely depends on the "hardness" of the guarantee. As a rule, the harder the financial assurance the more flexible the regulator can be in considering alternative proposals put forward by the miner. On the other hand if the assurance is soft, the regulator can exert very little leverage in its negotiations with the miner. The events surrounding the closure of the Summitville Mine in Colorado are a perfect example of how powerless a regulator can be in enforcing the law when confronted with the knowledge that the financial assurance it held came nowhere near the amount required to reclaim the site (Danielson and Nixon, 2000)⁹.

2.2.5 Important Issues Related to Performance Bonding

⁹ Danielson, L. and Nixon, M. (2000), Current Regulatory Approaches to Mine-closure in the United States, in Environmental Policy in Mining, Warhurst, A. and Noronha, L., Ed., Lewis Pub., Boca Raton, p. 311-350.

2.2.5.1 Calculating the bond

As has been noted here, there are a number of different financial mechanisms available to the company, and each of these carries with it certain advantages and disadvantages. As way of explanation several types of performance bonds are reviewed to illustrate some of the tradeoffs that are faced when selecting the appropriate financial assurance.

2.2.5.2 Surety Bonding

Sureties are businesses that have agreed to be responsible for the reclamation debts of the mining company. Sureties guarantee that either the costs of reclamation will be paid, or that the required work will be completed. Surety bonds transfer the risk of non-performance from the public to the surety. The size of the bond is calculated using current cost estimates for closure. Depending on the regulator, the money set aside for the bond may amount to 100% of the estimated cost of the reclamation.

For the regulator the usefulness of surety bonding can be problematic for several reasons. One difficulty is that a surety industry must first exist, and it in turn must be regulated. Experience in the US has shown that companies entering the surety business have had a high failure rate. In a situation where the surety company goes bankrupt, the costs of failure are passed back to the regulator and the mining company. To minimize the risks, governments must commit resources so that a system is in place to oversee the business practices of the surety industry.

2.2.5.3 Bond Pools

Bond pools are designed to pay for reclamation and closure costs incurred by the bond pool members if a member is unable (i.e., due to bankruptcy) to cover these costs themselves. Bond pools are seen as a way for small and medium mining companies that have limited access to funds to cover their reclamation liabilities. Membership in a bond pool often requires that a company pass a “requirements test”. Such tests seek to determine answers to such questions as the company’s financial health, past permit violations, years in operation, and reclamation experience.

Once allowed to join the pool, members are charged fees commensurate with the risks

ascribed to their operations. For instance, mines that operate in areas of high environmental sensitivity or in areas with the potential for acid generation¹⁰ will be charged higher membership fees.

Experience in the US has shown that the decision to implement bond pools should be taken with caution. In order to ensure financial integrity of the member companies it is important to have in place an administrative system that can effectively vet potentially “undesirable” members. As the member companies are required to pay for these administrative costs, they have proven to be a deterrent to such programs. Additionally the fact that the financial health of the member companies are all tied to rise and fall of commodity prices, a significant downturn in the marketplace may lead to the bankruptcy of all the member companies. In such a situation the money set aside in the risk pool would prove inadequate to cover the all of its member's liabilities.

2.2.5.4 Self-bonding or financial means tests

This approach is based upon evaluating the financial health of the mining firm, and acquiring assurance from the firm that it will set aside sufficient funds to carry out all required reclamation and closure obligations. This form of assurance is preferred by larger companies because it provides them with greater control over the funds and savings in reduced transaction costs. As part of its general overhaul of the Mining Act, the Province of Ontario has recently switched to a system of self-bonding for its mining sector.

With its heavy reliance on the ability of the company to self-finance its closure costs, self-bonding poses some serious risks for the regulator. Even companies with a long history of mining success can pass into bankruptcy, leaving the public to pick up the tab for the reclamation. To ensure that self-bonding companies take the necessary steps to set aside funds for future reclamation work, the regulator must have in place an adequate system for financial oversight. Unfortunately given the inherent complexity involved in determining the financial health of a mining company, these systems are difficult and expensive to establish. As the expertise needed to perform these evaluations is seldom found in government, the

¹⁰ Acid drainage is generated when sulfides are exposed to air and water. This can be a natural process but when waste rocks and tailings are inappropriately disposed, acid is produced quickly (see chapter 11 for details).

regulators must either contract out the work to private consultants or accept the risks of entering into negotiations to determine the required level of self-bonding.

2.2.6 Calculating Financial Assurance

No matter which form of financial assurance is selected, for the system to work as intended it is necessary to determine accurate cost estimates before final construction permits are issued. Because each mine site is unique, there is no simple recipe for the company to follow. Likewise if the government is to ensure proper oversight, regulators must be both highly trained and experienced.

Even if we assume that the original cost estimates were properly completed, operating mines have a tendency to evolve in ways that may not have been anticipated in the original mine development plan. If the reclamation bond is to do its job, it is necessary that the regulator ensure that the company provides periodic reviews of its reclamation plan. In Canada and the US these reviews are typically performed on an annual basis. Effective government monitoring of these plans requires that regulators maintain a level of staffing that allows for regular on-site monitoring to ensure industry compliance with the regulations.

An additional problem regulators face with respect to estimating the costs of closure bonds is the fact that it costs government more to do reclamation work than it does the company.¹¹ Negotiating a “fair” compromise between the company and the regulator can be difficult. The company does not want to commit scarce resources unnecessarily, whereas the government is under strong pressure to minimize its risk in the event that the company cannot meet its closure responsibilities.

The Ministry of Mines of British Columbia has produced a generic spreadsheet¹² in an effort to ensure consistency in reclamation cost projections. The ultimate use of the land after closure is not specifically factored into the spreadsheet to determine the reclamation costs. This calculation is solely based on cost of raw materials, revegetation activities and earth moving.

¹¹ The reason for this is that government is trying to do something that often it is ill prepared to do: deliver a field project, on an emergency basis, in often difficult circumstances.

2.2.7 Some Outstanding Policy Issues

In attempting to address many of the outstanding financial issues governments and companies face when dealing with mine-closure, there still remains a number of issues that both sides have yet to adequately address. Some of these outstanding policy issues include:

- How can reclamation bonding be integrated into the operations of artisanal and small-scale mines?
- How can the process be made more flexible to ensure that an overzealous application of the rules does not unnecessarily force a mine into bankruptcy?
- What steps need to be taken by government to ensure that a financial assurance system is sufficiently healthy to fulfill the reclamation obligations of an operator should the mine declare bankruptcy?
- What can be done to create and maintain an assurance system that is capable of covering the costs of unforeseen, catastrophic events such as tailing dam failures?

2.3 Latin America

For most Latin American countries the economic consequences resulting from mine-closure can be categorized under the following main headings:

- Increased unemployment – unemployment translates into both a social and economic cost that is passed on to the local community.
- Increased demand on social services – as a consequence of losing their jobs, laid-off mine workers must now turn to the government in order to support their families.
- Unanticipated changes in economic activity – the economic plans of the government and the people living in the affected community must be re-written following the closure of the mine. How disruptive this is to both parties depends in large part on how much closure planning was done while the mine was still operating.
- Reduction in tax revenue – closure results in less tax revenue coming from royalties on mineral production and worker income taxes.

¹² Information and/or copies of the spreadsheet may be obtained by contacting the Mines Branch, Victoria. <http://www.em.gov.bc.ca/mining/mineper/permreq.htm>

To effectively compete in a global marketplace, mining companies must look for opportunities to lower their costs of production. Some researchers maintain that the reason behind the upsurge in foreign investment during the 1990s in the Latin American countries is generally due to that region's less restrictive environmental legislation and enforcement. It is suggested that a more rigorous application of closure laws would have the concomitant effect of making the mineral sector in Latin America globally not competitive. It is also feared that for small and medium sized companies that supply the domestic market, the additional costs from more rigorous closure regulations would lead to widespread bankruptcy.

3. GOVERNMENT POLICIES RELATED TO MINE-CLOSURE

3.1 Introduction

In order to design a mine that will not become a major financial liability as a result of environmental violations, a mine company should have a thorough understanding of the relevant government policies that may affect the operation and eventual closure of the mine. It is prudent therefore, to predict the acid rock drainage (ARD) potential for each type of rock mined and exposed and any waste rock or tailing created by the operation. The questions critical to the waste handling and reclamation options should be addressed early in the mine's conceptual planning phase. All mines with a potential for acid generation must provide operation reclamation and abandonment plans detailing how they will reduce the generation of ARD to levels not deleterious to the short and long-term health of the environment. Detailed contingency plans must also be provided in the mine-closure plan that is submitted to the government regulator.

3.2 Environmental Policies in the World

The US, Canadian, South African, German and Australian governments have developed a complex body of laws and regulations directed at mitigating the adverse environmental impacts associated with mining. These policies have been put into place in response to the lack of environmental stewardship shown in the past by the mining industry. Although the specific regulations in each country are different, the general flavour of the regulations is similar. These general rules include: the requirement to produce a closure plan, the acceptance of evolving technical standards, the allowance for plan modification, bonding, monitoring, reporting, inspection, and enforcement.

In general, most reclamation regulations in North America promote the desirability of future use of the land following reclamation, however this lack of specific guidelines to enhance sustainability of the site creates a situation where most companies are targeting their reclamation objective to meet the needs of wildlife.

3.2.1 Mine-closure planning

Worldwide, there is a tendency that mine-closure planning must constantly and critically be

reviewed and modified as the operational life of the mine progresses. The mine-closure plan must be flexible enough to account for changes in information covering such things as the characteristics of mine waste, the functioning of the ecosystem, changes in the standards set by the government's mine-closure policy, etc.

Mining operations will not be authorized unless a conceptual plan is submitted which reviews the environmental impacts, contingency plans, engineering specifications, and the proposed mitigation measures to be used. A technical review is completed to verify if the plan is in compliance with the legal standards and technical requirements set down in the regulations. An opportunity for plan review and feedback from the public occurs during open hearings scheduled in advance of the mine receiving its operating permits. During these hearings the issues open for discussion are limited to questions over whether the closure plan complies with government requirements for the site to be reclaimed to an equivalent pre-mining condition. Government policies understand and recognize that plan will be modified and the policies provide for this flexibility.

During the operation of a mine, unanticipated problems may occur. These problems may be so significant that they may render the company's closure plan ineffectual. To forestall this from happening, government regulators must institute a system of on-site monitoring that includes periodic, unannounced site inspection.

Once the company has completed the reclamation plan in accordance with the plan, the regulatory body must determine if the plan has been complied with, in order that the company's reclamation bond may be terminated and the company free of any future financial obligations for the site. In British Columbia, Canada, the security bonds for reclamation is released based on a discretionary procedure as shown in the Article 10.5.3 of the Health, Safety and Reclamation Code of the BC Ministry of Energy & Mines:

"On the closure of a mine, and on the chief inspector or district inspector being satisfied that the conditions of the permit were complied with, the person who deposited a security ... shall be entitled to refund of the security and any accumulated interest..."

In British Columbia (B.C.), the bond values can vary a great deal. For new mines or companies which are regarded as high risk, the bonds try to cover the entire liability. For large companies,

the B.C. Government does not fully require to secure the whole liability. As the bonds can be deposited in a variety of forms such as cash deposits held by a bank or letters of credit which can be converted into cash or surety bonds issued by insurance companies, miners can negotiate with Government representatives to release part of the money following completion of a portion of the work. If it is a letter of credit, the B.C. Government can and do reduce the amount based on completion of a portion of the work.

3.2.2 Development of Environmental Policies

In order for environmental policies to be useful, comprehensive processes need to be created that will address impacts throughout the life cycle of the project and that will utilize follow-up programs to verify the accuracy of the assessment and mitigation measures. A policy must also be in place that sets a time frame for public comments and government action. The environmental policy must be administered by a regulator that will administer the policy in an impartial and efficient manner.

The regulator must develop a policy framework that encourages public reviews for complex and politically motivated projects by providing access to information and opportunities for public involvement throughout the review process. The regulator must also have the ability to directly interact with all levels of government during the review process and have special institutional mechanisms that would allow it to effectively monitor a reclaimed mine site over the long-term.

An effective reclamation policy must also address the issue of reclamation security bonding. As a condition of the reclamation security bond, sufficient funds must be available to cover all outstanding reclamation obligations, including long-term costs associated with monitoring, maintenance of preventive structures, and treatment of ARD following closure. The issue of the bond must be addressed in the mine-closure plan.

3.2.3 The Goals of Closure Policy

The goal of the mine-closure policy should be to reclaim land affected by mining so that it may be put back to a beneficial state of the people and the surrounding environment. Some of the mining performance standards include: restoration of mined land to conditions capable of

supporting pre-mining uses¹³ or acceptable higher or better uses; restoration of approximate original contour of the land; stabilization of surface areas to control air and water pollution; minimization of the effects of mining on the hydrologic balance and the quality and quantity of water in surface and subsurface systems; measurement of the productivity of the land; and protecting offsite areas from slides or damage. Other mine-closure goals include eliminating threats to public health and safety, the need to create self-sustaining ecosystems, and the desirability of minimizing post-closure visual effects.

3.2.4 Financial Commitment to Reclamation Measures

In order to ensure that funds will be available to implement the plan, and to encourage ongoing reclamation efforts during the operational phase, almost all regulatory systems require the operator to submit some form of financial guarantee for implementation the closure plan. This is not a guarantee of the obligations that the company may incur, but simply an assurance of compliance with the defined plan. To ensure the viability of the guarantee system, the regulator must ensure that the reclamation plan put forward by the company is sufficiently detailed to allow for accurate engineering cost calculations to be done. In most cases, the guarantee is adjusted periodically to reflect the amount of work that remains to be accomplished.

