4TH INTERNATIONAL CONFERENCE ON ACID ROCK DRAINAGE

SHORT COURSE
FOR
BONDING AND SECURITY FOR MINES WITH ARD

JUNE 1, 1997
VANCOUVER, BC
13:30 - 16:30

Chair:	Duane Anderson	Economist, Province of British Columbia
Speakers:	Dr. John Errington	Manager, Province of British Columbia
	Keith Ferguson	Manager, Placer Dome Canada Limited
	Glenda Ferris	Member, Equity Surveillance Committee
	Peter Adams	Partner, Semmens & Adams
	Dr. Alan Krauss	Professor, University of British Columbia

PROGRAMME

Topic	Speaker	Estimated Time	Section
Commence at 13:30			
Introductory Remarks & Overview	Duane Anderson	5 minutes	1
Security Policy Issues	Dr. John Errington	15 minutes	2
Equity Silver Reclamation Security Study			
Introductory	Dr. John Errington	5 minutes	3
Corporate Perspectives	Keith Ferguson	20 minutes	4
Community Views	Glenda Ferris	10 minutes	5
Facilitation Process	Peter Adams	20 minutes	6
REFRESHMENT BREAK		25 minutes	
Reconvene at 15:10			
QUESTIONS & DISCUSSIONS		15 minutes	
Reclamation Funds	Duane Anderson	5 minutes	7
Reclamation Fund Proposal	Dr. Alan Krauss	20 minutes	8
QUESTIONS & DISCUSSIONS		10 minutes	

BONDING AND SECURITY

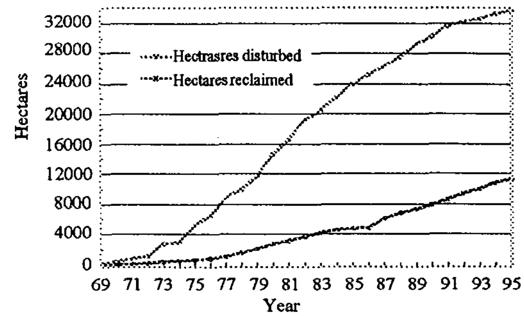
Presenter's Notes

Dr. John Errington

B.C. Ministry of Employment and Investment
Energy and Minerals Division

Reclamation Bonding Policy

Hectares Disturbed and Reclaimed Coal Mines and Metal Mines



PHOTOS

Reclamation Bonding Legislation

- Mines Act
- Bonding Act
- Finance and Administration Act

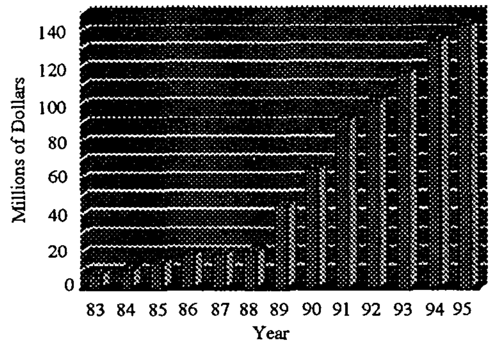
History of Reclamation Bonding Policy

- 1969 Legislation Introduced
  Maximum of $500 per acre
- 1975 Limit raised to $1000 per acre
  Provision to increase to actual cost
- 1989 Limit removed
- 1992 Cassiar Mine Receivership - $60,000 security,
  $5 million liability
  Westar Mines Receivership - $600,000 security,
  $20 to $30 million liability
  Policy decision to reduce risk to government
- 1993 Reclamation Security Policy Committee
- 1994 Whitehorse Mining Initiative
  Reclamation Security Policy Paper

Present Security and Liability

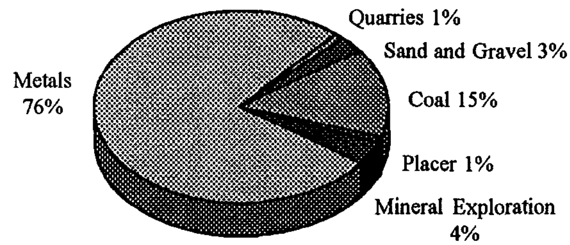
- Security Bonds - $140 million
- Liability - $400 million

Reclamation Securities



Breakdown of Reclamation Security

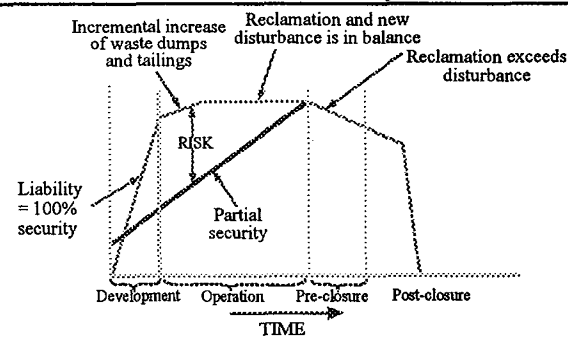
Deposits by Permit Type



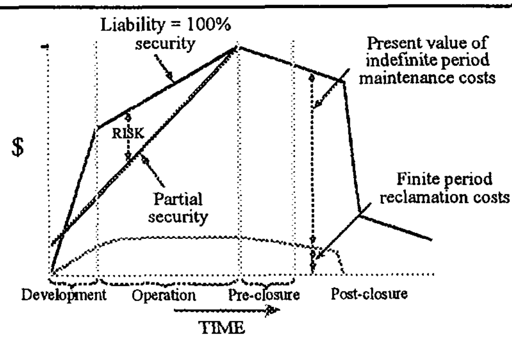
How do we calculated liability of individual mines?

- Company estimates
- Independent cost audits
- Spreadsheet program
- Mediation - Equity Silver

Reclamation Liability and Security Finite Period Only



Reclamation Liability and Security Over an Infinite Period



When is security required

- New Mines - before construction
- Existing Coal Mines - risk manage
- Existing Acid Producing Mines - fund for long-term treatment by closure
- Existing Metal Mines - risk manage

How does government manage risk?

- Security bonding
- Technical review
- Inspections and monitoring
- Minimize disturbance - reclamation performance
- Support of technical research

What Forms are acceptable?

- Letter of credit
- Cash
- Registered government bonds, 3 year maximum

What Forms are Currently Unacceptable?

- Bearer bonds
- Surety bonds
- Pledge of Assets
- Parent Company Guarantees
- Captive Insurance

Government's Criteria

- Liquid
- Certainty of Value
- Continuity - remains current
- Low cost of Administration

Industry's Criteria

- Low cost
- Minimum opportunity cost
- Reasonable rate of return
- Low cost of administration

Mine Specific Reclamation Funds

- Long-term liabilities
- Tax relief on earnings

Asymmetric Risk during bankruptcy

- When costs are lower than bond, company is refunded
- When costs are higher, government pays

Security Policy criteria

- Consistency
- Flexibility
- Clarity
- Administrative ease
- Incentives
- Competitiveness
- Technical integrity
- Public acceptability
- Accountability

Reasonable Assurance that Government will not pay

- Absolute assurance is not practical
- Risk must be clearly defined
- Technical uncertainty
- Financial uncertainty
- Clearly defined Standards

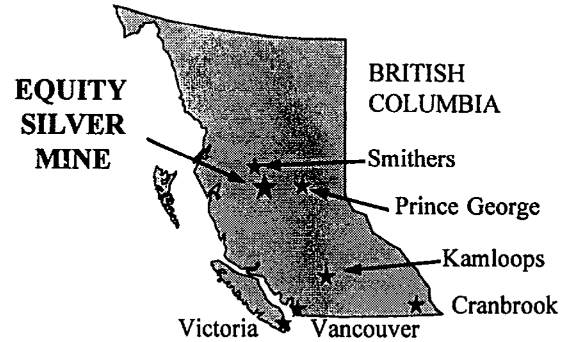
Bonding Rule

- It is easy to obtain security bonding from companies of low risk of default

Formalized Risk Assessment

- Liability
- Costs and uncertainties
- Capacity to fund work
- Property value
- Past performance
- Cash flow
- Financial Strength of parent company
- Diversification
- Credit Rating
- Liabilities elsewhere
- Financial performance

Equity Silver Mine



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1991

- Major concern about Acid Mine Drainage
- Mine to close in 1992
- Five estimates on annual treatment cost
  $1.28 to $2.4 million
- Equity Silver Mines Limited - single mine company

BONDING AND SECURITY

Background Information Papers

Mine Reclamation Security Policy in British Columbia, February 1995

Report of the Equity Silver Mines Limited Technical Committee, March 31, 1991

Equity Silver Mines Limited - Report of the 1995 Technical Committee, February 21, 1996

Mine Reclamation Funds - Final Report Submitted to The Mineral Policy Branch, Ministry of Energy, Mines and Petroleum Resources, November 19, 1990

Mine Reclamation Security Policy in British Columbia

A Paper for Discussion

February 1995

Province of British Columbia
Ministry of Energy, Mines
and Petroleum Resources

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INTRODUCTION

Over the past two decades, changing public values with respect to the environment and land use have put increasing demands on the requirements for mine closure and reclamation. Governments throughout North America have been developing more stringent standards for the planning of reclamation work and the posting of financial security to ensure that work is done. Today, mining companies recognize reclamation as an integral part of doing business.