3.2.5 Closure Plan Requirements

One of the most significant sets of issues in mine-closure revolves around the requirement for the company to produce detailed environmental baseline information. The state of the pre-mining conditions defines the success of the closure efforts. Therefore, technically sound data gathering is critical. Sometimes, information relating to hydrologic cycles, life cycles of living species, climate and weather cycles can not be gathered just before a mine opens but probably years before a mine goes into operation. Data collected must be site-specific and relevant to the project being pursued.

¹³ In the Health, Safety and Reclamation Code of the BC Ministry of Energy & Mines, (1997), the owner, agent, or manager of a mine shall undertake monitoring programs, as required by the chief inspector, to demonstrate that reclamation objectives including land use, productivity, water quality, and stability of structures are being achieved. The Article 10.6.3. of the Code says: *The land surface shall be reclaimed to an acceptable use that considers previous and potential use.*

Experience indicates that the most important aspects of a successful regulatory policy are the closure plan itself, the financial security and the information collected. The plan must contain sound environmental baseline information and be prepared prior to the commencement of the mine. If any hazard exist on site, a remediation plan should be developed to handle the situation. This plan should be reviewed and approved by the regulator. Furthermore, the plan should be subject to a public scrutiny.

3.2.6 Trends in Public Policy Making

The design, implementation and eventual outcome of government policies depends, in large part, on a combination of economic, political and institutional factors that impact on the public realm. The setting of environmental policy making should consider the important contribution the mining industry makes to the overall health of a nation's economy. Another factor that influences public policy making is the reputation of the mining industry in the country. Large global companies with headquarters in developed countries need to be perceived as being responsive to the needs of the host country. New knowledge concerning health and environmental impacts of economic activities have stimulated policymakers to modify existing standards and create new ones. Recently, the focus of public concern has been on the perceived shift from global environmental problems to regional ones. Further emphasis will be placed on prioritizing the effort on specific environmental problems with those problems that exhibit a higher risk to the environment and human health.

A trend in the way policies are being created is that there must be market incentives, with emission or effluent charges or pollution permits as a means for making changes to the established practices of the mining industry. Terms such as environmental stewardship and responsible care are becoming more and more a part of the language used by governing policymakers to regulate the industry.

Public perception is also an aspect that needs to be focussed upon. More information and new ways to involve the community are crucial if new policies are to be seen as credible in the eyes of the public.

3.3 Latin America

At a national level, the environmental and mining agencies generally work independently of one another. This has led to a series of ongoing conflicts because individually they don't have the necessary multidisciplinary skill to properly evaluate the environmental impacts resulting from mineral activity. Ecuador seems to be an exception to this rule. In that country there is an environmental department that works directly with the Ministry of the Mines and Energy to oversee the mining industry. Chile seems to be another exception to this general rule. There the evaluation of the projects is coordinated by the environmental agency (CONAMA) with the support and participation of staff from other relevant government institutions.

The concept of requiring mining companies to set aside security insurance for the purpose of guaranteeing that it abides by its closure obligations is now being discussed by some Latin American. Peru and Chile in particular are actively working out the details for instituting a security assurance program.

To ensure the execution of the activities identified in the Plans of Environmental Management, Ecuador in its Environmental Regulation for Mineral Activities, article 9, requires that the miner purchase the necessary insurance or bank warranty to cover the costs of its reclamation plan. This financial assurance must remain valid up to one year after the end of the mining concession before returning to the miner.

In Argentina there is no specific financial warranty aimed at mine-closure, although article # 23 of *Ley de Inversiones Mineras* requires a mining company to make annual deposits (until 5% of the costs of the extraction and dressing operations, deductible from the Income Tax) to an environmental remediation fund. If this fund is not used, it is turned into tax at the end of the production cycle. The law does not specify if this fund must be used exclusively to support closure and rehabilitation programs.

The legislation in Bolivia, while not specifically addressing the subject of financial warranties does use other mechanism to guarantee that the closure plan is implemented. Three years

after mine-closure an independent auditor is required to confirm that the company has implemented its closure plan. If the work is approved by the auditor, the company is exonerated from any further legal liability for the property.

In Brazil the *Plano de Recuperação de Áreas Degradadas – PRAD* contains no legal provisions that require a mining company to purchase insurance or any other form of financial assurance. What exists is a form of financial compensation royalty for the extraction of mineral resources, established by the Constitution of 1988, in its Article # 20, § 1st, and regulated by the Law 7.990, of 1989. That law stipulates how the royalty (2 to 3% of the mineral production) is to be divided between the states and the federal district (23 %), the counties (65%) and the National Department of Mineral Production (12%). The revenues raised by the counties are to be applied to projects that directly or indirectly support or compensate the local community from any losses associated with the mine. In the past such projects included measures to improve infrastructure, raise environmental quality, public health and education.

Recently several mining companies have taken the government to court over how it spends its share of the royalty it receives from mineral production. Of the 12% that is paid to the National Department of Mineral Production (DNPM), only 2% is spent on programs designed to protect the environment. This disparity has lead to charges by the miners that a portion of the royalty should be considered as an illegal tax under Brazil's constitution.

4. THE SOCIAL IMPACT OF MINE-CLOSURE

4.1 Introduction

What happens to a community following a mine-closure has lately become a hot subject for discussion. In the past the primary concern for both the company and the government centered on issues of revenue loss and how to minimize risk to public health and safety. Only later, typically in response to public pressure, has the direction of these discussions shifted to include wider issues such as the environment and the effect closure has on the social health of the local community.

The objective of this review is to attempt to highlight a number of the primary issues that industry, government and communities must seek to address in order to mitigate the adverse social effects of mine-closure. Some of the issues that will be addressed include issues of income, worker mobility, skills training, physical and mental well being, and alternative patterns of work. In attempting to assess the full impact mine-closure has on a community, it is necessary to look beyond those people and institutions that are directly affected by the closure. Consideration must also be given to those whose quality of life will suffer as a result of their indirect connection to the mine.

In conclusion, some brief comments will be made with respect to mine-closure and its relationship to sustainable development (SD). Since the publication of the Brundtland Report in 1987 a great deal has been written generally on the subject, including how SD principles can best be applied to address some perceived structural deficiencies in the economy. What has been received far less attention is how non-renewable resource industries, such as mining, fits into the SD paradigm. While no definitive answers yet exist, we do intend to show where the debate is likely to head in the future.

4.2 North America

4.2.1 The Impact of Closure on the Individual

The social impact of mine-closure has been well documented by behavioral scientists. The psychological impact of losing one's job can take the form of an increase in blood pressure

and cholesterol levels, increased substance abuse, as well as family violence and breakup. Research has further shown that for every 1% rise in unemployment, a community will experience similar increases in the rates of suicides (4.1%), homicides (5.7%), stress-related illnesses (1.9%) and admissions to mental institutions (4.3%) (Warhurst et al., 2000)¹⁴.

Further adding to the problem of designing transitional programs for displaced mine workers is the need to overcome the cultural milieu in which miners work. Miners have long prided themselves on their perceived physical toughness and independence of spirit. In this context, the effect closure has on a miner's sense of self-worth is particularly damaging.

In advance of creating support services for overcoming these problems, both the government and the mine company need to understand the dynamics of how individuals respond to job loss. In their examination of the problem, Warhurst et al. (op.cit.) have identified three basic unemployment typologies to describe which coping mechanisms an individual will adopt and the amount of psychological stress experienced as a result of losing one's job. These typologies are described as follows: 1. *Passive reaction*- an individual's actions are characterized by feelings of denial, passivity, inactivity, or intellectualization of the problem. 2. *Active and adequate way* - a person successfully responds to job loss by adapting existing behavior (i.e. instituting alternative income raising strategies). 3. *Active but inadequate* - a person adopts behaviors that are essentially negative. Because these are general typologies, both the government and the mining company must provide a range of support systems in order to effectively deal with individuals whose coping strategies may consist of a mixture of all three typologies. Experience in Canada and the US has found that the effects of mine-closure on an individual can only be understood when seen in the context of "the social meanings which actors attach to their actions, their definitions of their situation at particular points, and the ends which they are pursuing."

Further complicating the task of addressing the social impact of mine-closure on workers is the fact that, as in other industries, significant changes have occurred in the nature of mine work

¹⁴ Warhurst, A., et al. (2000). Issues in the Management of the Socioeconomic Impacts of Mine-closure: A Review of Challenges and Constraints. In Environmental Policy in Mining, Warhurst, A. and Noronha, L., Ed., Lewis Publishers, Boca Raton, p. 81 – 99.

itself. Greater mechanization and automation has substantially reduced, not just the number of jobs, but also the sense of autonomy and human interaction that formerly characterized work in a mine. The last ten years has also been witness to a gradual evolution in hiring practices that has resulted in mining companies relying more on outsourcing as a way to reduce their labour costs. The net effect of these and other employment practices has been to alter the way in which mine workers have come to view the “social meaning” of their employment. One can argue that the social effect of these changes may not be entirely bad as more “technical” jobs are created with automation. For instance, reduced attachment to one’s work may make it easier to reintegrate laid-off mine workers back into the larger labour market. However, automation can have negative effects to the local communities as usually highly trained technicians are outsiders and rarely companies provide training for locals.

4.2.2 The Impact of Closure on the Community

Communities too experience profound impact as a result of mine-closure. Loss of community cohesion as a result of increased tension between employed and unemployed mine workers is one of the inevitable of downsizing prior to closure. This tension is in addition to the traditional animosity that often occurs between marginalized locals and the relatively wealthy mine workers. In isolated regions these socioeconomic tensions are only likely to become magnified. It is important, therefore, that decision-makers initiate policies aimed at creating sufficient support infrastructure both during the operation of a mine and upon closure.

Potential impacts of mine-closure on a community will vary considerably depending on the number of jobs lost relative to the size of the affected community, its social composition and its level of internal cohesiveness. The effect of closure on spin-off industries will again be determined by the level of economic diversification that the community has obtained during the operational life of the mine.

In those cases where mining activities have occurred in isolated communities and have become closely integrated into their socioeconomic fabric, either through direct taxes, provision of important infrastructure, or as the cause of important economic spin-offs, mine-

closure can be particularly devastating to the health of the local community. Alternatively for mine-closures in towns with greater links to the surrounding region, the effects of closure can in turn have a much greater regional impact.

The life span of a mine can also play an important role in determining the degree to which its closure affects a community. New mining towns in Canada and the US are constructed with a known limited life span in mind. Employing workers who recognize the temporary nature of their community, these people typically do not form deep attachments with their community. Because these workers also tend to be on the whole younger and more educated, they are again more likely to find the eventual prospect of seeking alternative employment after closure less stressful.

The real problems arise in those communities where employment in mining has occurred across several generations, where meaningful economic diversification within the community is limited, where the lifestyle of people living in the community is somehow distinct, where the population is older, and where there is a high percentage of private homeownership. Under these conditions it becomes very difficult for individuals and their communities to conceive of a future without mining. In such situations it is common for communities to be stricken by a general malaise that saps their ability to devise effective coping strategies.

4.2.3 Best Practice for Reducing Closure Impacts

When developing policies aimed at countering the social impacts of mine-closure it is important to remember that one should not think in terms of generic answers. Because every individual and the community they are a part of are the product of their own unique history, solutions must be tailor made to fit circumstances of each unique closure situation. Those tasked with providing solutions must do so only after carefully weighing the socioeconomic capacity of the community to carry on past closure. And finally, if solutions are to be truly effective in achieving an equitable settlement for handling mine-closure and downsizing, they must represent the shared vision of government, the local community and the mining company.

4.2.4 The Move toward the Use of Social Impact Assessments

In the same way that a decade ago environmental impact assessments (EIA) were put forward as a way for measuring a mine's impact on the health of the surrounding environment, social impact assessments (SIA) are today seen by many social scientists as an equally effective device for determining a mine's social impact (Epps, 1997)¹⁵. More specifically, SIAs are seen as an effective new tool that decision-makers can use to better understand such issues as:

- Developing a management framework for implementing a policy vision for mine-closure;
- How to encourage the formation of partnerships between industry, government and communities for the purpose of facilitating a more equitable distribution of the benefits and costs of mining;
- How to initiate development strategies intended to foster long-term community socioeconomic independence and sustainability.

4.2.5 Mine-closure and Social Sustainability

A mining community is one whose population in some part is significantly affected by an associated mining operation. This may be through the provision of direct employment or some other impact arising from mining, albeit environmental, social or economic impact. The community can range in size from a city (which for example could be serving as a base for distant fly in-out operations, or a centre for supplies and financing) to a village (which relies extensively on local mining). Mining communities vary significantly in terms of culture, political orientation, geographical location, environmental characteristics and collective attitudes towards resource development. Nevertheless, there tends to be a common characteristic shared amongst communities that have had a poor relationship with a mining company: this is the perception that miners are intruders into their environment, culture and history. Such a feeling may particularly be the case where the community has no mining tradition and the benefits from mining have not been cooperatively determined nor equitably shared. How this perception can be minimised and a durable relationship created is key to building a sustainable mining community. A sustainable mining community is one that could realize a net benefit, from the introduction of mining through to the closure of the mine and beyond. The

challenge for any mining company is to engage in an equitable partnership with the associated community that leaves a lasting legacy of sustainability and well-being for the community, avoiding environmental degradation and social dislocation (Veiga et al, 2000)¹⁶.

As communities become better informed of the critical socioeconomic and environmental issues connected with mining, they increasingly want to be more involved in how decisions are made that affect their future. While those who are traditionally responsible for resource management decisions (i.e., government and industry) may oppose efforts to de-centralize decision-making, it is important that local leaders be given the opportunity to share in decisions that affect the quality of life in communities in which they live. Such partnerships, involving governments at all levels, the industry, and NGOs are widely seen as the central tenet of an effective management strategy of the social issues connected with mine development and closure. While this alternative approach to decision-making may take longer to achieve consensus, when agreement is reached it is more likely that the result will reflect both the community's and the company's goals and aspirations.

4.3 Latin America

The effect mining has on the social institutions in Latin American countries may be viewed in a simple way. The old paradigm was that if mining provides jobs for communities and taxes for governments, the relationship between companies/miners and local communities would generally be considered positive. It was a perception by governments and companies that communities prefer to avoid conflict in order not to jeopardize local employment opportunities. Another reason for choosing accommodation over conflict is the desire to avoid lengthy and unpredictable court battles. However, recent experiences in Peru, Ecuador, Bolivia and Venezuela have shown that communities are much more vocal in their demands for more equitable distribution of the benefits of mining. The presence of Environmental Groups, more educated workforce and the Internet have combined to change this picture. Conflicts with communities such as in Yanacocha, Peru and Las Cristinas, Venezuela as well as in hundreds

¹⁵ Epps, J. (1997). The social agenda in mine development. *Industry and Environment*, vol. 20, n. 4, p.32-35. UNEP, Paris, France.

¹⁶ Veiga, M.M.; Scoble, M.; McAllister, M.L. (2000). Mining with Communities. Paper presented at Mining Millennium 2000, PDAC/CIM Conference, Toronto, March 5-10, 2000. (just abstract published in CD).

of exploration programs all over Latin America suggests that the future direction for companies is to adopt a strong public involvement policy beginning as early as the exploration phase (Thomson and Joyce, 1997)¹⁷.

In Latin America, as in other parts of the world, the environmental effects of mining are thought to be better understood by mining companies than the comparable social effects. Most countries require companies to produce Environmental Impact Assessment Reports prior to receiving the necessary operating permits. Unfortunately no comparable document exists to measure the social impact of the mine, either during operation or after closure. Some Latin American government agencies still abide by a set of outdated rules that do not require companies to address any of the social issues connected with their proposed mining operation. In the absence of policy direction, some companies are accused of taking advantage of the situation by investing in these countries. An exception to the rule is found in the regulations governing the treatment of indigenous peoples. If they reside within the confines of their reserves, aboriginals may be protected by law from the environmental and social impacts of nearby mines.

¹⁷ Thomson, I. and Joyce, Susan A. (1997). Mineral Exploration and the Challenge of Community Relations. Paper presented at the International Conference and Roundtable on Mining and the Community sponsored by the World Bank in Quito, Ecuador, May 6-8, 1997. Also published in *PADC Communiqué*. Prospectors and Developers Association of Canada. 8p.

5. MINE-CLOSURE AND GENDER ISSUES

5.1 Introduction

Through the course of the review of the available literature, we found that presently very little has been written that directly addresses the question of how reclamation uniquely affects the quality of life of women. At least two possible explanations may account for this situation. First, women do not in fact experience unique hardships following the closure and reclamation of a mine site. Second, though women may experience unique hardships, this fact has yet to be thoroughly researched and documented. Whatever the explanation, until further research is conducted there will be no clear understanding of the effect mine-closure has (unique or otherwise) on the lives of women.

In remote areas in Latin and North America the presence of women at the mine site represents a critical component for the formation of a viable community. For example, in the Amazon region the presence of women during the gold rush of the 1980's was of fundamental importance to the process of creating new settlements that still exist today.

5.2 A Review of the Available Literature

While accepting that the paucity of available literature makes it difficult to formulate conclusive statements regarding the specific impact mine-closure has on women, some general observations are still possible. These observations suggest that while men may shoulder the greatest direct impact, it is women who suffer most from the indirectly effects of closure. In a 1987 study on the socioeconomic impact of job losses resulting from mine-closure, researchers found that the displaced male workers tended to transfer their negative emotions onto their immediate families (Kinicki, et al., 1987)¹⁸. When combined with a noted increase in the consumption of alcohol and drug use, husbands were more likely to physically and mentally abuse their wives. Even in those cases where husbands tended to internalize their emotions following the loss of their jobs, women still were left to deal with the fallout. Faced with the sudden loss of their self-worth, many of these men fell victim to physical and/or mental

¹⁸ Kinicki, A., Bracker, J., Kreitner, R., Lockwood, C., and Lemak, D. (1987). Socially responsible plant closing. *Personnel Administrator*, 32, p. 116.

breakdown. In these circumstances the responsibility for maintaining the continued social and economic viability of the family unit now rested entirely with women.

Adapting to the demands of having to provide for the material needs of their families, one might expect that these women would naturally look to find gainful employment. Interesting enough this is often not the case. In response to their husbands' job loss, women have been found to either delay their return to the workplace or resign from their present employment. In either situation, women are being required to make career sacrifices in an effort to maintain social harmony in the home. In a situation like this where the socioeconomic costs of mine-closure to a community would be estimated for the purpose of providing compensation, the true costs of closure would tend to be underestimated.

Because women in most developing countries still tend to spend a large part of their child-bearing years in the home looking after the needs of their children, it is arguable that women would benefit differently from men from alternative approaches to mine reclamation. Reclamation practices that stressed the benefits of public health and safety and alternative uses for the former mine site could benefit women in the following ways:

- Reduce the likelihood that former mine sites would threaten the health and safety of women and children living, working and/or playing in the area;
- Create economic opportunities for women by allowing them to engage in substance farming and/or fishing on the site.

Public participation in resource management decisions is another area where an understanding of gender differences may play a key role in appreciating some of the unique problems women face following mine-closure. The way governments make decisions has changed dramatically in the last thirty years. Today it is no longer acceptable for just a few people to make decisions purportedly on behalf of the community but who at the same time refuse to include members of the community in the decision-making process. While the public now exerts a far greater influence over how decisions are made that directly affect their lives, many commentators still argue that the process still contains many systemic flaws which

prevent many marginalized groups from participating fully (Thomas, 1995)¹⁹. For reasons based on lower socioeconomic standing, education and greater responsibilities in the home, women are often thought to be working from a disadvantage when involving themselves in public decision-making forums. Until these systemic problems are either addressed internally, or an alternative approach to public decision-making is found, the particular concerns of women will likely remain unresolved.

5.3 Latin America

The connection between women and mining in Latin American countries has not received a great deal of attention over the years. Many people involved in the mining industry have thought that with all of the other pressing issues that face the industry, gender issues may not even be a problem. Only recently has some interest been shown to take a more systematic look at the impact mining has upon the lives of women.

The mining community has traditionally looked upon women as a source of problems. In some cases they have even come to symbolise bad luck. Though far more widespread in the 1960s and 1970s, even today some mining camps bar women from coming on the property. Whether based on superstition or concerns over the health and safety of their wives and daughters, women are confronted with a number of institutional and societal barriers that prevent them from fully participating in the economic rewards that flow from mining.

In the last twenty years some of these barriers have begun to break down. While direct employment opportunities are still limited when compared to men, the mere presence of women in the mining camps is no longer seen as a source of problems. In fact, the presence of women (i.e., wives) is viewed as a stabilising force in the mining camps. Unfortunately for these women, there are limited opportunities for them to pursue a career of their own. What employment opportunities that are available are usually in support of the mining company's operations (i.e., cooks, cleaning staff, etc.).

Due to harsh economic conditions of the rural communities, participation of women in artisanal

¹⁹ Thomas, J.C. (1995). *Public Participation in Public Decisions*. Jossey-Bass Publishers, San Francisco.

mining activities has grown, however it remains controlled by social and cultural aspects. The number of women involved directly with mining is not officially recorded. Female miners are rare in the macho-dominant environment. Most women in the artisanal mining sector have been working in very small productive systems (e.g. batea) in a typical subsistence work. Unfortunately, the most significant way by which women participate in the artisanal mining is through marginal activities as cooks or prostitutes. Their living condition is usually on the boundary between poverty and misery. As the majority of the labor force in artisanal mining, women are also lured by the gold mystique. They expect to have mining as a temporary way to make quick money to become a landowner in the near future. Women have been involved with mining activities usually by an invitation from someone who convinces them about an easy way to make money. In this case, women migrate to the mines leaving behind their families (children and mother) who periodically receive some money by mail²⁰. It is estimated that all production units in Brazilian "garimpos" employ a woman, i.e. one woman out every six employees (17%)²¹. Even representing a contingent around 200,000, unfortunately, Latin American governments have never acknowledged the presence of women in artisanal gold mining as a significant production factor. When an artisanal mining operation ceases, the workers move to other regions (or countries) usually in a dispersed and disorganized fashion and rarely women are taken with them. This has created sites of poverty concentration all over Latin America, in particular in the Amazon region. Women are those most affected by this migratory peculiarity, as they do not have means to return to their hometowns or have other source of income in an environmental and social degraded site left behind by gold mining.

While working for the company presents women with an opportunity to share in the same economic rewards offered to men by mining, it leaves women just as vulnerable to sudden job loss when the mine eventually shuts down. However, some observers suggest that women may be better able than men to participate in the site's reclamation. They cite several reasons in support of this belief:

- The particular difficulty many men have in dealing with the loss of self-esteem

²⁰ Veiga, M.M. (1997). Introducing new technologies for abatement of global mercury pollution in Latin America. Book edited by UNIDO/UBC/CETEM. Rio de Janeiro, 94p. ISBN: 85-7227-100-7.

²¹ Rodrigues, R.M. (1994). Women of Gold: the Feminine Work in the Tapajós "Garimpos". Secretaria de Indústria, Comércio e Mineração do Estado do Pará. 131 p. (in Portuguese).

that comes from losing one's job;

- That women are more aware of the socio-economic importance of reclaiming former mine sites; and
- The perception that the nurturing qualities that are generally ascribed to women give them skills that make their participation in reclamation particularly useful.

While the first point has some standing in the literature, the other two may be passed off as just another attempt by a paternalistic society to downplay the contribution women can make to society. Until more is done to fully understand how gender differences influence how people are affected by mining, misinformation and age old prejudices will continue to dominate the discussion.

6. RECLAMATION AND CLEAN-UP TECHNIQUES

6.1 Introduction

Most discussions on the effect changing government policies have had on a nation's closure practices have focused too narrowly on just regulatory issues. Taken in the context of this section's area of study, it may be more useful for the reader to understand the relationship that exists between policy, regulations and the technology. How these three interact with one another has taken on a new significance in recent years as public policy managers have demonstrated an increased willingness to consider the value to society of new approaches for resolving the many environmental problems associated with mine-closure. This new approach to problem solving is best characterized by a preference for policies that could be described as anticipatory and preventive, rather than reactive and corrective (Isnor, 2000)²². This change reflects an ongoing debate over the relative merits of those regulatory regimes that require mining companies to adhere to very specific technical norms (i.e., the US's SMCRA of 1977) versus a more generalized set of performance based reclamation objectives. How this debate is ultimately decided will have a significant impact on which technologies are ultimately selected to achieve the environmental, economic and social objectives of closure.

In association with the issues identified above, this section will comment on what are currently viewed as industry best management practices (BMPs) in the area of mine-closure and reclamation. As the acknowledged leaders in the field, the BMPs from Australia, Canada and the United States will be highlighted.

6.2 Government Policy and Reclamation Technology

In response to increased economic and environmental pressures, mining companies in Australia, Canada and the US have been forced to direct more of their limited R&D budgets to make their operations more cost efficient and environmentally friendly. While the main responsibility for technological innovation lies with industry, governments often play an

²² Isnor, R. (2000). Explicit and Implicit Technology Policies Affecting Closure: Examples from Australia, Canada and the United States. In *Environmental Policy in Mining*, Warhurst, A. and Noronha, L., Ed., Lewis Publishers, Boca Raton. p. 463 – 480.

important role in deciding the pace of technological advancement. Depending on how the regulations are written, governments can either create or remove barriers to the way industry is allowed to close and reclaim a mine site. The most obvious example of the impact specific government policies can have on how mines are closed is found in the US Surface Mining and Reclamation Act (SMCRA) of 1977. This national set of regulations governing the closure and rehabilitation of coal mines consists of hundreds of pages of highly detailed specifications for the construction, ongoing maintenance, and eventual reclamation of every aspect of the mine site (Danielson and Nixon, 2000 - op. cit.).

While the SMCRA is generally regarded in government and industry circles as a success story, many observers caution against using the Act as a model for how other nations should attempt to regulate their domestic mining industries. Given the Act's highly proscriptive approach to achieving the government's policy objectives, it was necessary to create an enormous supporting bureaucratic apparatus of highly trained reclamation specialists. The costs of administering the SMCRA are substantial and it is only because of the unique economics of the coal production that the industry has been able to support the Act and still remain competitive. Given the high level of competition that exists in the mining industry, it would be virtually impossible for any single nation to apply a SMCRA type approach for fear that it would likely bankrupt the industry.

Another problem with the SMCRA approach to mine reclamation is that the Act creates enormous practical barriers to corporations seeking to introduce new reclamation techniques. When approached by outside agencies, the national body that oversees the SMCRA has demonstrated a consistent lack of interest in any initiative that deviates from its existing set of rules. An important institutional stumbling block to change is that the potential rewards from innovation benefit only the industry.

The regulatory practice in Canada and the US non-coal mining industry has been grant bureaucrats with a great deal of discretion over how companies are allowed to achieve the government's reclamation objectives. While there has been some problems with this approach, from the perspective of encouraging greater technological innovation within the mining sector, this less structured approach has proven to be successful.

6.2.1 Industry Best Management Practice (BMP)

The governments of Australia, the US, and Canada have all put into place programs that encourage the free flow of information between public and private sector organizations²³. Building upon the knowledge and experience of reclamation experts in government, universities, and private industry, this sharing of information is intended to form the basis for BMPs that are freely available to all interested parties. An important benefit for those participating in this partnership is that it allows each member to leverage their R&D dollars by bringing together research talent from a range of disciplines to tackle common problems related to closure.

It is interesting to note the evolution that closure BMPs have undergone in recent years. Originally conceived to address pressing environmental issues, they have now begun to report on methods for minimizing the socioeconomic consequences of closure as they affect local communities²⁴. This shift reflects what has become a growing realization within government and industry that social issues have now eclipsed environmental concerns as the principal issue to be addressed when planning for mine-closure.