British Columbia has actively pursued mine reclamation for 25 years. Our mining industry is recognized around the world for its achievements in land restoration and environmental protection. Nevertheless, BC's record in reclaiming mine sites has not been perfect, and there remain some important areas where government policy must be improved.

A Task Force to examine reclamation security policy is being established under the Minister's Advisory Council on Mining. This paper is meant to provide a basis for discussion by the Task Force, and to initiate a dialogue with key stakeholders. Its purpose is three–fold:

- Outline provincial objectives concerning mine reclamation in BC;
- State the government's current policy and thinking on reclamation standards and security, as a starting point for discussion; and
- Identify policy areas for further investigation by the Reclamation Task Force.

The paper focuses on reclamation at major mines in the province. Although it does not explicitly deal with mineral exploration sites and small mining operations (e.g. placer sites, sand and gravel pits, and quarries), many of the principles and policies outlined here have wider application. The government is currently developing guidelines for mineral exploration management that will address reclamation requirements at exploration sites.

Background

BC was one of the first jurisdictions in Canada to enact mine reclamation laws, and the first to extend its requirements to exploration sites. Under current legislation, mining is regarded as a temporary use of land, thereby requiring mining companies to carry out a program of environmental protection and reclamation.

What is Reclamation?

Mine reclamation is the process of restoring and rehabilitating land and watercourses disturbed by mining operations. In BC, as in other jurisdictions, the goal is to ensure that land and watercourses are returned to productive use, and that the site is safe and environmentally sound.

For most BC mines, reclamation involves the dismantling of buildings and structures and the stabilization and revegetation of waste rock dumps and tailings ponds. A portion of this work begins during the mine's operating life; the majority is usually finished within ten years of closure. Generally, the costs of these reclamation activities are significant but fairly predictable.

For a few mines, however, ongoing site management may be required long after closure, in which case costs can be large and hard to predict. For example, at sites where acid rock drainage (ARD)[1] is occurring, it may be necessary to collect and treat acidic run–off for many years into the future. Of BC's 24 operating or recently closed metal mines, eight now generate ARD and another nine have the potential to do so.

BC Legislated Requirements

Reclamation laws were first enacted for major coal and hardrock mineral mines in 1969. In 1973, legislation was extended to include coal and mineral exploration, as well as sand and gravel pits and quarries. The amended *Mines Act* (1990) and its accompanying *Health, Safety and Reclamation Code* provide today's legislative framework, which applies equally to operations on public and private land.

Part 10 of the Code sets out broad technical objectives for reclamation, mainly pertaining to major coal and hardrock mineral mines. These comprise minimum requirements for productivity and water quality, long–term stability of waste rock dumps and tailings structures, site clean–up, and treatment and monitoring of discharges. Requirements for exploration activity are outlined in separate exploration

1 Acid rock drainage refers to acidic run–off that contains heavy metals and can contaminate surface and groundwater.

guidelines, while those for placer mines and sand and gravel pits are set as conditions of individual reclamation permits.

Under the *Mines Act* and the Mine Development Assessment Process (MDAP), mining companies must submit a reclamation plan with any application for a new coal or mineral operation. This plan is reviewed by an inter–agency Regional Mine Development Review Committee and a central Reclamation Advisory Committee based in Victoria. If the new development receives MDAP certification, then the *Mines Act* requires the company to obtain a reclamation permit before mining can begin. During mine operation, reclamation programs are regularly reviewed and permits modified, where necessary, as the reclamation plan responds to changes in mining conditions.

One of the conditions of all reclamation permits is that companies post financial security to be held in trust by the province. This security can then be used if the company defaults on its obligations and the government must complete outstanding reclamation work. Bonding protocols are in place to rationalize the security requirements of different government agencies.[2]

The Roles of Industry and Government

By law, mining companies are fully responsible for environmental protection and reclamation at their mine sites. They must develop reclamation plans, estimate costs, and carry out planned reclamation work. The government's main role is a regulatory one—that is, to review reclamation plans, issue permits, inspect reclamation work, and administer security deposits on behalf of the province. In practice, however, planning and permitting involves a process of negotiation and exchange between the government and individual mining companies.

The province is currently developing new policies for historic mine sites with environmental problems. Under the *Mines Act*, the responsibility for such problems rests with the owner of the mineral rights.[3] The government is committed to establishing a registry of properties where acid rock drainage is now occurring and ones with ARD potential. Regulatory policy should encourage active exploration and development at historic mine sites, since the best way to contain ARD is to recommence mining using modern environmental control practices.

Aside from its regulatory duties, the government encourages technical research to support mine reclamation in BC. The Ministry of Energy, Mines and Petroleum

2 The Ministry of Energy, Mines and Petroleum Resources collects and holds security on behalf of the Ministries of Forests and Environment, Lands and Parks.

3 The Ministry of Environment, Lands and Parks, under the *Waste Management Act*, may assign responsibility to past and current owners.

Resources (hereafter the "ministry") takes a vital role in several committees, including the Technical and Research Committee on Reclamation (TRCR), the British Columbia Acid Mine Drainage (BCAMD) Task Force, and the national Mine Environment Neutral Drainage (MEND) Committee. The government has also sponsored the Chair of Mining and the Environment at the University of British Columbia. Through the federal–provincial Mineral Development Agreement (MDA), funding is provided for reclamation and acid rock drainage research projects.

BC Reclamation Record

The BC mining industry has achieved some outstanding successes in mine reclamation. For example, East Kootenay coal producers have been very successful in reclaiming disturbed land to elk range, and in rehabilitating lakes and streams to fish habitat. Fording Coal, Line Creek Resources, Byron Creek Collieries and Westar Mining have all received the BC Mine Reclamation Award for superior achievement. Several metal mines—Highland Valley, Brenda, Similco and Craigmont—have restored grazing land on waste rock dumps and tailings ponds, much of which is now used by local ranchers. Equity Silver Mines is successfully treating a serious ARD problem, and has placed a $38 million security with the government.

These industry success stories have been achieved in cooperation with government agencies, the public and academic/research organizations. Public liaison committees have worked effectively to solve closure difficulties at the Equity Silver, Brenda and Sullivan mines. Several BC consulting firms have developed international expertise in the prediction, prevention and control of acid rock drainage.

In spite of such successes, the province has a legacy of historic mining sites and is currently contributing to the clean–up of abandoned properties, including ARD control at Mount Washington on Vancouver Island. Most major mines still in operation do not have the financial security in place to fully cover their outstanding reclamation work. The government is taking steps to address this situation. In the meantime, the majority of mines that are now underfunded are perceived to be low–risk for default, to the extent that they are financially sound and are progressing with their reclamation work.

Recent Events

Recent events have highlighted the need for policy development in mine reclamation, notably:

- *Rising Security Levels*—Since 1985, the province has been increasing its funds set aside for reclamation work. For BC's major mines, the total amount of reclamation security held by the government has grown by ten times to $120 million. Nonetheless, most mines remain underfunded in terms of their expected reclamation costs. It is estimated that the total liability represented in the reclamation plans of these mines lies somewhere between $300 and $500 million.

- *Security Instruments and Tax Changes*—For several years now, provincial governments and industry have been working on the concept of special Mine Reclamation Funds, which would operate like trust funds. This new form of security is meant to ease the financial burden of companies facing a long–term reclamation problem (e.g. ARD), especially single mine companies. In recent changes to the *Income Tax Act*, the federal government has made contributions to such funds tax–deductible. Industry continues to argue that, for funds to be a viable security instrument, fund earnings must be sheltered from tax.
- *Company Bankruptcies*—In 1992, Cassiar Asbestos Corporation and Westar Mining Limited entered bankruptcy with large unsecured reclamation liabilities. The mines were subsequently sold and the new owners agreed to address the province's reclamation concerns. Despite the favourable outcomes, as well as closure successes at other BC mines, these examples point to the potential vulnerability of public funds when a company can no longer meet its reclamation responsibilities.

Government Initiatives

Reclamation policy has been addressed through a number of national and provincial initiatives. At their 1992 conference in Whitehorse, Canada's mines ministers launched an effort to ensure the continued health of the mining industry into the 21st century. The Whitehorse Mining Initiative (WMI) brought together members from industry, government, labour, aboriginal peoples and environmental groups to develop a strategic vision for Canadian mining. A recent accord included principles for environmental protection and reclamation, the endorsement of a flexible regime for both reclamation standards and security, and recommendations for the tax deductibility of mine reclamation funds.[4]

Also at the national level, an Intergovernmental Working Group (IGWG) helped to estimate the environmental liability arising from acid rock drainage at Canada's metal mines. Over the long term, the total liability was estimated at $5.2 billion. In addition, the IGWG examined the financial capability of Canadian mines to absorb

4 The Whitehorse Mining Initiative Leadership Council, *Searching for Gold: The Leadership Council Accord*, 1994.

increased security requirements. It concluded that, in order to generate additional funds for reclamation, the mining industry as a whole would have to curtail dividends or raise more capital.[5]

Here in BC, the government released a policy overview on mine reclamation in September 1991.[6] Since then, it has investigated Mine Reclamation Funds and the taxation and management issues surrounding them. In Spring 1993, a government–industry working group was struck to review alternative forms of reclamation security and related issues of reclamation risk. The committee's findings are presented in a new ministry report, *Reclamation Security in British Columbia.*[7]

At the September 1994 Mines Ministers' Conference in Victoria, representatives from industry and government discussed the status of reclamation policy in Canada. As follow–up to its WMI commitment, the province subsequently announced that it will appoint a Reclamation Task Force as one of the first initiatives under the Minister's Advisory Council on mining. The task force will help develop government policy on specific issues related to reclamation security.