6.3 Latin America

Each mine-closure project faces its own unique set of technical challenges. Before one can reasonably attempt identify the appropriate ways and means for reclaiming a minesite, it is necessary to identify the physical processes that influence reclamation decisions. At a minimum these processes include:

- Physical and chemical characteristics of the mine, specifically how it pertains to overburden material and available soil cover;
- Regional climatic conditions;
- Surface and ground water conditions;

²³ Examples include MEND (Canada), IMEC and MRRP (Australia). With the demise of the US Bureau of Mines in 1995 it remains unclear how government will continue its role in fostering the sharing of information between public and private sources.

²⁴ An excellent example of BMP is the initiative of the Australian Environmental Protection Agency that has been publishing a series of booklets entitled Best Practice Environmental Management in Mining. There are over 20 books covering technical, managerial and social issues such as Community Consultation and Involvement.

- Mine production history;
- Alternative land uses for the site following reclamation.

As a general rule it is easier using existing techniques to close and reclaim mines in arid climates. As the amount of natural rainfall increases, there is a concomitant increase in the range of reclamation problems that may potentially develop. ARD production, soil erosion, and tailings dam reclamation become important concerns when deciding on a reclamation strategy for a mine site in a region that experiences significant rainfalls.

It must be emphasized that a well-written closure plan is only one of the preconditions for successful mine reclamation. The thoughtful application of industry based best management practices (BMPs), combined with an ongoing system of site evaluation are equally important.

7. FACILITATION AND MEDIATION IN RESOURCE MANAGEMENT DISPUTES

7.1 Introduction

The fundamental reason for increasing the level of public involvement in decision-making is to help develop better public policies that in turn will lead to more informed decisions (Dorcey et al. 1994)²⁵. Processes that facilitate increased public involvement have the potential to provide both elected officials and bureaucrats with a clearer understanding of the facts, values, opinions and aspirations of the people they are charged to represent.

Until relatively recently, decisions on how to manage mineral resources have remained within the principal domain of the government and the mining industry. This policy of excluding the general public in decisions that directly affected their quality of life was based on the long-standing belief that public managers are technicians who worked best when insulated from unnecessary public interference. Only within the last thirty years have most public managers come to the realization that public preferences are often more important to the successful implementation of a policy than technical criteria.

This new approach to public involvement has placed additional demands on public managers. Where this approach has been successfully implemented, public participation can lead to the creation of more effective decisions, increased public support for those decisions, and a strengthening of democratic institutions. Conversely, when it has failed it has led to an increase in public dissatisfaction, ineffective decisions, and a weakening of the democratic process.

7.2 North America

At its core, the desirability of public participation in decision-making depends largely on the public manager's perceived need for quality versus the need for public acceptability of the final decision. In reviewing the history of multi-party resource management decisions in North America, disputes between competing groups have often occurred when one party (for

²⁵ Dorcey, A., et al. (1994), *Public Involvement in Government Decision-making: Choosing the Right Model*, Government of British Columbia, Victoria, Canada.

example, government) fails to adequately acknowledge the concerns of another (typically the weaker one) as being relevant to the settlement of the dispute. As a consequence many of the decisions resulting from this process have lacked the legitimacy that is necessary to ensure their proper implementation (Box 1). This issue of legitimacy becomes even more problematic when the disparity of power between groups (often government and industry versus private citizens) is highest.

Box 1: Perceptions of public involvement processes (adapted from Dorcey et al., 1994 - op. cit.)

Key problems in public involvement processes:

- Not being involved early enough.
- Last minute invitations to participate.
- Scope too broad or ill defined.
- Delayed receipt of background information.
- Timeframe too short.
- Lack of funding for preparing for and attending meetings.

Key obstacles to implementing recommendations from the public:

- Predetermined political agendas at senior levels of government.
- Lack of political will to alter status quo.
- Failure within responsible government agencies to view recommendations seriously.
- Concerns from other agencies or special interests overriding public concerns.
- Lack of funding to research and act on recommendations.
- Uncertainty over how to deal with irreconcilable values or interests.

To increase the perceived legitimacy of the process, governments in Canada and the US have taken steps to move away from using the public merely to rubber-stamp their decisions, to actively involving the public in both identifying the important issues for consideration, and in devising appropriate solutions.

7.2.1 Choosing the Right Model

What constitutes an appropriate level of public involvement, however, is not always an easy question to answer. There are many models of public involvement to choose from. Each model has been developed to address different policy and decision-making requirements. Each model also places differing demands on the government and public to work together to produce enduring policies and decisions. A simple way to understand what differentiates each model is to view public involvement as existing along a continuum defined by the purpose the public manager has in gathering public input (Figure 1). Generally one will move from left to

right along the continuum when faced with the following situations:

- Public opinion is divided;
- The public's desire for government action is absent or unclear;
- There is a problem in identifying specific public interest groups;
- The facts pertaining to the situation remain unclear or are contested; and/or
- Government goals and interests differ from the public's.

7.2.2 Who Should Lead the Process

Experience has shown that the appointment of the person who should lead the government-based public involvement process should be made with great care. To ensure the legitimacy of the proceedings, the government must select an individual who is perceived by all parties to be impartial. Depending on the nature of the issue to be negotiated, the choice of who should lead the process can include senior bureaucrats, elected officials, independent facilitators or a person chosen from by the participating group.

7.2.3 What is the Government's Role in the Process

To safeguard the legitimacy of both the process and the decisions that flow from it, the government has an obligation to take steps to level the playing field. This means that in disputes that pit the mining industry against private citizens, the government must assist the latter in presenting its case. While the specific nature of this assistance will vary according to which dispute mechanism is selected, in general they will address the following areas:

- Include persons that represent the range of affected interests;
- Provide appropriate funding (to cover research, travel, etc.);
- Provide information;
- Make clear statements about the goals and objectives of the process;
- Provide opportunities for the public to provide constructive input;
- Timely reporting of decisions back to the public; and
- Provide justification for the final decision.

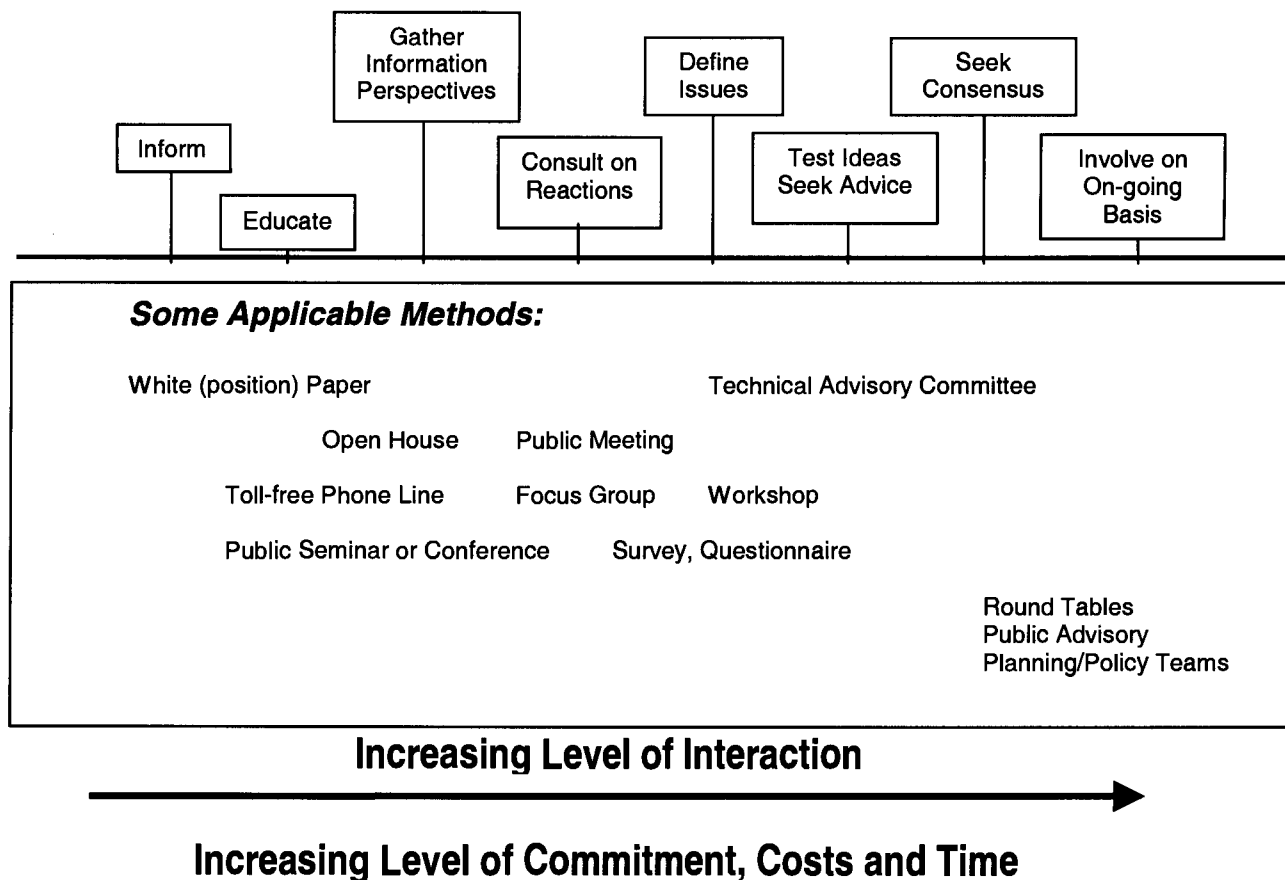


Figure 1: Continuum of Public Involvement (adapted from Dorcey et al., 1994 - op.cit.)

As long as the process is perceived as fair by those involved, the additional time and cost that is required to make the process work will be justified in the long run. Though all parties may not be in agreement with the final decision, experience has shown that they will abide by it.

7.2.4 Tailoring New Approaches to Negotiation to the Mining Industry

When practiced skillfully, the process of negotiating settlements between representatives of the mining industry and the communities they affect is often limited to the initial start-up and operational phases of a mine (Figure 2). As the life of a mine draws to a close, traditionally the lines of communication between the mine and the community have been one way. The company informs the community that the mine is closing (often with very little warning) and the community is left scrambling to pick up the pieces. Unlike when the mine was initially permitted, during closure there exists no formal mechanism that brings together the company and community to negotiate an equitable closure settlement. Without a more systematic approach to addressing the social and economic costs of closure, decisions on post-mine land uses often fail to help the community in its transition to life after the mine.

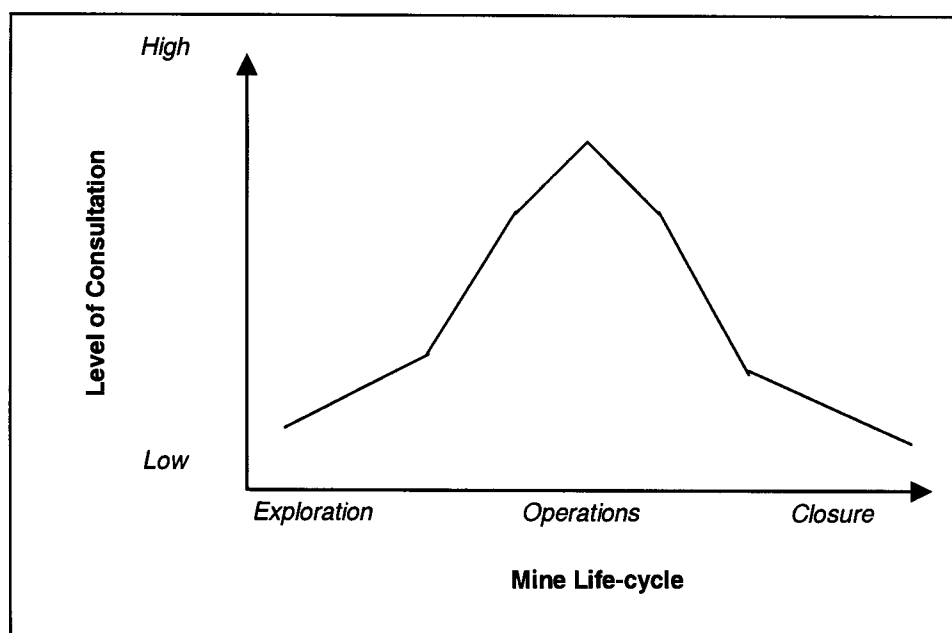


Figure 2. Traditional Approach to Community Consultation (adapted from Warhurst et al., 2000 - op.cit.)

In an effort to redress what they perceive as an unnecessary source of disagreement between miners and the communities they serve, some researchers suggest that a new approach to community consultation be considered (Figure 3). This approach would see both parties becoming much more active in developing a closure strategy that balances the legitimate concerns of each side. The onus for making this approach work falls primarily upon the industry. Rather than seeing it as just another attempt by government to download its social responsibilities onto the industry, miners should instead view it as a cost-effective way for removing a major source of the bitterness that has plagued industry/community relations.

In Canada important progress has been made in developing a framework for bringing together stakeholders from government, the mining industry, and community groups. This framework, known as the Whitehorse Mining Initiative (WMI) Leadership Council Accord, was signed in September 1994 and represents a critical first step in a process that would see the Canadian mining sector adopt a much more sustainable approach to the development of mineral and metal resource industry. The WMI sought to develop a set of guidelines for achieving stakeholder consensus in a number of areas where action was required to further the goal of a prosperous and sustainable mining industry in Canada. The Accord recognized the fact that in order to attain these goals, no element of economic, environmental or social sustainability can be pursued in isolation without it negatively impacting the whole.

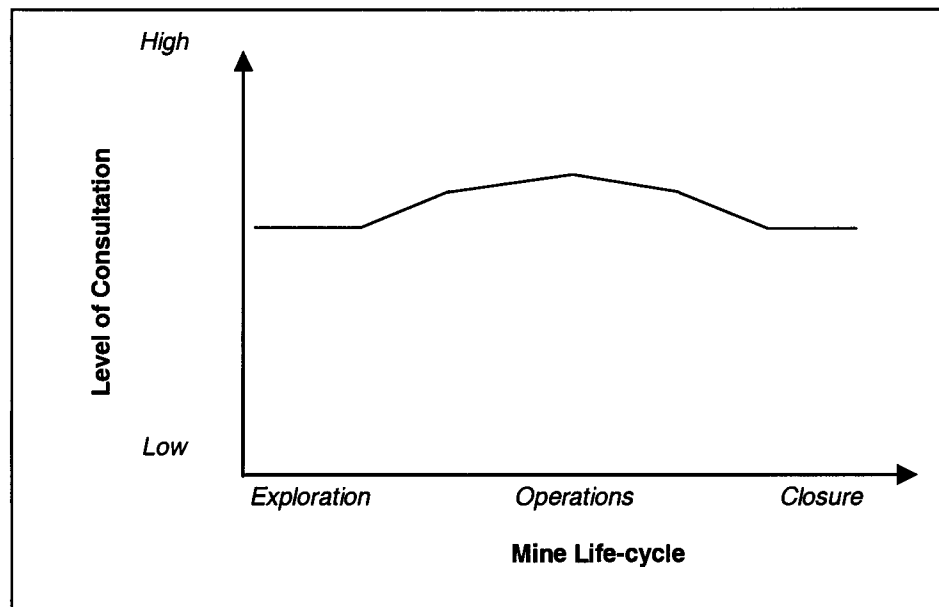


Figure 3. Proactive Approach to Community Consultation (adapted from Warnurst et al., 2000 - op. cit.)

7.3 Latin America

Facilitation and mediation techniques are increasingly accepted by the mining industry as alternative dispute resolution tools. During the Amazonian gold rush in the eighties, the mining association of Brazil (IBRAM), and the Mining Federal Agency (DNPM), invited representatives from the “garimpeiros” (artisanal miners) and the mining companies to attend a forum held to try to address the simmering problem of land invasion. It was unfortunate that previous clashes between the two groups had been so acrimonious that it poisoned this attempt to resolve the issue through constructive negotiation. This would confirm the commonsense notion that negotiated settlements are only possible when they are built upon a foundation of mutual trust.

Upon a careful review of the available literature, very little has been written in Latin America on how to apply conflict resolution principles in the context of mine-closure. Available information suggests that a multi-stakeholder approach has been used with some success to build consensus on the future direction of regional economic planning. Using a similar methodology, efforts are underway to assist artisanal quarry workers near Santo Antonio de Padua, Rio de Janeiro State, Brazil. The objective of the meetings is not only to try to upgrade current production and resolve some nagging legal problems, but also to start to make stakeholders

think about what will happen to the community once the quarries close. By thinking about these issues now, well in advance of the predicted closure date, local officials are hoping to mobilize the community to develop its own vision of the future. Assuming that this is achievable, it becomes far more likely that the mine site will be reclaimed in a manner that is consistent with the community's vision of tomorrow (Peiter et al., 2000)²⁶.

The main area of concern in Latin America with respect to the social and environment costs of mining is on the question of informal mining. Command and control methodology proved to be of little efficiency in most cases. In most places cultural and educational issues can be regarded as the main obstacles to technical development, but the difficulties to obtain loans to increase productivity are also a problem that most governments give little attention to. The connection of conflicting interests in such cases can only be established with the use of alternative dispute resolution techniques.

²⁶ Peiter, C.C.; Villas Boas, R.C.; Shinya, W. (2000). Implementing a Consensus Building Methodology to Address Environmental, Social and Economic Impacts Associated with Small Mining and Quarry Operation. *Natural Resources Forum*, v. 24, n. 1, p.1-9.

8. ETHICS AND MINE-CLOSURE

8.1 Introduction

Environmental ethics is a branch of moral philosophy that concerns itself with questions relating to man's proper relationship with nature, his understanding of natural processes, his responsibility to maintain ecological function, and his obligation to preserve a viable ecosystem for the benefit of future generations (Pojman, 1997)²⁷. Because morality forms the basis for how individuals and/or society *ought* to live, it (ethics) is the point of reference from which all our actions will ultimately be judged.

When evaluating the efficacy of government reclamation policies and regulations it is important to consider the pertinent technical and legal issues, but what is often overlooked is how mine-closure and reclamation decisions measure up against a society's dominant ethical beliefs. If government regulators and the mining industry both had a clearer understanding of the ethical consequences of their actions, it could be argued that much of the public's dissatisfaction with current reclamation practices could be addressed.

To clarify the relationship between ethics and mine reclamation policies and practices, this section examine the following issues:

- Are there ethical issues specific to mine reclamation; and
- How ethics and the concept of sustainable development are connected with the issue of mine reclamation.

8.2 Ethics and the Environment

8.2.1 Western Views on the Cause of our Current Environmental Crisis

To understand the ethical position of those who criticize existing government and industry approach to reclamation, it is best to step back and take a broader view of the debate over how best to manage the natural environment. While the debate is often reduced to arguments over technical details, at its heart it really is a struggle between competing ethical positions.

²⁷ Pojman, L.P. (1997). *Environmental Ethics: Readings in Theory and Application* (2nd Edition), Wadsworth Publishing Company, New York.

Some western commentators have suggested that our current ecological problems are based largely on our arrogant and exploitative attitude toward nature that is expressed in early orthodox Christian teachings (White, 1997)²⁸. Still others suggest that a strong environmental ethic is in fact central to the Judeo-Christian religious tradition (Dobel, 1997)²⁹. Understanding the significance of this difference of opinion over the role of religion is particularly relevant to any discussion on the ethics of mine reclamation. Because the mining industry maintains that its activities represent only a temporary use of the land, the debate over how mine sites are best reclaimed looms as an important ethical issue.

8.2.2 How Ethics Influence Resource Management Decisions

Those who study moral philosophy maintain that the ethical model to which one subscribes is instrumental in guiding one's real-life actions (Pojman, 1997 - op. cit., Thompson, 1998)³⁰. In terms of the various competing theories of environmental ethics it has been shown that each has a very different view of the proper relationship that should exist between humans and nature. As a consequence of these differing viewpoints, each theory should be examined on the basis of how morally founded attitudes toward the environment will influence the direction of resource management policies (Table 1).

After reviewing the contents of each of the four sub-categories, one can readily identify the impact ethics has on how evaluate resource management decisions as either good or bad. In terms of evaluating the relative "goodness" of a particular mine reclamation project, it is important to be cognizant of one's own ethical predisposition. It also means that when government and industry attempt to devise new rules for reclamation, they must keep in mind that societal values evolve over time. In this context being proactive means that regulators and industry reps must anticipate the direction society is heading if future reclamation projects are be in sync with public expectations.

Table 1: Competing Theories of Environmental Ethics (adapted from Thompson, 1998 - op. cit.)

²⁸ White, L. (1997). The Historical Roots of Our Ecological Crisis, in *Environmental Ethics: Readings in Theory and Application* (2nd Edition). Pojman, L.P., Ed. Wadsworth Publishing Company, New York, p. 15 – 20.

²⁹ Dobel, P. (1997). The Judeo-Christian Stewardship Attitude to Nature. In *Environmental Ethics: Readings in Theory and Application* (2nd Edition). Pojman, L. Ed., Wadsworth Publishing Company, New York, p. 26 – 29.

Anthropocentric		Nonanthropocentric	
Egocentric	Homocentric	Biocentric	Ecocentric
Self-interest "Laissez faire"	Greatest good for the greatest number	Members of the biotic community have moral standing	Ecosystems and/or the biosphere have moral standing
Mutual coercion (mutually agreed)	Stewardship of nature (for human use and enjoyment)		Duty to the whole environment Holism
Classical economies Capitalism New Right	Utilitarianism Marxism Left Greens Eco-socialism "Shallow ecology"	Moral extensionism Animal rights Bio-egalitarianism	Deep ecology Land ethic Gaianism Buddhism American Indian
Thomas Hobbes John Locke Adam Smith Thomas Malthus Garret Hardin	J.S. Mill Jeremy Bentham Barry Commoner Murray Bookchin	Albert Schweitzer Peter Singer Tom Regan Paul Taylor	Aldo Leopold J.Baird Callicott

8.2.3 Ethics and Mining

Mining brings both costs and benefits to the communities that it affects. Those who stand to gain or lose from the operation of a mine are typically referred to as stakeholders (Cragg et al., 1997)³¹. Ethics requires that a mining company take steps to identify the nature and extent of its obligations to these stakeholders. How can a company determine its ethical responsibilities to its stakeholders? Cragg et al. (1997) suggest that a company must address stakeholder concerns in four key areas:

- The development of a mine requires the voluntary participation of many different individuals. Because participation that is truly voluntary is built upon informed choice, the company is ethically bound to disclose any information that may affect a stakeholder's decision to become involved with the project;
- The company must identify all involuntary stakeholders and determine the extent to which the development will impact the quality of their lives;
- Ethics requires that a company engage in a fair distribution to stakeholders of the

³⁰ Thompson, I.H. (1998). Environmental Ethics and the Development of Landscape Architectural Theory. *Landscape Research*, v. 23, n. 2.

³¹ Cragg, W., et al. (1997). Ethics, Surface Mining and the Environment. *Mining Environment Management*. v. 5, n. 1. London, UK.

costs and benefits that flow from the project; and

- An ethical company has an obligation to avoid actions that cause undue harm to stakeholders.

In assessing a mining company's ethical responsibilities, is it necessary to consider the environment as a separate stakeholder? Some environmentalists have argued that the answer is yes (Naess 1997)³². They maintain that the interests of man and the environment cannot be reconciled within a modern capitalist economy. Conversely Cragg et al. (1997) counter that argument by suggesting that for all practical reasons it is not necessary to isolate nature as a separate stakeholder. They maintain that policies aimed at protecting human well being will inevitably lead to policies that also protect the environment.

8.2.4 Sustainable Development and Mine-closure and Reclamation: Putting Environmental Ethics into Practice

Growing public concern over the state of the environment has proven to be a force for change in the mining industry. The terms and conditions which a mining company is able to develop, operate and close down a mine site reflect significant changes in the public's attitude concerning the social, economic and environmental impacts of mining (Brevik et al., 1997; Carbon, 1997; Cragg et al. 1997- op.cit.; Cordes, 1997)^{33,34,35}. The public's demand that the industry becomes more sustainable is forcing many companies to re-examine their business practices. However for some this begs several important questions: How can mining be sustainable? and what is the relationship between sustainable development and mine reclamation (Lavkulich, 1991)³⁶? Answers to these questions are complex, contentious and constantly evolving in response to changing circumstances. One approach that has been taken to simplify the problem is to understand mining as a temporary use of the land. In this

³² Naess, A. (1997). The Shallow and the Deep, Long-Range Ecological Movement. In *Environmental Ethics: Readings in Theory and Application* (2nd Edition). Pojman, L.P., Ed., Wadsworth Pub. Co., New York, p. 137-143.

³³ Brevik, T. et al. (1997). Mining: Changing the focus for a sustainable future. *Industry and Environment*. UNEP. v. 20, n. 4, p.3.

³⁴ Carbon, B. (1997). Sustainable Development and the evolving agenda for environmental protection in the mining industry. *Industry and Environment*. UNEP. v. 20, n. 4, p. 10-13.

³⁵ Cordes, J. (1997). Mining and the Environment: Driving forces for change. *Industry and Environment* UNEP. v. 20, n. 4, p. 25-28.

³⁶ Lavkulich, L. (1991). Mine Reclamation and Sustainable Development. Proceedings of the Fifteenth Annual B.C. Mine Reclamation Symposium, Kamloops, BC. June 24-28, 1991. Ed. British Columbia Technical and Research Committee on Reclamation and Canadian Land Reclamation Association.

regard mining is deemed to be sustainable only in the context that its effect upon the surrounding ecosystem and local community is sustainable. Given this understanding, it naturally follows that the act of reclamation assumes critical importance when reestablishing the sustainability of both the ecosystem and community that have been impacted by a mine (Powter et al., 1991)³⁷.

8.3 Latin America

A new "ethics" is being adopted by senior companies to enhance their environmental performance in response to public outrage over such incidents as tailings spills, acidic drainage and the failure of the industry to address problems related to mine-closure. Acting in the role of good environmental stewards is a relatively new concern for mine companies, but it is a role that the public increasingly demands of them. Even today there is less public concern over the social damage caused by the firing of several hundred workers than the environmental damage caused by an oil spill. The former is viewed as a natural consequence of globalization, while the latter is seen as a callus act performed by heartless corporation.

A very important initiative that is receiving support from IDRC through its Mining Policy Research Initiative is being undertaken by CAMMA - "Conferencia Anual de los Ministros de Minería de las Américas" regarding mine-closure issues. In a draft outline of the general principles that underlie the initiative, it suggests a new appreciation for the need by government and industry to acknowledge that the social impacts of mine-closure must be considered along with the environmental and economic impacts. As an indication of the growing importance social issues have been accorded, at the International Forum of Mining Ministers held in Toronto in March 2000, one of the scheduled workshops has focused on the issue of "Mining and Communities".

Another subject that the Ministers of Mines have been addressing is how the concept of sustainable development should be applied in the context of mine-closure. While the

³⁷ Powter, C.B. and Chymko, N. (1991). The Relationship between reclamation and sustainable development. Proceedings of the Fifteenth Annual B.C. Mine Reclamation Symposium, Kamloops, BC. June 24-28, 1991. Ed. British Columbia Technical and Research Committee on Reclamation and Canadian Land Reclamation Association.

environmental component of sustainable development is again expected to be given greater emphasis, socioeconomic concerns will also be addressed.