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5 See Mining Association of Canada, *Financial Assurance for Mine Reclamation, Decommissioning and Post Closure Obligations*, September 1994.

6 Ministry of Energy, Mines and Petroleum Resources, *Mine Reclamation in British Columbia: Policy Overview*, 1991.

7 Reclamation Security Policy Committee, 1994.

Policy Objectives

The government's objectives with respect to mine reclamation policy reflect its broader priorities in environmental protection, sustainability, economic development and land use planning. Policy development in reclamation requires a careful weighing of the costs and benefits to society, including environmental impacts, competing land use values, and the jobs and tax revenues from mining activity.

Primary Objectives

In determining reclamation standards and security requirements, the government has three primary objectives in mind:

- *Mine Site Restoration*—To ensure a sustainable mining industry in BC, companies must manage their mine sites in an environmentally sound manner and fully reclaim them after mining ends. The *Health, Safety and Reclamation Code* requires that land and watercourses be restored to at least the same level of productivity that existed prior to mining. In addition, public health and safety must be protected, and any potential discharges which could harm the receiving environment must be controlled and managed.
- *Efficiency and Cost–effectiveness*—Reclamation costs and security requirements can be a major expenditure item for many mines, and can affect economic viability. In the course of negotiating reclamation plans and minimal permits, the government and mining companies seek the most cost–effective way to satisfy mine–specific reclamation requirements. The government's goal is to meet its reclamation objectives with the least financial burden to industry and the minimal administrative cost to the province.
- *Risk Management*—The government seeks "reasonable assurance" that companies will be able to fully reclaim their mine sites at no cost to the Provincial Treasury. Reclamation policy must be designed to limit the exposure of public funds. The province's policy regime is meant, through a combination of regulatory requirements, financial security and incentives to mining companies, to minimize the risk that any residual costs will be borne by the tax-paying public.

Policy Criteria

For the purposes of developing mine reclamation policy, the government considers its three primary goals outlined above, plus several key policy criteria:

- *Flexibility*—Reclamation policies should be based on a flexible approach for achieving requirements, to suit the unique and site–specific features of BC mines.
- *Transparency*—Reclamation requirements should be as clear and predictable as possible, to minimize uncertainty for industry, government and the general public.
- *Integrity*—In keeping with the principles and goals of sustainability, reclamation requirements must reflect society's long–range expectations concerning the environment, land use and public health and safety.
- *Fairness*—Reclamation policies should be sensitive to their impacts on the mining industry in terms of the financial burden on companies, individual project economics, overall industry competitiveness and consistency in the treatment of mines.
- *Incentive*—Mining companies should be given the right incentives to remain committed to cost–effective reclamation throughout the mine's life and after closure.
- *Administrative Ease*—Reclamation policies should incorporate efficient administrative procedures, which minimize the financial costs and resources for both government and industry.
- *Public Acceptability*—The processes for setting province–wide reclamation requirements, and for planning and implementing programs at individual mine sites, must be transparent and accessible to the public, and must lead to reclamation requirements that have public support.
- *Accountability*—Reclamation performance in BC must be monitored and reported on a regular basis, and in a manner which allows both the public and industry to assess the effectiveness of the province's requirements.

Reclamation Requirements

Since 1969, the government's approach has been to set broad reclamation objectives, and then to negotiate mine–specific requirements through the review of reclamation plans and issuing of permits. The philosophy behind this approach is that every mine is unique and, therefore, reclamation requirements must be tailored to suit the site specifics. Broad reclamation objectives are outlined in Part 10 of the *Health, Safety and Reclamation Code.*

Broad versus Detailed Requirements

The main advantage of BC's current reclamation regime is that industry appears comfortable with broad objectives, which give mining companies some latitude in finding the best ways to meet them. As well, this high–level approach can be managed within the government's existing resources for mine reclamation.[8] However, the process of reviewing reclamation plans, setting permit conditions and enforcing these conditions can pose an administrative challenge, since government staff must have a thorough understanding of each mine's individual circumstances. While the current approach is flexible, it does not ensure consistency across mines, given that final reclamation requirements are negotiated with each mine.

As an alternative, the government could develop specific technical standards, as used by the federal US Bureau of Mines and other mining jurisdictions. This approach would produce a detailed manual laying out precise requirements and responsibilities for all aspects of mine reclamation.[9] Explicit standards would be more transparent for industry and easier for government to regulate. However, they would not recognize the considerable variation in reclamation costs from one mine to the next, and site–specific opportunities to minimize these costs.

The government favours a compromise that combines broad reclamation objectives with more detailed requirements for certain reclamation issues. Explicit technical standards can be expensive to develop and can impose administrative and other costs on mining companies. By developing specific requirements in a controlled way, the government can use existing staff, focus on key areas where consistent standards are needed, and avoid the inefficiencies that may result from excessive standardization.

8 The ministry currently has a staff complement of seven people who handle all aspects of reclamation for major mines in the province.

9 For example, the broad objective of returning sites to an acceptable level of productivity could be specified in appropriate units for agriculture, forestry and other land uses, given site specifics related to geology, topography, climate, etc. Stability requirements for waste rock dumps could be expressed as maximum slope angles.

Moving Goalposts

The mining industry is concerned that, over time, government will continually tighten reclamation requirements, or "move the goalposts" on regulation. This can be problematic for existing mines, whose economics were determined under a less stringent regulatory regime.

The province's current practice for reclamation security is to set security levels based on estimated reclamation costs, and then to refund surpluses (i.e. security held in excess of actual costs) to mining companies as they arise. The goal is to encourage efficiency and innovation so that reclamation objectives can be met at minimum cost. Industry is concerned that the government will simply increase its reclamation requirements to absorb any surplus security. In such a regulatory environment, the benefits to the company from efficient and innovative reclamation work would be offset by the costs of complying with higher requirements. This is of particular concern to mines that will have long term post–closure reclamation programs.

In order to alleviate industry concerns, the government has to be clear about its requirements for reclamation and environmental protection. To this end, explicit reclamation standards are desirable.

Economic Considerations

At present, all mining companies are expected to meet the province's reclamation objectives as part and parcel of their business. Satisfactory reclamation and environmental protection at the mine site is a legitimate cost of mining like any other. Companies must factor the capital and operating costs of meeting reclamation requirements into their mine investment decisions. If an operation cannot meet certain basic objectives— consistent with a socially and environmentally acceptable mining industry—then the mine should not be approved for development.

To date, the setting of reclamation requirements has not explicitly taken into account economic considerations. For example, mine–specific requirements have not been subjected to any kind of formal cost–benefit analysis to determine whether they are justified on economic grounds. In practice, however, economic factors have an influence informally, through the negotiation process for reclamation plans and permits. Often during these negotiations, mining companies and the government consider a range of reclamation options to find the most cost–effective approach.

Reclamation can be very expensive and, in some cases, the costs may outweigh the apparent benefits in terms of environmental protection or restored productivity. There is concern that too stringent reclamation requirements may render new mining projects uneconomic and reduce overall industry competitiveness. Reclamation requirements must be designed to ensure efficiency and cost–effectiveness, while meeting appropriate environmental and social policy goals.

Public Involvement

The general public must have a say in the determination of mine reclamation requirements, if these requirements are to reflect society's changing values and the concerns of local communities. Although there has been a history of multi–stakeholder collaboration in researching techniques, developing policies and setting requirements for reclamation, participants have tended to be experts from industry, government and academia, with limited public involvement. At the permitting stage, the reclamation permit applications for many mining operations are advertised in local newspapers and the BC Gazette, but generally this elicits little public interest or input. Recently, the government has made changes to the MDAP to allow for better public involvement.

Where specific mines have developed serious closure problems, public liaison committees have been used successfully to increase public awareness and ensure local community input. These committees draw their membership from local government and business, environmental organizations, labour, aboriginal groups and other interests. They allow the community to review mine closure and reclamation plans, and to provide input on specific reclamation options and requirements. Public liaison committees have worked effectively for the Equity Silver, Brenda and Sullivan mines.

In addition to public involvement, there is a need for accountability, both in developing reclamation policy and in monitoring and reporting reclamation performance. In the past, the public's awareness of reclamation issues, as well as the reporting of performance, has been erratic. Statistics are currently compiled on the amount of land disturbed by mining, the amount so far reclaimed, ultimate land use objectives of major mines, and total security held by the province. When released, these statistics and other records on mine reclamation achievement in BC tend to be dated and poorly distributed.

Government Policy

The province will maintain its current policy of deriving mine–specific requirements from the broad reclamation objectives in Part 10 of the Code.

A flexible approach to setting reclamation requirements has worked reasonably well to date in BC. Broad objectives provide industry with the appropriate incentives to minimize costs and seek out innovative reclamation techniques. Explicit technical standards will not be pursued for all aspects of mine reclamation.

Detailed province–wide requirements will, however, be developed for specific reclamation issues, as needed.