In most developing countries, sustainable development is considered to have five core components (social, cultural, environmental, economic and regional). We believe that a comprehensive evaluation of these five components will prove to be a valuable tool for overcoming closure problems in the future.

As a general view, it can be said that participation of communities in Latin American mine-closure process related issues need much work to be considered a step as important as the mine opening. Groups that have to be invited to participate on studies are: rule makers and enforcement agencies, decision-makers from the private and public organisations/companies, communities leaders and politicians in order to build knowledge and consensus searching an equilibrated formula of distribution of costs and benefits regarding social and environmental components of mine-closure.

9. INSTITUTIONAL CAPABILITIES AND MANAGEMENT STRATEGIES

9.1 Introduction

The focus of this section is to examine the nature of the relationship that exists between a government's mine-closure policy objectives and the industry's institutional capability to successfully carry them out. As a practical matter, it can only be a source of unnecessary friction between government and industry when the expectations of the former exceed the latter's ability to perform. In order to achieve an appropriate balance, both parties must be willing to engage in an open and honest exchange of information on the appropriate ways and means for achieving the government's mine-closure objectives.

9.2 North America

Since the passage of laws in North America mandating the reclamation of mine sites, governments and the mining industry have been engaged in an on-going series of negotiations over how best to achieve the objectives of the legislation. Initially the focus of most reclamation laws was to protect the health and safety of people living in communities adjacent to the former mine sites. Over time the scope of the regulations was eventually broadened to include environmental, aesthetic and social land use issues. In the future it is highly probable that this trend toward a more holistic approach to closure planning will continue.

The traditional route adopted to industry and governments to a sustainable mining community has tended to focus on a three-step approach. The first was to establish infrastructure to support and nurture the workforce. Mining companies in Canada, for example, set high standards in being the driving force to create towns and infrastructure with medical, educational and utilities support. Noted examples of new towns, planned specifically to support mining operations, might be Leaf Rapids (Manitoba) and Fermont (Québec). Some of the communities that grew within the town and infrastructure have evolved further through diversification, whilst others have wilted after the departure of the mine on closure. The second step was to generate sustained employment through discovering and mining all available ore deposits in the locale. Communities such as Flin Flon and Snow Lake in Manitoba, for example, have been sustained by the continued discovery and operation of many ore deposits

within reasonable proximity to these towns. The third step generally was to leave infrastructure such as roads, power, and housing to local communities when the mine was closed or in remote areas to demolish it.

The planning for mine closure has been only a relatively recent development and its scope and practice is still evolving. In the past, contributing infrastructure has been viewed by many companies as leaving a major asset and donation to the communities. While the hard infrastructure remained, the soft infrastructure (social considerations) and the environmental residues were left primarily as responsibilities of government. Experience has shown, however, that bricks and mortar are no substitute for enlightenment, education and organization. Villages left behind by mining companies can become shanty towns, as the example in the Amazon region demonstrated. Today, in both highly developed and developing economies, the approach to creating a sustainable mining community has changed. There is now a requirement to contribute to the ecological integrity or viability of the local bio-physical environment, to diversify the economy into different areas, and to consider long-term community sustainability.

The advent of developing mines as long-distance commuting “fly-in fly-out” operations has added a further dimension to planning for sustainable mining communities. In these operations, remote ore deposits are mined without the development of the traditional mining town. Fly-in mining brings with it its own set of implications for rural and remote communities. Fly-in, fly-out work cycle rotations have an impact on small communities and family life, particularly if that community has not experienced this type of mine employment previously. A greater concern for declining mining communities is the prospect that they may be “flown-over” by company managers that may choose to hire mine employees from larger regional centres rather than from the smaller, more remote towns. On the other hand, fly-in, fly-out operations can be far less environmentally disruptive if the alternative is to build a new mine town. Significant environmental (socio-economic and biophysical) costs accompany the building of a mining community with its requirements for extensive infrastructure, schools, social and health programs needed to sustain people in a remote setting. A fly-in operation can avoid many of these costs by flying in workers from established towns. The opportunities and costs posed by this type of operation for the company as well as for the affected mining towns need to be

carefully weighed on a case-by-case basis (Veiga et al., 2000 - op. cit.).

As the regulations have become more inclusive, the task of preparing mine-closure plans have become increasingly more complex and time consuming. While most mining companies have the in-house expertise to address most of the hard engineering components of the plan, they lack the personnel with the required backgrounds in biology, community development, landscape architecture, historical anthropology, etc. This has forced many companies to broaden their traditional hiring practices to include many non-engineers and/or look to outside consultants to provide the necessary specialist expertise.

In either case the mining industry as a whole has had to develop new capabilities in order to respond to the gradual ratcheting up of North America's reclamation laws. For those companies that failed to keep pace with changing circumstances, the costs to themselves, and mining in general, has been high. In the case of the coal industry in the US, their failure to take strong action in the face of wide scale public outrage resulted in the creation the SMCRA. While this draconian piece of legislation forced the industry to radically improve its standard of environmental performance, these changes did not come without a cost to the industry.

In retrospect SMCRA may be seen as a case where changes to government policy came close to exceeding the institutional capability of the industry to successfully respond. An unexpected side benefit of SMCRA has been to light a fire under the rest of the mining industry to improve the quality of their reclamation efforts so that a "hard rock" equivalent to SMCRA, i.e. applicable to metal mining industry, is not enacted.

9.3 Latin America

One of the main obstacles to implementing mine-closure and reclamation plans is the fact that many companies have been in operation long before there were reclamation regulations. As a consequence, these companies are often not structured to assume the added costs that are associated with reclamation. In spite of the changes that new environmental legislation demanded from these projects, some Latin American observers feel that many of the closure and reclamation plans prepared by the mining companies were written just to fill a bureaucratic

requirement.

Many of the articles identified in the database point out that it is of extreme importance that closure activities should be considered during the earliest stages of the mining project. Only after developing a clear understanding of the scope of the final reclamation requirement can the feasibility of a project be properly evaluated. In most Latin America mining projects there is no consideration made for calculating the true costs of closure to the company. Until the companies begin to see this as more than just an exercise to satisfy the bureaucrats, they (the companies) will not take the necessary steps to integrate closure planning into their corporate structure.

Another problem is enforcement capabilities and control by government agencies that many times don't have enough human and financial resources to face such tasks. There are also problems regarding the difficult interaction among the several public agencies at several levels (county, state and federal). As an example, it can be mentioned the case of the *Indústria e Comércio de Minérios S/A – ICOMI* company, located at *Serra do Navio* County, State of Amapá, Brazil.

ICOMI, responsible for the operation of a large manganese deposit, an enormous enterprise that was made possible through a contract with the former-territory, current State of Amapá, assuming the exhaustion of the reserves, informed the end of production activities and tried to transfer the area and the assets to Federal/State agencies, as liabilities as agreed in the contract signed fifty years ago. The government of the State then requested auditing to the competent federal agency, i.e. the National Department of the Mineral Production - DNPM, whose Director created a Working Group that presented an opinion that is favorable to the company, thwarting the local interests. The beginning of the closure procedures of ICOMI generated a public debate on the final destination of the part of assets to be returned to the Government by the company, being this accused of having negotiated part of the patrimony yet, before the end of the contract. The discussions regarding the subject do not approach only geological and economic aspects, but mainly a complicated juridical equation regarding the contract. Also political subjects are mixed here, because the current rulers are not the same of 50 years ago, time of the signature of the contract, and it seems clear now that even

at the State Government level there was not a preparatory phase regarding the end of this project. As a result the community that acquired the mine assets (houses, schools, roads, etc.) is facing problems to survive in unsustainable circumstances with no viable economic option. Even the railroad, the main access route to the community, cannot be operated and maintained by the local government.

10. RISK ASSESSMENT OF ABANDONED AND RECLAIMED SITES

10.1 Introduction

The issue of how best to reclaim abandoned mine land (AML) has been a source of much heated debate between various levels of government, the mining industry and the public. By most accounts the scale of the problem is enormous; by some estimates there are over 500,000 AML sites in the United States alone (Mining Watch, 2000)³⁸. Less from a technical perspective, the task of dealing with these sites is made more difficult by a regulatory system that makes third party intervention exceedingly risky. Regarding technical issues associated with AML, slope stability of abandoned tailing dams, subsidence of underground workings and acid drainage are the major concerns related to public safety and environmental aspects.

This section will address some of the most pressing issues regarding AML sites including:

- The relevant issues governments should consider when attempting to deal with the problem of reclaiming AML sites;
- What are some of the alternatives available to the government for financing the reclamation of previously AML sites; and
- What are the necessary preconditions for determining when a walk-away solution is possible for a reclaimed mine site?

10.2 North America

Any serious examination of the issues at play for resolving the on-going problem of how best to deal with AML sites will quickly discover that easy solutions will not be forthcoming. While each site presents its own set of unique technical problems, the real challenge facing government regulators is developing mechanisms that establish civil and criminal liability to companies or individuals after the land has returned to public administration. Unfortunately, the question of how best to amend the existing regulations is subject to much debate. This squabbling over the facts of the case has stalled most moves by government regulators to take decisive action to resolve the problem. In contrast to the regulator's inertia, private

³⁸ Mining Watch (2000). This is an Environmental Non-Governmental Organization with website at <http://www.miningwatch.ca/>

citizens and NGOs have become increasingly vocal in their demands something to be done. The need for immediate action appears obvious when one considers the following:

- That the government is presently directing mining companies to allocate enormous resources to minimize their impact on the environment when a far greater benefit to the environment would be possible if a portion of these funds were directed towards reclaiming AML sites; and
- There appears to be little to be gained by an existing set of regulations that requires existing mine operators to meet zero discharge requirements for their effluent when the receiving waterway is already heavily contaminated by toxic drainage from AML sites.

10.2.1 Canada

Mining related Acts are currently in place for the administration of abandoned mines and mine reclamation in Newfoundland and Labrador, Nova Scotia, New Brunswick, Quebec, Ontario, British Columbia and Yukon. In Saskatchewan, Northwest Territories, Nunavut and Yukon government regulators rely instead on environmental related legislation. In Alberta the Coal Conservation Act is used. Manitoba has written a policy document that covers the administration of AMLs. At the federal level, Ottawa can use sections of the Environmental Assessment Act, Environmental Protection Act, Fisheries Act, and Atomic Energy Control Act to manage the reclamation of AML sites on federal land.

Most jurisdictions in Canada require that mine-closure plans be approved before mining operations can commence. Only in the province of Quebec does the government require that closure plans contain provisions to address accidents that might occur after reclamation has been completed. Several provinces and territories are currently reviewing their regulations to account for problems that may occur after reclamation. The Government of British Columbia has been studying the possibility of requiring insurance from companies to cover costs of eventual accident after reclamation.

10.2.2 Priority Systems

All of the ten Canadian provinces, NWT and the Yukon have in place legislation that requires mining companies to specifically set aside funds to be used for reclamation following mine-closure. In the event that the company later slips in bankruptcy, most provinces have in place a priority system for allocating funds for reclamation based on factors such as proximity to populated areas, public health and safety, and the protection of the environment. Two agencies, the Federal DIAND and Ontario Ministry of Northern Development and Mines (OMNDM) have each introduced automated management tools to assist personnel in evaluating potential risks from AML. Northern Environment Risk Assessment Strategy (NAP) is used by DIAND. NAP uses four basic factors – legal and environmental liability, threats to human health and safety, aboriginal land claim obligations, and public concerns. OMNDM uses a system called the Abandoned Mine Hazard Rating System (AMHAZ). AMHAZ generates a hazard rating for each AML site based on factors that include probable risks to public health and safety, the environment, social institutions, and the local economy.

10.2.3 United States

As in Canada, the division of responsibility between the federal and state governments further complicate the search for solutions to the problem of AML sites. Though the states carry much of the regulatory responsibility for AMLs, it is often the case where Federal Acts carry the most influence. Under current Environmental Protection Agency (EPA) policy the runoff from AML is subject to meeting the Federal Clean Water Act's (CWA) Section 402 National Pollutant Discharge Elimination System (NPDES) permit program. Section 402 requires that all mine discharge must be treated to meet all water quality standards until the time that untreated effluent meets the required water standard. Unfortunately an unintended consequence of the regulation has been to provide an overwhelming disincentive for any voluntary cleanup efforts of AML sites. Because liability for any discharges from the site can be inherited, it is simply too risky for either public or private agencies to take on the role of the "Good Samaritan".

Liability concerns also prevent mining companies from going back into historic mining districts and re-mining old abandoned mine sites or doing volunteer cleanup work. While either of these actions may provide valuable environmental and economic benefits to a local community, companies that are interested are justifiably hesitant to incur liability for cleaning up AML sites.

10.2.4 Funding Cleanup Costs

In the US there are two important funds for cleaning up AML sites. The first – the Abandoned Mine Reclamation Fund – was created by a nation tax on the mining of coal. A severe limitation of the fund is that it prioritizes the cleanup of abandoned coal mines over other types of mines, regardless of the environmental or safety risks associated with the site. Furthermore, the fund places threats to human health and safety, no matter how small, ahead of environmental concerns, no matter how great (Danielson and Nixon, 2000 - op.cit.)

The other source of money for reclaiming AML sites is through the Superfund programme. It too contains many systemic problems which seriously detracts from its usefulness as a mechanism for funding AML cleanup. One problem is the source of the Superfund money itself. The fund was created through a levy on the US chemical industry. It may seem odd to some observers that a fund designed to address the environmental ills of one industry is being used to treat the environmental ills of another. Another problem with the fund is that to access the money the recipients expose themselves to inheriting the liability for the site.