Separate reclamation guidelines have already been issued for coal and mineral exploration, sand and gravel pits and quarries, and ARD prediction and control.[10] Similar guidelines will be developed in other areas, including placer mining and resloping angles for waste rock dumps. The province recognizes that the use of explicit standards in selected areas can provide greater certainty to industry with regard to reclamation requirements.

The government will examine and evaluate opportunities for detailed technical requirements, as part of its ongoing Code review.

Under the *Mines Act*, the *Health, Safety and Reclamation Code* must be reviewed regularly to ensure that it keeps up with changes in technology, worker and public hazards, and society's environmental concerns. A technical committee on reclamation, including experts from industry and academia, will review the province's ARD Guidelines, as well as upcoming ministry discussion papers on resloping angles for waste rock dumps and specifications for land use and productivity. The committee will also investigate criteria for the stockpiling of topsoil to restore waste dumps and tailings ponds to productive use.

The government will improve its policies for public input into determining reclamation requirements through public involvement in the Code Review Committee.

Currently, the code review for health and safety matters is conducted by a tripartite committee of industry, labour and academic representatives. A broader–based committee will be established to deal with issues of reclamation and environmental protection.

Public liaison committees will continue to be established for mines with reclamation issues of significant concern to the public.

These committees allow local stakeholders to have effective input into mine closure and reclamation planning, in a more cooperative relationship with government and industry. They are flexible in that their structure and meeting format can be tailored to the particular community's needs. Public liaison committees have also proved successful as communication channels for increasing public awareness of reclamation issues.

10 See for example William Price and John Errington, *ARD Guidelines for Mine Sites In British Columbia*, 1994.

The ministry will publish statistics and reports to better account for reclamation performance in BC, and for its own reclamation policies and procedures.

Statistics on mine reclamation will be released on a more timely and comprehensive basis. This discussion paper, the report of the Reclamation Security Policy Committee and the ARD Guidelines are all examples of recent efforts to inform, as well as solicit input from industry, the public and other stakeholders.

TYPE OF SECURITY REQUIRED

At present, the forms of reclamation security accepted by the government are limited—primarily cash, Canadian government bonds and irrevocable letters of credit. These securities meet the government's General Management Operating Policy (GMOP), which identifies financial instruments that are generally acceptable to the province. In recent years, the mining industry has been arguing for a broader range of acceptable instruments. A government/industry working group was formed in early 1993 to review alternative forms of security and advise the province on appropriate instruments.[11]

Hard and Soft Security

There are two basic categories of reclamation security, depending on how liquid the financial instrument is and how certain its value when liquidated. "Hard" security (e.g. letters of credit) are reasonably liquid and certain in their value, while "soft" security (e.g. parent company guarantees and pledges of assets) are less liquid and certain in their value.[12]

The government prefers hard security instruments because they give better assurance that funds will be easily available, and in the full amount needed, when reclamation work must be done. This helps the province limit its financial exposure in the event that mining companies default on their obligations. Requiring hard security in every case meets the criteria of a transparent, consistent security policy in which all mines are treated the same. Also, the government avoids the administrative problems of having to assess the financial risks associated with softer instruments. All other things being equal, the mining industry prefers security instruments that are lower cost. If security is funded out of the company's working capital, then there may be a significant impact on project economics. Consequently, hard security can pose a problem during mine start–up, when companies often have limited capital. The burden can be especially onerous on the many smaller mining companies ("juniors") which form an important part of BC's industry structure.

11 See Reclamation Security Policy Committee, op. cit. The discussion here is taken largely from the Committee's report.

12 For example, a pledge of physical assets could be hard to liquidate and the government could end up with a low value if forced to sell the assets quickly.

What the Government Can Accept

Under the *Mines Act*, the province has some leeway in determining acceptable forms of reclamation security.[13] The government is willing to consider additional instruments than those currently accepted, in the interests of fairness and flexibility. Based on a preliminary review by the Reclamation Security Policy Committee, further consideration will be given to Mine Reclamation Funds, surety bonds and captive insurance vehicles. All of these hard instruments require extensive development if they are to be applied to specific mine reclamation cases in BC.

The government is also willing to entertain the use of softer security instruments in certain circumstances. To minimize its financial exposure, the province should only consider accepting soft security where the risk of default is relatively low. Examples include where: reclamation costs are moderate and predictable; the mine is profitable, with robust cash flows; and the mining company is diversified or has a good financial track record.

Mine Reclamation Funds and Taxation Issues

Since 1988, the province has been investigating Mine Reclamation Funds (or Cash Trust Funds) as one alternative security instrument. These funds could satisfy provincial security requirements and provide individual mines with the income from which to finance post–closure reclamation work. They were enabled by an amendment to the *Mines Act* in 1989, with tax deductibility allowed for under the *Mineral Tax Act*. Mine reclamation funds were officially created by Order–in–Council in August 1994.

Although the mining industry supports the concept of mine reclamation funds, it is concerned about the federal government's decision to tax fund earnings. The federal Income *Tax Act* specifies that contributions to a fund are tax–deductible, but the income earned over the fund's life is considered taxable. The Act also specifies that reclamation costs can only be deducted in the period in which they are incurred.

Since most reclamation expenditures occur after the mine has closed, companies are often prevented from deducting costs against resource income. Industry views the sheltering of fund income as a critical feature if mine reclamation funds are to become a practical security instrument.

13 The Act gives the Chief Inspector of Mines discretion over what form of security to accept. It is not bound by either the *Bonding Act* or the *Finance and Administration Act* under which the GMOP guidelines fall. In practice, however, the ministry has been reluctant to allow any instrument that does not satisfy GMOP.

Other Forms of Assurance

Other potential forms of assurance that could provide security in the period before closure include claims on mine or corporate assets and some measure of the company's financial standing. At present, the government does not have the authority to make a claim against residual mine or corporate assets if a company goes bankrupt and defaults on its reclamation obligations. Such a policy would require changes to the *Mines Act*. The main difficulty with claims on assets are the competing claims from other creditors—for example, from employee salaries or income taxes owed.

The government could develop a "risk rating" scheme for each mine reclamation situation. This scheme would assign a rating depending on the estimated reclamation cost and its uncertainty, mine profitability, the company's financial track record and other risk factors. These factors would have to be monitored over time, to ensure that the risk rating did not change significantly.

Government Policy

The government will work with industry to expand the range of acceptable security instruments, in order to provide greater flexibility in reclamation funding.

The province will consider new or untried forms of security that are potentially acceptable to both government and the mining industry. In particular, it will investigate and develop specific hard security instruments—surety bonds, captive insurance vehicles and mine reclamation funds. In addition, it will examine softer instruments, such as parent company guarantees and pledges of assets, for use as a temporary form of security during mine operation.

The government and the mining industry will work with insurance companies to develop a customized surety bond for mine reclamation work.

Surety or insurance bonds[14] are an existing type of hard security that meets the GMOP guidelines. They are currently not accepted for mine reclamation in BC because of past experience in which insurance companies successfully challenged government claims against these bonds. To mining companies, however, surety bonds can be lower cost than other hard security instruments. These bonds are common in the construction industry, and have been adapted to environmental protection issues in other jurisdictions (e.g. New Brunswick).

14 A surety bond is a guarantee by an insurance company that it will meet all reclamation commitments if the mining company fails to complete its work as planned.

Government and mining representatives will also approach the insurance industry to explore options for mine reclamation insurance.

Generally, there are no insurance policies readily available to cover reclamation costs, especially long–term costs. But the insurance industry has expressed some interest in this area and could consider custom designing an insurance instrument to meet government requirements for reclamation. A captive insurance company offers one vehicle for managing reclamation risk in a regulated financial environment[15] Much work needs to be done, however, to assess the viability and design of insurance instruments for different aspects of reclamation and post–closure issues.

The ministry supports the concept of Mine Reclamation Funds.

These funds offer a flexible mechanism for providing reclamation security and income over the long term. They ensure the mining company's ongoing involvement in post–closure reclamation. Mine reclamation funds offer tax incentives to industry, since contributions to the funds are tax–deductible; fund earnings, however, remain taxable in the hands of companies. The ministry, along with the mining industry, believes that the income earned in the fund should be considered a contribution to capital and, therefore, non–taxable.

The ministry views the development of workable Mine Reclamation Funds as essential for single mine companies with long–term reclamation problems (e.g. ARD).

Mine reclamation funds could allow the mining company to provide for post–closure reclamation work out of the mine's operating income. This is crucial for single mine companies confronted by a long–term reclamation problem, such as acid rock drainage. Development of a security instrument to deal effectively with such difficult and costly environmental problems is a top priority for provincial mine reclamation policy.

Work will proceed to define a tax–deductible fund instrument, and to resolve other outstanding issues.

This ministry will continue to work with the Ministry of Finance and Corporate Relations on the treatment of mine reclamation funds under federal income tax legislation. Furthermore, government and industry will cooperate to address some other practical issues including: a fund structure to appropriately share risk between mining companies and the province; a process for fund management; legal rights and responsibilities of the parties; and a mechanism to protect the funds from competing claims in cases of company default.

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15 A *captive insurance company (captive)* is a separate corporate entity created to self–insure all or part of the risks of an organization or group of organizations. In BC, all insurance companies are regulated by the Financial Institutions Commission.

The government will investigate soft security instruments and other non–traditional forms of assurance, and will determine the conditions under which they would be acceptable.

In particular, the government, in cooperation with industry, will develop the concepts of parent company guarantees and pledges of assets, as temporary forms of security. It will also examine the potential use of claims on assets, including ways to ensure a government priority among competing claims and legislative changes that would be needed to accommodate these claims. Finally, the government will investigate a risk rating scheme to be applied to individual mine reclamation cases, including procedures for monitoring the mine ratings over time.

Responsibilities of the Task Force

The Reclamation Task Force will help develop policy on the types of security that may be acceptable to government, and under what conditions. In doing so, it will examine the risk and taxation implications of each security instrument. Its work will build on the findings of the Reclamation Security Policy Committee, and will focus on the practical matters involved in bringing specific instruments, such as mine reclamation funds and surety bonds, to fruition.

Amount of Security Required

The amount of funds that should be set aside for mine reclamation is perhaps the most pivotal issue for reclamation security policy. Prior to 1990, there was a legislated limit on the amount of security that could be held by the province ($2,500 per hectare of mine disturbance). In recent years, this dollar restriction has been removed, and security levels have been rising to better reflect the expected reclamation costs at BC mines.

Estimation and Reporting of Reclamation Costs

Mining companies prepare detailed cost estimates as part of the reclamation planning and permitting process. These cost estimates are to be reviewed regularly by the company and the government's Reclamation Advisory Committee. Having industry estimate costs is an efficient approach, since it is most familiar with its reclamation plans, mine operating conditions and opportunities for cost savings. The government will perform cost estimation on a selective basis—that is, when industry estimates are disputed, costs are technically difficult to predict (e.g. ARD control), or periodic audits are being conducted of industry estimates.

Currently, mining companies use their own highly variable methodologies and formats to estimate reclamation costs. The ministry is developing a computerized spreadsheet to help standardize cost estimation. This spreadsheet will make it easier for the ministry to compare cost estimates across mines, identify costing anomalies, improve the accuracy of industry estimates, and disseminate information on cost–effective reclamation techniques.

At the present time, companies are obligated under current accounting rules to report reclamation security in their balance sheets only when the amount of security has been firmly established. The province is moving to tie down its security requirements and to require "full security" from mines prior to closure. As a result, the government needs to clarify reporting rules, to provide more certainty to industry and ensure that company statements reflect their true financial situations.

Resolution of Cost Disputes

While the costs of "finite" reclamation work (e.g. site clean–up and waste dump stabilization and revegetation) can be relatively predictable, long–term reclamation costs (e.g. ARD control) are often very hard to estimate with any accuracy. These costs are a complex function of biological, technical, financial and social factors. As a result, mining companies and the government may produce radically different cost estimates for long–term reclamation work. Where costs are highly uncertain, and government and industry differ in their estimates, a mechanism is needed to and government and industry differ in their estimates, a mechanism is needed to resolve the discrepancies. The province has used both facilitation and independent auditing to resolve disputes in the past.

An example is given by the Equity Silver mine near Houston, which faces a serious acid rock drainage problem. Here, the mining company and the government had widely disparate cost estimates for the reclamation work required. To help bridge the gulf, the parties brought in an independent facilitator. This facilitated government/industry review was deemed a success by the participants.

Reasonable Assurance

Reclamation work, and its associated costs, are the responsibility of mining companies in BC. This is consistent with the principle of polluter pay, whereby industry is held accountable for the environmental harm caused by its actions. To the maximum extent possible, the province wants to avoid the risk that a mining company will default on its reclamation duties, and taxpayers will have to fund a portion or all of the remaining work.

In practice, it is not realistic for the province to have ***absolute assurance*** (zero risk) that it will bear no reclamation costs. Mine reclamation is an uncertain business, and there is always the possibility of remote, unforeseen events that could significantly increase costs. Without private insurance for reclamation, setting security requirements to cover all of these remote occurrences would put an overwhelming financial burden on mining companies. The social costs in terms of reduced industry competitiveness, employment and tax revenues would outweigh any benefits from the high security levels. Therefore, zero risk to the province is neither practical nor desirable.

The province's working objective is to have ***reasonable assurance*** (minimal risk) that in all reasonably foreseeable events it will not have to contribute to reclamation costs. As long as the amount of reclamation security is carefully determined, with the right incentives for companies to complete their work, then a certain amount of risk on the margin is acceptable.

Risk Assessment

To provide reasonable assurance, the amount of security must be such that it covers the mine's expected reclamation costs plus a risk premium. This premium is justified by the asymmetric risks facing the province.[16] The extent of the premium will

16 Specifically, if the security exceeds actual reclamation costs, then the province refunds the surplus to the mining company. But if the security is less than actual reclamation costs, and the company lacks the resources to fund outstanding reclamation work, then the province must make up the difference. Its risks are "asymmetric."

depend on the individual mine's circumstances—the predictability of reclamation costs, their distribution over time, etc. Determining the premium requires a technical risk assessment to evaluate the probabilities and outcomes of alternative scenarios.

Where post–closure reclamation occurs over a long period (e.g. ARD control), the risk assessment should consider the impacts of inflation, fluctuating investment yields, technological progress, changing environmental standards and other variables on reclamation costs. In 1991, the government and Equity Silver Mines cooperated in a risk analysis to determine an appropriate level of reclamation security. Their analysis, which focussed on the rate of acid rock drainage, produced a 40 percent range between the minimum and maximum scenarios. The province chose the maximum scenario for setting the level of security.

Once the risk assessment has been made, and the amount of security determined, then the provision of security should not give rise to unintended risks to the government. It is the role of financial institutions to assess the risk of company default and set an appropriate fee for issuing the required security. Reasonable assurance can be provided by the traditional security instruments (e.g. letters of credit) and, potentially, by other forms of assurance (e.g. pledges of assets). Some combination of these assurances may be acceptable to the government under specific circumstances.

Exit Tickets

Mining companies would like to be able to surrender mineral title and all liabilities for the property to the province once they have met their reclamation obligations. An exit ticket could be an arrangement whereby the company would first develop, operate and fund a satisfactory post–closure reclamation program. Subject to provincial approval, another company or the government would then agree to accept the liability and manage the reclamation plan, in return for compensation. The original mining company would be discharged from any further responsibility or liability, except in cases of fraud.

The advantages of the ***exit ticket*** concept are that risk could be transferred to firms specialized in reclamation, properties could be freed up for exploration, and mining companies could move on to other economic opportunities. The main drawback relates to provincial risk in cases of long–term environmental problems (e.g. ARD). The province may not be willing to discharge companies from their liabilities, given the risk that environmental problems may emerge many years after closure.

The Whitehorse Initiative examined exit tickets and concluded that they should be granted under the following conditions: the mining company has completed all work specified in the reclamation plan; adequate security has been provided to cover expected long–term costs; and a risk–based security fund is in place to account for unexpected costs and changing standards.

Government Policy

Mining companies will continue to have primary responsibility for preparing their reclamation cost estimates, based on detailed technical studies.

A policy of requiring industry to estimate its own reclamation costs is the most efficient one. Companies will continue to prepare cost estimates on the basis that they will perform all work (pre–closure and post–closure) themselves, according to the manner and schedule laid out in the reclamation plan. This will encourage the company's ongoing commitment, and will provide the appropriate incentives for cost–effective and innovative reclamation work.

The ministry will promote the use of a computerized generic spreadsheet to enable detailed cost studies and comparisons.

There are benefits from a standardized electronic spreadsheet, in terms of ensuring consistency and completeness and allowing for better comparisons across mines. A consultant has prepared a prototype "Made–in–BC" spreadsheet, based on reclamation costing at three different test–case mines (Fording, Gibraltar and Sullivan). This prototype will be further developed and refined to make it applicable to all major mines in BC.

The province will consider facilitated reviews where there are substantial differences between industry and government cost estimates.

As used in the case of Equity Silver, the government is willing to employ the services of an independent facilitator to narrow the range of reclamation cost estimates. The mining industry has expressed its desire for a more structured process with facilitation first, followed by mediation and arbitration. However, the government will retain its authority over determining the final level of reclamation security. An arm's length dispute resolution mechanism, such as formal arbitration, would impinge on that authority.

The government may also commission independent cost audits, if it questions mining company estimates.

An example would be where the estimated value of an asset—say, a building or piece of physical equipment—was significant. The government could then require a regular (annual) evaluation of the assets' value by an independent expert.

Mining companies will be directed to estimate reclamation costs based on premature closure scenarios.

BC's recent mining history includes a number of precious metal mines that have closed prematurely due to weak commodity prices or geological difficulties. When mine operations are cut short, the outstanding reclamation work can cost much more than originally estimated, resulting in a security shortfall. All mines will be required to estimate costs based on a premature closure, followed by a contractor completing the work. This requirement may be relaxed over time, as mine operations become more economically stable and technically proven.

To ensure reasonable assurance (minimal risk), the province requires an amount of security sufficient to fully cover estimated reclamation costs plus a risk premium.

Reclamation costs are to be estimated using detailed engineering and technical studies. Risk premiums should be determined based on formal risk assessment procedures. It is expected that the risk premium will decline through time, as reclamation costs become better understood.

To provide more certainty to industry, the government will develop standards for carrying out risk assessments.