10.2.5 Walk-away Solutions

True walk-away solutions are few in number when confronted with an AML site whose drainage does not meet the water quality standards as specified in the Clean Water Act. Under this scenario anyone taking over the site would be required by law to put in place an expensive active treatment system until such time that the effluent met the federal standard, or treat the effluent until a passive water system could be used. At sites where ARD is particularly a problem, the costs associated with the active long-term treatment of water could easily run into the tens of millions of dollars. Until such time as a more cost-effective system of ARD treatment is perfected, the notion of there being a walk-away solution for many AML sites may not be possible.

10.3 Latin America

Ordinarily the task of dealing with AML is a difficult one, however in Brazil it is further complicated by the fact that there is little cooperation between the various levels of

government to resolve the problem. This has prevented any action from being taken on the important issues of financing AML reclamation and creating a public process for deciding on future land uses for AML sites.

Another problem to be overcome is the lack of information that accompanies most discussions of the AML problem in Brazil. In most cases there is simply not enough data available to assess the impact on local air and water quality posed by AML sites. Without such data it is nearly impossible to accurately measure risk and assign priorities for reclaiming AML sites.

Of the handful of AML reclamation projects that have taken place in Brazil, the mining companies have so far declined from taking a leadership role. Instead it has been left to the industry and real estate companies as well as the government to come up with solutions to that country's AML problem (Bitar, 1997)³⁹.

³⁹ BITAR, O. Y. Avaliação da recuperação de áreas degradadas por mineração na região metropolitana de São Paulo. São Paulo, 1997. 183 p. Tese (Doutorado) – Escola Politécnica, Universidade de São Paulo.

11. WATER QUALITY

11.1 Introduction

As most technical issues related to mine-closure are more visible and quantifiable than social aspects, they usually receive more attention from companies, inspectors and legislators. Large investments have been made to generate sound solutions for problems related to mine effluents, but, unfortunately, "walk-away" solutions are not quite universally achievable yet.

Mining and mine related activities result in certain environmental effects that, depending on their specific nature, can adversely impact the quality of water in the receiving environment. While much has been done over the last two decades to address the problem of mine water effluent, the target of zero emission still remains just out of reach. Because aquatic systems and the biota living in them are often acutely sensitive to even minor changes in pH, heavy metals and/or suspended solids, the mining industry is under a great deal of pressure to minimize its ecological footprint. In a recently prepared document⁴⁰ by the MPC-Mineral Policy Center (1999), a Washington based non-governmental organization (NGO) that is active in environmental issues, a series of sweeping changes were presented that, if adopted, would greatly reduce the impact of mining on surface and groundwater resources. Though the document contained many valid criticisms of current industry practice, they are nonetheless generalizations whose efficacy can only really be determined when taken in the context of a specific mine site. For example, MPC's call for a complete ban on submarine tailings disposal overlooks the fact that under the right circumstances and in specific cases, this practice has been proven to be the most effective way to prevent ARD and to reduce the aesthetic impact of tailing piles

Acid Rock or Mine Drainage (ARD or AMD) has been considered to be the industry's greatest mine-closure and reclamation challenge. ARD occurs naturally in regions with high concentrations of sulfide ore. However when a mining operation exposes sulfidic rock to air and water, the process that leads to ARD is accelerated. In sufficient quantities, this acidic drainage can liberate trace metals associated with waste rocks and/or tailings. In general

metals entering the aquatic environment react with other constituents in the soils, water or bottom sediments. The metals are then removed from solution and fixed in the sediments or suspended particles. The damage caused by ARD can be reduced when metals are strongly adsorbed by hydrous iron, manganese oxides, or clay minerals.

The intense weathering process in the tropics creates conditions to minimize, in some respects, the effects of metals release in acidic streams. Clay minerals are naturally abundant in the tropics and as was mentioned earlier clay can mitigate some of the effects of ARD. Conversely, in temperate or sub-tropical climates, like those found in North America and the southern part of South America, acid drainage can be an insidious problem.

Because the mining and mineral processing often uses large amounts of water, this can be a source of conflict in places where water resources are limited. In an effort to reduce some of these conflicts, the mining industry actively promotes the use of technologies that allows for much of this wastewater to be recycled. For instance, in Canada 70% of the water used in mining operations is reclaimed to be re-used in the mineral processing. While recycling can reduce the quantity of water used by the mining industry, it is the issue of water quality that is of greater concern to the communities located near mine sites. Storage of wastewater and tailing pulps facilitates the mobility and access of pollutants to water streams. Water siltation, increasing suspended sediments, has been a common issue when tailing dam spills occur or as a result of poor mining practices, such as use of hydraulic monitors in Northern Canada or by artisanal mining activities in Latin America. As particulate matter is the main pathway in which metals and other contaminants enter water systems, tailing containment is an ongoing source of anxiety for local communities. The increased turbidity caused by suspended sediments may also lead to a decrease in the growth of aquatic animals by reducing the amount of light reaching photosynthetic plants that the animals depend on as a source of food and/or protective cover.

The main effects of mining on water bodies has been listed by Bakau (1993)⁴¹:

⁴⁰ Mineral Policy Center (1999). 14 Steps to Sustainability. Mineral Policy Center: Placer Dome, Sustainability Grade: Incomplete. Washington, D.C., 40p.

⁴¹ Balkau, F. (1993). Pollution Prevention and Abatement Guidelines for the Mining Industry. UNEP IE/PAC, 19p.

- Suspended solids and sediment from runoff and processing operations;
- Acids from various processes;
- Acid mine drainage during and after operation;
- Heavy metals leached from wastes and concentrates around the site;
- Sulfate, thiosulfate, polythionates etc. from acid drainage;
- Arsenic and other salts from oxidized mine waters;
- Mercury, if used in the process, or from ores;
- Cyanide if used in leaching processes;
- Oil and fuels from ancillary operations;
- Other processing chemicals as may be used on the site;
- Groundwater constituents that may be pumped or discharged off-site; and
- Sewage from the site.

By themselves, the large volumes of waste produced by metal mining and mineral processing should cause minimal environmental damage. However, when surface and ground waters are allowed to interact with these wastes, metals and other potentially toxic substances can be released. When this release is uncontrolled, it can lead to serious contamination of surface and groundwater stocks. The BHP owned Ok Tedi mine in Papua New Guinea is striking example of how poor mining practices can seriously damage an entire watershed. Due to the rugged terrain of the area, the local Government allowed the mine to release annually over 20 million tonnes of copper-rich tailings directly into a river. The suspended sediment level is 4 to 5 times higher than pre-mine conditions and siltation is affecting 1350 km² of forest and has reduced the local fish population by 90%. Riverine tailing deposition has been also practiced by Placer Dome in the Porgera Mine near Ok Tedi. In many regions of the globe riverine deposition has been applied for long time creating environmental impacts and tarnishing image of the mining industry. This is fundamentally different from responsible subaqueous (lake or marine) disposal.

Tailings dams are among the largest structures ever constructed by man. Some of the biggest contain as much as 100 million tonnes of stored slurried tailings. With over 3500 tailings dams worldwide, these structures represent what is potentially a large and growing problem for the

industry (Davies et al., 2000)⁴². The recent failure of some of these dams has resulted in loss of human life, extensive terrestrial and aquatic environmental damage, and serious economic costs to the mines. The contaminants often reported in surface and groundwater as a result of tailings impoundment failures include heavy metals, cyanide and in some cases, radioactive elements.

The impact of cyanide into the environment as a result of a tailings dam failure was highlighted in 1997 by the Omai Mine in Guyana. A breach in the dam caused the release of 3 million m³ of cyanide-laden effluent into the river system. The event caused extensive downstream environmental damage. In January 2000, a spill of 100,000 m³ of cyanide effluent from a gold leaching operation in Romania generated an enormous public outcry about use of such a hazardous reagent in mining industry.

11.2 North America

The degree of contamination of an aquatic ecosystem resulting from natural processes rather than from anthropogenic sources has been investigated by the Mining Association of Canada with the support of the Ottawa-based International Council of Metals in the Environment (ICME). The ICME represents twenty-seven major mining companies from around the world. Whether by natural or man-made causes, the contamination of water supplies near mining operations infers liability to the company. Therefore the company must endeavor to understand the physical processes that cause the transformation and dispersion of metals in surface waters in order to apply the mitigation procedures. In some respects, mining companies have realized that by understanding the biogeochemical cycle of trace elements in different environmental compartments, it may be possible to develop an appropriate "walk-away" solution once mining operations have ceased. Conversely, drainages from abandoned mines require "eternal" environmental monitoring or maintenance after closure due to a lack of understanding of the local geochemical reactions.

Water use by mining has been a contentious issue in those jurisdictions, like Nevada, were

⁴² Davies, M.; Martin, T.; Lighthall, P. (2000). Mine Tailings Dams: When Things Go Wrong. Proc. Tailings Dams 2000, p. 261-274. Assoc. State Dam Safety Officials Inc. Kentucky, March 2000.

water resources are scarce. To sustain the operations of a mine, it may be necessary to withdraw water to aid in extraction or processing through damming or water diversion channels. These withdrawals of water may potentially deplete groundwater reservoirs and permanently lower the groundwater table. The design of the mine infrastructure may also alter the flow patterns of existing watercourses. For example, the Ekati Diamond Mine in the Northwest Territories, Canada, requires the de-watering of many lakes since the ore deposit is located beneath the water body.

Water quality is impacted by sources of ARD: discharge from open pits; waste rock dumps, tailings and ore stockpiles. Open pit operations in particular can expose very large quantities of sulfide-bearing rocks that may potentially affect water quality through the production of ARD. To put the magnitude of the problem into context, in US about 16,000 km of streams and about 12,000 ha of impoundments are estimated to be seriously affected by acid generated by sulfide-related mining activities⁴³. In 1987, it was estimated that in Canada alone ARD from active and abandoned mine sites impacted an area of approximately 15,000 ha. The estimated cost for treating this problem has been conservatively estimated at Cn\$ 6 billion dollars. In an attempt to address the issue of ARD, the Government of Canada created the Mine Environment Neutral Drainage Program (MEND). The principle objective of the MEND program is to provide scientific, technical and economic basis for the mining industry and government agencies to predict the long-term management requirements for monitoring and combating the effects of reactive tailings and waste rock dumps.

The placement of tailings or waste rock underwater may occur in a flooded open pit, in a lake or man-made impoundment. The low content of oxygen prevents propagation of sulfide oxidation and acid generation. In the most recent conference on ARD control in British Columbia (Dec. 1999) various authors have approached subaqueous deposition as the safest solution for acid-generating tailings. However, there are many public and regulatory issues related to the potential impact this disposal method may have on the health of benthic communities. Underwater disposal requires an advanced understanding of the local and regional hydrogeology and the characterization of the tailings if the sulfide-bearing rock is to

⁴³ Canty, M. (1999). Overview of the sulfate-reducing bacteria demonstration project under mine waste technology program. *Mining Engineering*, v. 51, n.6, p.93-99. Ed. SME.

be safely disposed of in a marine environment. Island Copper Mine on Vancouver Island, Canada, is an example of where this disposal technique has been successfully applied. From 1974 to 1995 between 30,000 to 60,000 tonnes of tailings were daily discharged at 50-m depth into the ocean⁴⁴. For almost thirty years a comprehensive program of marine monitoring was conducted by an independent team of scientists to determine what effects this form of waste disposal would have on the health of the receiving environment. What the scientists found was that the site's fish and shellfish population experienced no lasting adverse effects from the dumping, and that local populations had returned to pre-mining levels⁴⁵. In any case, the environmental effect of subaqueous discharge depends on the water depth, type of tailing and characteristics of the site. This has been a polemic subject and deserves further investigation.

Overall, the most prudent approach to ARD prevention is to reduce the production of acid in sulfide-bearing waste rock by processing the waste rock. However, the most common (and currently the most cost-effective) approach for preventing or controlling the migration of ARD is the use of dry covers to impede the movement of contaminated groundwater or diversion of water from the sulfide-bearing rock. There is a large group of environmental engineers in Canada that believe that the costs associated with the flotation of sulfides from tailings would be lower when compared against those costs associated with the construction of dry covers. The application of this approach may result in a viable "walk-away" solution for mine sites containing sulfide-bearing rock.

Another alternative strategy for treating ARD is through the use of constructed aerobic or anaerobic wetlands. Extensively used to precipitate iron, aluminum and manganese from mine waste water, the US Bureau of Mines has estimated that over 400 aerobic wetlands have been constructed to treat mostly coal mine effluent. Sorption on organic matter seems to be the predominant mechanism to remove metals from the acid drainages. While the use of constructed anaerobic wetlands to treat effluents from base metals mines is promising, it is still

⁴⁴ Welchman, B. and Aspinall, C. (2000). Mine-closure and Sustainable Development: Island Copper Mine: A Case History. Proc. of Mine-closure and Sustainable Development Workshop. World Bank, March 1-3, 2000, Washington, D.C. 16p.

⁴⁵ Ellis, D.V.; Poling, G.W.; Bare, R.L. (1995). Submarine Tailings Disposal (STD) for Mines: An Introduction. Marine Georesources and Geotechnology, v. 13 n. 1-2, p 3-18.

experimental with limited application in large-scale mining operations.

Many advances have been made in the past ten years in the prediction of ARD from mine waste. Appropriate predictive testing along with waste characterization and scientific interpretation of the data is now considered essential if proper waste management practices are to be developed. As the understanding of the mechanisms responsible for the production of ARD increase, it may be possible to assess the acid-generating potential of wastes at earlier stages in a mine's operational life cycle. Therein lies the importance of understanding the factors that promote and inhibit acid production in sulfide-bearing waste. The assessment of the acid generating potential of waste may even cause the mine to be judged uneconomic when the reclamation costs associated with ARD mitigation and treatment measures are factored into the equation.