The province's goal is to avoid arbitrary, mine–by–mine risk assessments and ensure greater certainty and consistency in the estimation of reclamation security. Therefore, it will develop guidelines for the determination of risk premiums, with input from the Reclamation Task Force.

The province will continue its current practice of returning security surpluses to mining companies, and factoring salvage values into the determination of security requirements.

The policy of returning, on application, any security which is surplus to the province's requirements helps encourage companies to reduce reclamation costs through efficiency and innovation. The government does not require reclamation security where the cost of removal exceeds the estimated salvage value of assets. An independent appraisal is required annually to assess both the salvage value and the removal cost in such cases.

The ministry is willing to look further at the concept of exit tickets to release mining companies from their long–term reclamation responsibilities.

Currently, provincial law would not permit the use of exit tickets. While there is nothing in the *Mines Act* to prevent them, the *Waste Management Act* does not allow industry to shed its environmental liability. As an untried concept, exit tickets require a great deal of development work to determine how they would work in practical terms. Despite the current legal constraints, the ministry is willing to discuss exit tickets further, given strong interest by industry.

Responsibilities of the Task Force

The Reclamation Task Force will help develop policy on the amount of reclamation security as follows:

- *Estimation and Reporting of Reclamation Costs*—The Task Force will review the current approach to estimating costs in BC, and will recommend any necessary changes. Its review will focus on the use of computer spreadsheets and other opportunities to standardize cost estimation, to ensure greater consistency across mines. It will also recommend requirements for reporting reclamation security in company financial statements.
- *Dispute Resolution*—The Task Force will examine procedures for resolving disputes when government and industry disagree over reclamation cost estimates. The government seeks an effective compromise between mine–specific lobbying and a formal mediation and arbitration process.
- *Risk Assessment*—The Task Force will develop guidelines for determining the risk premium to be attached to expected reclamation costs. It will consider any differences in methodology for a single mine versus a multi–mine company.
- *Exit Tickets*—The Task Force will investigate the role of exit tickets to determine their appropriateness for BC. It will examine the practical requirements needed to make exit tickets work in the province.

Required Timing of Security

Another important issue for mine reclamation policy is the timing of when security deposits must be made. The mining industry is concerned that it be allowed to adjust adequately to the government's rising security requirements. The government, for its part, is willing to be flexible in allowing companies to provide the necessary reclamation security.

Full versus Partial Security

The province is working towards the goal of requiring full security from existing mines before closure. ***Full security*** is defined as hard security to cover the full amount of the expected costs of outstanding reclamation work, plus a risk premium, at the specific point in time (closure or earlier).

In the past, the government has accepted less than full security, or ***partial security***, from companies which it considers to be low–risk for default. Typically, these are companies that are in good financial health and are keeping up with their reclamation plans. In addition, arrangements have been made with the Job Protection Commissioner to delay bonding requirements, where the province's interest is best served by having the mine start up or continue operation. In some cases, such as the Sullivan mine, security has been required for a long–term acid rock drainage problem, but not for finite reclamation work.

The recent bankruptcies at Cassiar and Westar Mining are a reminder of the potential risks associated with partial reclamation security.

Timing and Transition Issues

The timing of full security is critical for both new mines and existing operations. In general, new mines are better equipped to deal with the adjustment to full security, since higher security requirements can be factored into their decision on project viability. However, an immediate move to full security ("front–ending loading" of requirements) can be difficult for companies with limited start–up capital, especially those in the junior mining sector. As a result, industry would prefer to see a flexible approach that allows security to build up over the mine's life.

For existing operations, the adjustment to full security can be more difficult, given that the mines were planned and financed under lower security requirements. The economics of marginal operations will be especially impacted. Clearly, the province wants to avoid a transition to full security that would threaten industry competitiveness. For this reason, it has been gradually phasing in the requirement for increased security levels.

The government is willing to consider arrangements that would see full security (hard security) accumulate during mine operation, with softer instruments and other assurances used as temporary forms of security (see Figure 1). While these temporary assurances would not be preferred from the standpoint of provincial risk, they could be acceptable in cases where the mine appears profitable, the company is in good financial standing, and reclamation work is progressing satisfactorily. The province might accept some small degree of risk in exchange for the benefits of a more financially secure mining industry.

Government Policy

Full security, in the form of hard security instruments, will be required from all mines before closure.

A policy of full security (equals hard security) minimizes the province's financial exposure. It also provides mining companies with the right incentives to do progressive, efficient reclamation work and to seek out innovative technologies and reclamation methods.

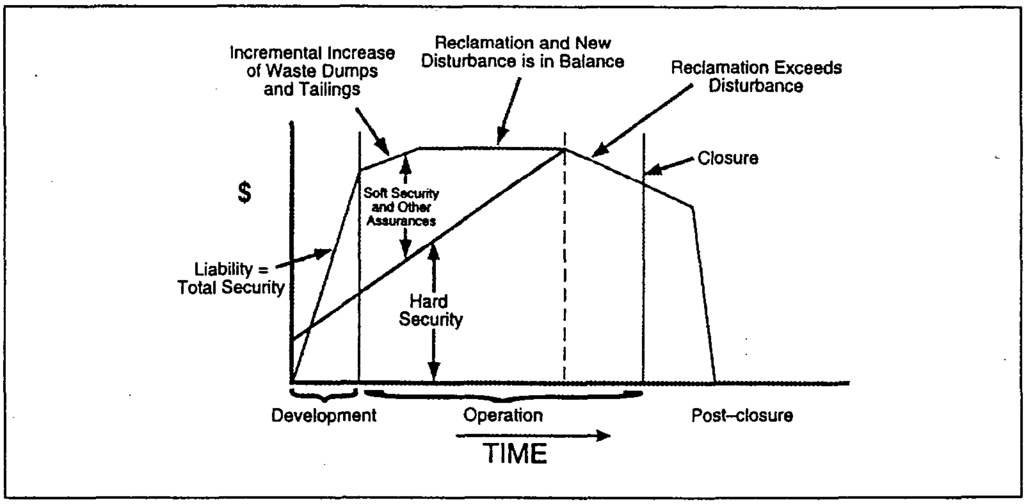

Figure 1: Reclamation Security—Timing and Transition

For simplicity, this figure shows the expected reclamation liability for a new mine whose reclamation work ends just after closure (finite reclamation). The expected liability varies over the mine's life as the extent of disturbance increases. At some point, new disturbance is balanced by completed reclamation work.

The government could consider arrangements whereby a share of the company's security requirement would be provided out of softer instruments and other assurances (e.g. pledges of assets and a favourable mine risk rating) during the mine's operating life. The share would decline over time, as income was generated to provide hard security. Before closure, all of the security requirement would have to be met by hard instruments (full security).

To ease the impact on existing mines, the province will phase–in its requirement for full security.

In recent years, the government has been gradually amending reclamation permits to increase the security required from existing mines. It will continue to do so, towards achieving a full security policy for long–term operations by 1997. This phase–in is meant to reduce the burden on mines which were planned under lower security requirements. All new mines, however, will be immediately required to provide full security.

Responsibilities of the Task Force

The Reclamation Task Force will develop guidelines on when the different types of security instruments (hard and soft security, other assurances) may be allowed prior to closure. It will also review and make recommendations on the government's timetable for moving existing mines to full security, in order to give industry a "fair" time period for adjustment.

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REPORT OF THE
EQUITY SILVER MINES LIMITED
TECHNICAL COMMITTEE

March 31, 1991

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CHAPTER ONE

INTRODUCTION AND TERMS OF REFERENCE

> Equity Silver Mines Limited (the Company) owns and operates a silver-gold-copper mine approximately 30 km southeast of Houston, B.C. Operation of the Equity Mine has given rise to a condition known as acid mine drainage. To prevent major environmental impacts on downstream resources, Equity will be required to collect and treat acid mine drainage for a considerable period after the mine's expected closure in 1992.

> The Ministries of Energy, Mines and Petroleum Resources and Environment have been holding discussions with the Company for over two years to determine the amount of funds necessary to ensure sufficient securities are available at closure to provide for long-term collection and treatment of acid mine drainage.

> During the last two years, five estimates of the annual cost have been made, three by consultants, and two by Equity. These estimates have varied from $1.28 million to $2.4 million. Discussions have identified three areas of uncertainty: the lime consumption costs; sludge disposal costs; and, road maintenance costs.

> In January 1991, a Technical Committee was formed to identify and resolve outstanding differences between the government and Equity staff. **Our task was to establish an unbiased probability distribution of expected long-term, post closure reclamation costs.**

> The Committee was composed of representatives of Equity Silver Mines Ltd., the Ministry of Environment and the Ministry of Energy, Mines and Petroleum Resources. The group was assisted by an independent consultant who acted as a facilitator to the Committee. The Committee met six times over a period of three months.

> This document presents the results of the Committee's work. By their signatures on the following page, the Committee members indicate their agreement with the contents of the report.

Equity Silver Mines Ltd.

Brian Robertson

Bob Patterson

Ministry of Environment

Terry Roberts

John Ward

Ministry of Energy, Mines and Petroleum Resources

Ralph McGinn

John Errington

CHAPTER TWO

SUMMARY OF CONCLUSIONS

> The Technical Committee has examined the three outstanding cost issues: road maintenance; sludge disposal; and, acid neutralization/minimization. Based on their resolution of these issues estimates have been made of post-closure reclamation costs.

Road Maintenance

> The cost of maintaining the access road from Houston to the Equity site is no longer an issue. The Ministry of Transportation and Highways has confirmed that it will remain responsible for the road.

Sludge Disposal

> Disposal of low-density sludge into the pit is considered a more appropriate course of action than disposal of high-density sludge into secure land fill sites, for three reasons:

- A report commissioned by the Company provides sufficient comfort that the pit will not turn acid (although some problems with zinc may occur).

- The volume of sludge produced at current rates would require a vast area for land fill sites. Even if sufficient space could be found, opening up of new areas could pose more environmental concerns than disposal into the pit.

- The funds required to construct a high density sludge plant would be better used to help finance efforts to minimize acid and sludge generation.

> For the purposes of costing, the Committee has assumed that the AMD treatment plant will stay in its current location and low-density sludge will be pumped to the pit. Capital costs would be incurred prior to closure.

Acid Neutralization/Minimization

(a) Actual Lime Consumption to Date

> Lime use has been increasing by more that 10% a year over the last 3-4 years. However, waste rock has been added to the dumps each year and lime use appears to be correlated with the amount of waste rock in the dumps.

> Acid production at the #1 Dam site, the only site where the volume of waste rock has not changed, appears to have peaked quickly after the Dam was built and has been relatively constant since that time. The waste rock in the #1 Dam came from the Southern Tail Pit. This rock is known to be faster reacting than the rock from the Main Zone pit. Main Zone waste makes up most of the dumps.

(b) The Time Profile of Lime Consumption

> Based on evidence from other sites and from computer models the Committee anticipates a time profile of acidity that peaks relatively quickly after the mine closes and declines thereafter until reaching a steady level of acid production much lower than the peak.

> Using this same general time profile the Committee has prepared three estimates of lime requirement assuming no additional covers are placed on the dumps. The three scenarios are labelled minimum, most likely and maximum. Exhibit 2.1 shows the peak and low level lime assumptions for each of these scenarios, together with the annual average use of lime over 100 years.

EXHIBIT 2.1
PROJECTED LIME CONSUMPTION - EXISTING COVERS

	Minimum	Most Likely	Maximum
Peak Lime (tonnes)	10,000	12,000	15,000
Low-level Lime (tonnes)	2,000	2,500	3,500
Annual Average Use of Lime (tonnes)	2,650	3,780	5,980

(c) The Impact of a Compacted Clay Cover

> Today the dumps are only partially covered. By installing a compacted clay cover over the dumps the Company can expect to reduce substantially the amount of acid that will be produced. The Committee has estimated the impact of such a cover on the lime required to neutralize the acid -- see Exhibit 2.2.

EXHIBIT 2.2
PROJECTED LIME CONSUMPTION - COMPACTED CLAY COVER

	Minimum	Most Likely	Maximum
Peak Lime (tonnes)	7,500	8,500	10,000
Low-level Lime (tonnes)	600	800	1,200
Annual Average Use of Lime (tonnes)	1,080	1,470	2,270

Post-Closure Reclamation Costs

> Post-closure reclamation costs have been divided into three categories:

> > **Fixed Costs:** - those that will have to be incurred regardless of the volume of AMD to be collected and treated. They include the cost of sludge disposal into the pit and road maintenance.

> > **Variable Costs:** - those associated with collecting, pumping, and treating AMD.

> > **Lime Costs:** - the cost of reagent used in the neutralization process.

> Exhibit 2.3 shows the estimated present value of annual reclamation costs over a 100 year period for each of the three scenarios. It is calculated in 1993 dollars and assumes a 3% discount rate.

> Given the considerable uncertainty surrounding these cost estimates, the Committee has not been able to assign probabilities to them.

EXHIBIT 2.3
COST PROJECTIONS – PRESENT VALUE ($ MILLION)

	Minimum	Most Likely	Maximum
Existing Covers			
Fixed	13.2	13.2	13.2
Variable	4.1	4.1	4.1
Lime	16.9	25.2	39.3
Total Cost	34.2	42.5	56.6
Compacted Clay Cover			
Fixed	13.2	13.2	13.2
Variable	1.2	1.2	1.2
Lime	8.4	11.5	17.7
Total Cost	22.8	25.9	32.1

CHAPTER THREE

ROAD MAINTENANCE

Introduction

> In their estimate of post-closure costs, the Company has assumed that the road from Houston to the Equity site will continue to be maintained by the Ministry of Transportation and Highways.

> The SRK report[1] estimated an annual cost of $90,000 if the road were to become the responsibility of the company.

Clarification of Responsibilities

> The company has now received written confirmation from Mr. G.L. Freer (District Manager, Burns Lake) of the Ministry of Transportation and Highways[2] that the Ministry will "continue to be responsible for the road maintenance on the Equity Road". However, given the lower level of traffic on the road after closure, the ministry has indicated that "the standard of maintenance will be reduced to an appropriate level".

Conclusions

> The maintenance costs of the Equity access road are no longer an issue.

> Included in post-closure costs is $20,000 for annual maintenance of roads on the Equity property.

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[1]Steffan, Robertson and Kirsten (SRK) produced one of the consultants' reports on acid mine drainage at the Equity Site.

[2]Mr. Freer's letter is in the Appendices.

CHAPTER FOUR

SLUDGE DISPOSAL

Introduction

> In estimating post-closure costs, the Company has proposed that low-density sludge be placed into the Main Zone pit. A concern has been expressed over long term stability of the metals in the sludge if the pit waters became acidic.

> Disposal of high density sludge into secure land fill sites has been identified as an alternative method of sludge disposal.

> The Committee has examined the potential impact of disposal into the pit and has compared the low density and high density approaches.

Disposal of Low Density Sludge Into the Main Zone Pit

> The Company commissioned a report from Norecol Environmental Consultants Ltd. on the water quality issues associated with disposal of low density sludge into the Main Zone pit. Based on two types of sludge stability tests, the Norecol study[3] concluded that "the Main Zone pit will provide a suitable long-term (more than 150 years) sludge disposal site". The Committee has reviewed the findings of the Norecol study and accepts this conclusion.

> Two alternative methods of disposal into the pit were reviewed by the Committee:

- the treatment plant remains at its current location and sludge from the holding pond is pumped to the pit.

- the treatment plant is moved to the edge of the pit and treated water is discharged directly into the pit.

> The choice between the two alternatives is linked to two questions:

- What is the appropriate fill time for the main zone pit? The Committee discussed two possibilities: flooding the pit to the top to minimize acid production on the walls; and, flooding the pit to cover the Waterline Pit waste rock and then filling slowly. The second of these alternatives would allow acid generation to be closely monitored and more easily treated if the water in the pit did turn acid.

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[3]Norecol Environmental Consultants Ltd: Assessment of Disposal of ARD Treatment Sludge in Main Zone Pit, January 1991.

- What are the risks in discharging treated water directly into the pit? Would sufficient safeguards be in place to avoid disposal of a large volume of "off-spec" water into the pit?

> From a cost point of view, the choice between the two low-density alternatives is not significant. For this reason, the Committee did not try to choose between them. At a later date, Equity will present its preferred option as part of its decommissioning plan.

Disposal of High Density Sludge into Secure Land Fill Sites

> The Ministry of Environment representatives were able to assure the Committee that, based on the information received from the Company, the sludge would not be classified as "special waste" and any land fill sites containing the sludge would be acceptable for commercial/industrial uses under the current contaminated sites management policies. With this understanding, the Company was able to cost the high density option using land fill design requirements provided by the Ministry of Environment.

> A major concern with the land fill option is the large volume of sludge. The Main Zone Pit can absorb sludge for over 200 years at current rates of sludge production. Land fill sites to absorb an equivalent volume of high density sludge would cover an area as large as the tailings pond (an area approximately 1,144,000 m^2 assuming the sludge is laid to a thickness of 3 metres).

> It would be difficult to find an environmentally and socially acceptable disposal site other than the Equity property. In addition, long-distance transportation of the sludge could cause environmental concerns. For these reasons, off-site disposal has not been pursued as an option.

Comparison of Options

> For summary purposes, the Committee prepared a comparison of three options:

- low density sludge into the pit - plant remains as is

- low density sludge into the pit - plant is moved to the edge of the pit

- high density sludge into secure land fill sites

> Exhibit 4.1 compares the capital and operating costs of the three options.

> Exhibit 4.2 compares the advantages and disadvantages of each option.

EXHIBIT 4.1
CAPITAL AND OPERATING EXPENDITURE OF EACH OPTION

	Low Density Leave Plant As Is	Low Density Move Plant to Edge of Pit	High Density Secure Land Fill
Work Required	Install pipeline & booster pump	Move to edge of pit Change pipeline & pump stations	Convert existing plant to H.D.S. system
Capital Cost	$200,000	$1,000,000	$4,100,000
Operating Cost ($/m^3)			
Salaries Operating	0.060	0.060	0.213
Salaries R&M	0.030	0.030	0.092
Supplies	0.031	0.031	0.074
Lime	1.020	1.020	0.892
Flocculent	--	--	0.024
Sludge Pumping	0.051	____	0.883
TOTAL OPERATING COST	$1.192	$1.141	$1.378

Note: Operating costs are per m^3 of AMD. Existing acid loading levels have been assumed in estimating these costs.