In the US, there exists the Acid Drainage Technical Initiative (ADTI) which carries a similar purpose. From an administrative point of view, there exists a need for a global body whose mandate would be to facilitate the open exchange of knowledge on ARD issues. The concept of information sharing would clarify the technological requirements in the industry and concentrate industry resources in areas where knowledge is lacking.

11.3 Latin America

Given the great diversity of climate, geology and mining activities that can be found in Latin America, it is not surprising that there is no single water quality issue that affects the continent's principal mining countries. For instance, in Brazil the main concern of regulators is controlling mercury pollution from that country's huge artisanal mining community. In the case of Chile the concern shifts to addressing the problem of ARD from that country's extensive base metal mines.

11.3.1 Brazil

While Brazil is an important producer of many types of minerals, it is as a gold producer that most concerns those who study the effects of mining on that country's water resources. Recent estimates suggest that there are 10,000 of so small-scale mines in Brazil employing

between 100,000 – 250,000 people⁴⁶. While the mining operations themselves can seriously degrade the water quality of local streams and rivers through increased siltation, the main problem occurs when mercury is added to the whole ore or concentrates to assist in the recovery of the gold. Due to a lack of education amongst the miners, the low cost of mercury, and the unregulated nature of the industry, there is no concerted effort to recycle the added mercury. As a result, it has been roughly estimated that for every tonne of gold recovered, a tonne of mercury is released into the environment⁴⁷. To appreciate the importance of the problem posed by mercury pollution, it is necessary to understand how the chemistry of dark water systems helps mercury to move up the food chain.

Dark water systems are characterized by low productivity in terms of living biomass, low dissolved solids, and high concentrations of organic matter. In dark water environments, most metals form stable complexes with organic substances. Consequently, an abundance of organic matter in aquatic systems can significantly influence the mobility and availability of metals to organisms (bioavailability). For instance, metals adsorbed to soluble organic acids can be transported much greater distances than in other forms. As well, it is generally believed that most metals complexed to organics are less bioavailable to organisms than in other forms. For example, copper is highly toxic to many fish species in the form of a free ion (Cu^{2+}) and inorganic complexes ($\text{Cu}(\text{OH})_2$ and $\text{Cu}(\text{Cl})_2$), but essentially unavailable to fish and other aquatic organisms when complexed with organic acids.

Mercury is an important exception to the rule. Many studies have shown that fish from dark waters in the Amazon have significantly higher mercury levels than those from clear water (poor in dissolved organic matter) rivers^{48,49}. The specific mechanisms controlling this are largely unknown, although some research suggests that organic acids can mediate the

⁴⁶ These estimates from various sources, including Brazilian National Dept of Mineral Production, the United Nations and the World Bank. In 1996, UNIDO (United Nations Industrial Development Organization) has estimated that 200,000 to 400,000 artisanal gold miners were active in the Brazilian Amazon representing, that time, about 37 to 40% of artisanal gold miners in Latin America.

⁴⁷ Veiga, M.M. (1997). *Introducing New Technologies for Abatement of Global Mercury Pollution in Latin America*. UNIDO/UBC/CETEM/CNPq. ISBN:85-7227-100-7, 94p.

⁴⁸ Tromans, D.; Meech, J.A.; Veiga, M.M. (1996). Natural Organics and the Environmental Stability of Mercury: Electrochemical Considerations. *Journal of Electrochemical Society*, v. 143, n.6, p. L123-126.

⁴⁹ Veiga, M.M.; Hinton, J.J.; Lilly, C. (1999). Mercury in the Amazon: A Comprehensive Review with Special Emphasis on Bioaccumulation and Bioindicators. *Proc. of the NIMD (National Institute for Minamata Disease) Forum'99, Minamata, Japan, October 12-13, 1999*, p. 19-39.

methylation of mercury. Methylmercury is a highly soluble compound, readily bioavailable and extremely toxic. Elevated mercury levels and symptoms of chronic mercury toxicity have been documented throughout the Amazon in several villages located adjacent to dark waters. Potential impacts of long-term consumption of moderate concentrations of mercury-contaminated fish can include neurological damage, such as seizures, impairment of peripheral vision, muscle tremors, exaggerated emotional response and mental instability. In addition, mercury is a developmental toxicant with effects ranging from inhibition of learning processes to severe mental retardation.

Mercury pollution caused by artisanal mining as well as by other sources such as wood or fossil fuel combustion, reservoirs flooding, etc. has been of great concern in all Amazonian countries (French Guyana, Suriname, Guyana, Venezuela, Colombia, Ecuador, Peru, Bolivia, Brazil). Bioaccumulation of mercury in aquatic organisms has been demonstrated in a large number of monitoring programs, but little has been done by Governments to provide solutions for the problem. UNIDO, World Bank, CETEM, CIMM, Intermediate Technology, Projekt-Consult, Swedish Geological AB, CENDA Foundation, US Agriculture Dept., Geological Survey of Canada and another large number of international organizations have published technical and regulatory procedures to reduce mercury emissions in developing countries but these measures rarely were implemented or reached more organized sectors of the artisanal mining. Unfortunately, the reduction of the mining activities as a consequence of depletion of easily extractable gold ores, seems to be the only reason by which mercury emissions from gold mining has been reducing. As no clean-up activity has been carried out in Latin America, the legacy to deal with highly contaminated sites will be transferred to future generations.

11.3.2 Chile

Recent political changes in Chile have proven to be a catalyst for changes in that country's approach to regulating the reclamation activities of mining industry. Taking an approach that was similar to that of Canada and the US in the early 1970's, Chile in 1997 introduced reclamation regulations that were intended to address potential threats to human health and safety following mine-closure. By looking at the issue of mine reclamation so narrowly, the government soon realized that it was unable to effectively manage many of the other problems that are associated with mine-closure. To address problems such as ARD, the Government of

Chile has recently initiated a process of regulatory reform that will eventually lead to a complete overhaul of the country's laws governing mine reclamation⁵⁰. As pollution does not observe national borders, Chile intends to promote through CAMMA (Annual Conference of Ministers of Mines of Americas) a process that would see the adoption of a transcontinental approach for addressing water quality problems caused by mining.

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⁵⁰ When completed, Chile's reclamation regulations may be the most progressive in the world. It is their intention to put into place a series of rules that would encompass the technical, social, environmental and political issues that would underlie a more sustainable approach to mine reclamation.

APPENDIX A - QUESTIONNAIRE RESULTS

Part A

When considering the following questions the respondents were asked to indicate the correct answer by placing a checkmark (✓) beside the appropriate item.

1. Are you employed by:

<u>13</u>	Government
<u>2</u>	Industry

The questionnaire was sent out to fifty-five (55) government and ten (10) industry representatives who are currently involved in the planning, management and/or regulation of mine reclamation projects both in Canada and the United States. The government personnel were selected to represent a cross-section of the different federal and state/provincial organizations that currently oversee the monitoring and enforcement of mine reclamation legislation. Those representing industry were selected on account of their importance as major North American mineral producers. While the small number of questionnaire returns (15) limits our ability to analyze the data with any statistical certainty, it is still possible to draw some general conclusions with respect to the present attitudes of those who oversee mine reclamation in Canada and the US.

2. How would you rate the knowledge of the personnel within your organization with respect to the issue of mine-closure?

<u>8</u>	Excellent
<u>4</u>	Good
<u>1</u>	Adequate
<u>2</u>	Deficient
<u>0</u>	Non-existent

However critically the public, media and NGOs may view the conduct of those organizations responsible for mine reclamation, the personnel responsible for planning and overseeing the work rate themselves as highly competent. To what should we attribute these differences? Is it simply a case of organizational loyalty, or are there critical perceptual differences that separate the decision-makers from the public? How these questions are answered will profoundly influence how people react to the prospect of mine development near their communities.

These results also highlight another area of possible concern. How readily will these "experts" respond to outside pressures to reorient the focus of mine reclamation away from what has essentially been an environmental issue to one that encompasses a more diverse range of social, economic and environmental concerns? Politicians, NGOs and local citizen groups will have to remain vigilant to prevent institutional inertia from blocking the move toward a more holistic approach for dealing with the full range of problems that result from mine-closure.

3. At what point during the engineering design phase does your organization consider the issue of mine-closure?

<u>2</u>	Geological Exploration
<u>8</u>	Pre-feasibility Study
<u>3</u>	Basic Engineering Design
<u>1</u>	Detailed Engineering Design
<u>1</u>	Implementation and Operation

These results clearly indicate the extent to which planning for closure early in the mine development cycle has been adopted throughout Canada and the US. With few exceptions, it is no longer possible to acquire either the necessary government permits or financing guarantees in the absence of at least a conceptual reclamation plan.

4. As a general statement, can the application of sustainable development principles mitigate the harmful effects a mine-closure may have on a community?

<u>12</u>	Yes
<u>2</u>	No
<u>1</u>	N/A

The overwhelmingly positive response to this question is intriguing given the great deal of confusion that surrounds the concept of sustainable development and its relationship to the mining industry. In both Canada and the US the government and mining industry remains wedded to the Brundtland Report's 1987 definition of sustainable development. While useful as a statement of general principles, this definition fails to adequately address how sustainability is to be achieved by an industry engaged in the exploitation of a non-renewable resource. Only recently have academics attempted to go beyond generalizations in the hope of outlining a vision of sustainable development that is specific to the mining sector. While this work is still ongoing, it is nonetheless possible to anticipate at least some of the outcomes. If the mining industry is to move in the direction of increased sustainability, it will have to demonstrate an increased willingness to develop working partnerships with the communities that it directly affects. Through these partnerships a more equitable distribution of the rewards and costs of mining will occur. By adopting these types of measures, the mining industry will have addressed one of the key barriers that separate it from the communities in which it must operate.

5. As a general statement, do women experience any unique **hardships** following the closure of a mine?

<u>3</u>	Yes
<u>11</u>	No
<u>1</u>	N/A

Based on these results it is clear that decision-makers presently do not perceive that women experience unique hardships following mine-closure. In fact, several respondents even noted that they could not understand the relevance of this question. In light of the paucity of material written on the subject of mine reclamation and its impact on women, it should not be surprising that few practitioners view this as an important issue. Until additional primary research has

been conducted to ascertain the relative impact of mine-closure on women, it is unlikely that existing attitudes in government and industry will change.

6. As a general statement, are there any unique **benefits** to women resulting from the reclamation of mine sites?

<u>2</u>	Yes
<u>12</u>	No
<u>1</u>	N/A

7. Are there any practical obstacles that limit the effective enforcement of mine-closure plans in your country?

<u>8</u>	Yes
<u>7</u>	No

- 7a. If you answered yes to question 7, would you comment on what these obstacles are?

The obstacles that were frequently cited include:

- *Direct and indirect political interference. It is worth noting that it was the representatives of government who specifically identified political interference as a major obstacle preventing them from doing their jobs. This interference was seen to take on two distinct forms; first as direct interference by politicians to circumvent the rules in response to industry lobbying. The other source of interference came in the hiring of personnel whose only qualification for the job came as a result of their political connections.*
- *Inadequate understanding of the technical issues (i.e., ARD).*
- *Inadequate budgets. The perceived inability to adequately monitor and enforce closure plans on account of shrinking budgets was cited by over 50% of the respondents.*
- *Lack of corporate will to meet stated goals and objectives.*
- *Insufficient staff. This obstacle can be seen as the obvious outcome of government policies aimed at deficit reduction. One respondent noted that as a result of staff and other cutbacks, his department had moved from a proactive to a reactive approach in its dealings with the mining industry.*

Part B

The following questions required that the respondent rate each of the possible answers according to their relative importance in achieving their organization's operational goals and objectives. The rating scale is as follows:

Highest 1



Lowest 5

The overall group rating for each item was determined by simply adding the scores of all fifteen questionnaires. The number on the left hand indicates the average priority of the item: this was obtained adding all rating numbers of the item and dividing by the total number of respondents. The number in () indicates how many times that item was awarded the top score. In some cases respondents chose to award the highest score to more than one item.

1. When designing a mine-closure plan, which issues does your organization consider to be the most important?

1 (9) Complying with Government Regulations
2 (5) Reclamation and Re-vegetation
2 (4) ARD and Waste Disposal
3 (4) Future Land Use
4 (2) Community Development

2. What are the most important engineering issues that must be considered in a closure plan?

1 (9) Water Quality
2 (4) Erosion Control
2 (4) Infrastructure
3 (3) Re-vegetation
3 (1) Land Form

3. Which of the following items should be considered when preparing ARD control measures after mine-closure?

1 (4) Wildlife
1 (3) Local Community
2 (1) Vegetation
3 (2) Soil
4 (1) Buildings and Infrastructure

4. When considering social issues and mine-closure, which of the following does your organization consider the most important?

- 1 (8) Future Land Use Opportunities (i.e., recreation, agriculture, forestry, etc)
- 2 (2) Post-mining Employment Opportunities
- 3 (0) Infrastructure (i.e. power plant, waterworks, roads, hospitals, schools, etc)

5. What does your organization consider to be the most important objective of a closure plan?

- 1 (2) Address the Concerns of the Local Community
- 2 (5) Address the Concerns of Government
- 3 (3) Increasing the Environmental Productivity of the Land (i.e., creating habitat for plants and animals)
- 4 (4) Restoring the Land to its Pre-mined Condition
- 5 (1) Increasing the Economic Productivity of the Land (i.e., fishing, agriculture, recreation, etc)
- 5 (0) Address the Concerns of NGOs

6. Of the following list of issues, which should receive additional research funding?

- 1 (7) Sub-aqueous Disposal of Mine Waste
- 2 (6) Re-vegetation
- 3 (5) Sustainability
- 4 (3) Community Relations
- 5 (2) Paste Backfill of Tailings

7. As a general statement, which of the following items best reflects your organization's position on how mine-closure standards should be enforced?

- 1 (7) Strictly Enforced Government Legislation
- 2 (4) Government Recommended Codes of Conduct
- 3 (4) Industry Derived Best Management Practices