EXHIBIT 4.2
CAPITAL AND OPERATING EXPENDITURE OF EACH OPTION

Low Density - Leave Plant As Is

Advantages

- established & working well
- safeguards in place to minimize plant upset
- AMD storage and treated water pumphouses built and in place for long term
- low capital cost

Disadvantages

- sludge pumping from ponds to Main Zone pit more difficult
- not set up to pump water to pit if needed

Low Density - Move Plant to Edge of Pit

Advantages

- completely eliminate sludge handling problems
- could convert diversion pond to large AMD holding pond

Disadvantages

- considerable capital outlay to move and change pumphouse
- AMD storage will be some distance from plant
- need for fail proof system to prevent contamination

High Density - Secure Land Fill

Advantages

- process better set up for sludge handling
- better lime efficiency
- less sludge (volume)

Disadvantages

- higher capital cost
- higher operating cost
- little land available for disposal
- difficult to land fill because of density
- disturbs more land

Conclusions

> The Committee agreed that disposal into the pit is the most appropriate course of action for three reasons:

- The Norecol report provides sufficient comfort that the pit will not turn acid (although some problems with zinc may occur).

- The volume of sludge produced at current rates would require a vast area for land fill sites. Even if sufficient space could be found on the Equity property, opening up of land-fill sites could pose new environmental concerns.

- The funds required to construct a high density plant would be better used to help finance efforts to minimize acid and sludge generation.

> For the purposes of costing, the Committee agreed that the treatment plant will stay in its current location and low-density sludge will be pumped into the pit. Capital costs would be incurred prior to closure.

> These lime consumption figures are slightly different than actual lime used because some AMD has been discharged into the tailings pond and was not treated with lime. An adjustment has been made to account for this diversion.

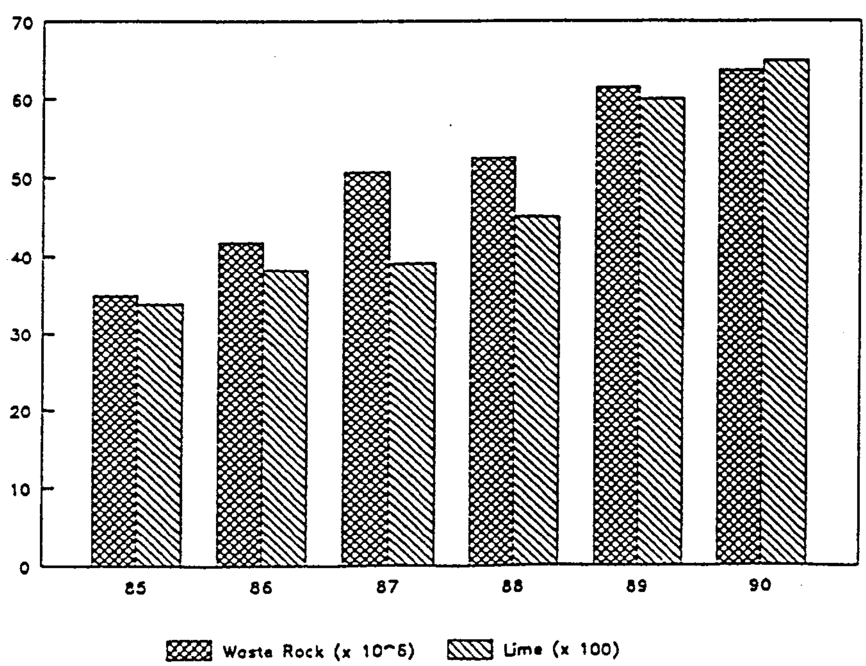
> While the mine has been in production, new waste rock has been added to the dumps. As Exhibits 5.3 and 5.4 show, there is an apparent correlation between lime consumption and the amount of waste rock on the Main Dump.

EXHIBIT 5.3
RELATION BETWEEN WASTE ROCK AND LIME CONSUMPTION

Year	Waste Rock ('000 tonnes)	Lime Consumption* (tonnes)	Ratio %
82	9,594	n/a	
83	17,179	n/a	
84	24,804	n/a	
85	34,901	3,379	9.7
86	41,570	3,806	9.2
87	50,721	3,896	7.6
88	52,277	4,489	7.8
89	61,463	5,998	9.8
90	63,710	6,488	10.2

* Main Collection Pond

EXHIBIT 5.4
RELATION BETWEEN WASTE ROCK AND LIME CONSUMPTION



> The Company has estimated the contribution of each site to acid loading at the Main Collection Pond for the last four years - see Exhibit 5.5. The Main Dump and the Bessemer Dump are the major producers of acid. These estimates are based on actual precipitation and measured acidity levels. The percentage infiltration rates are derived but they approximate the type of infiltration rates observed in other studies. The sharp drop in infiltration at the Main Dump between 1987 and 1988 is attributable to the installation of a till cover over the surface of the dump.

EXHIBIT 5.5
ACID LOADING BY SITE

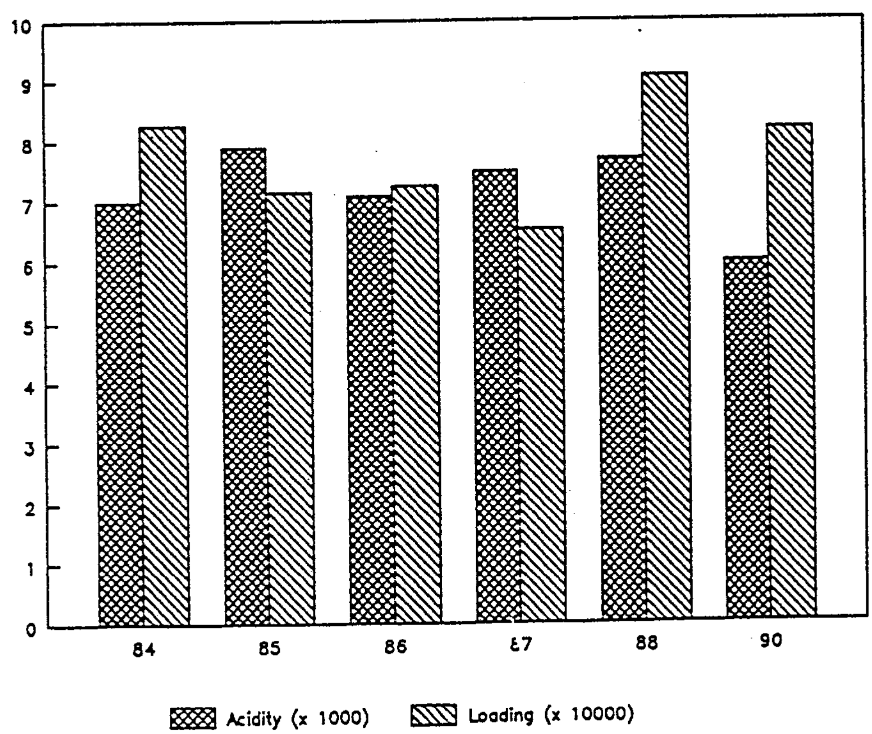
	1987	1988	1989	1990
Main Dump (56,300 m^2)				
Precipitation mm	666	844	860	836
Precipitation (m^3)	374,958	475,172	484,180	470,668
Infiltration (%)	65%	37%	37%	40%
Infiltrate (m^3)	243,723	175,814	179,147	188,267
Acidity (mg/l)	13,970	19,231	25,000*	24,000
Plantsite (400,000 m^2)				
Precipitation mm	666	844	860	836
Precipitation (m^3)	266,400	337,600	344,000	334,400
Infiltration (%)	75%	65%	65%	65%
Infiltrate (m^3)	199,800	219,440	223,600	217,360
Acidity (mg/l)	514	343	250	200
Between Pits (267,600 m^2)				
Precipitation (mm)	666	844	860	836
Precipitation (m^3)	178,222	225,854	230,136	223,714
Infiltration (%)	75%	65%	65%	65%
Infiltrate (m^3)	133,666	146,805	149,588	145,414
Acidity (mg/l)	200	200	200	200
Bessemer Dump (593,000 m^2)				
Precipitation (mm)	666	844	860	836
Precipitation (m^3)	394,938	500,492	509,980	495,748
Infiltration (%)	70%	50%	53%	55%
Infiltrate (m^3)	276,457	250,246	270,289	272,661
Acidity (mg/l)	6,900	11,600	14,500*	16,000
Total Areas (1,823,000 m^2)				
Precipitation (mm)	666	844	860	836
Precipitation (m^3)	1,214,118	1,538,612	1,567,780	1,524,028
Infiltration (%)	70%	51%	52%	54%
Infiltrate (m^3)	853,645	792,305	822,624	823,702
Acidity (mg/l)	6,375	8,063	10,313	10,870
Lime (tonnes)	3,809	4,472	5,939	6,267
Actual				
Flow (m^3)	851,000	796,000	829,000	825,000
Acidity (mg/l)	6,580	8,100	10,000	10,800
Lime (tonnes)	3,896	4,489	5,998	6,252

* estimated

> Because of the constant addition of waste rock, it has not been possible to observe the behaviour of acidity under steady state conditions except at the #1 Dam site. The #1 Dam was constructed in 1980 with waste material from the Southern Tail pit.

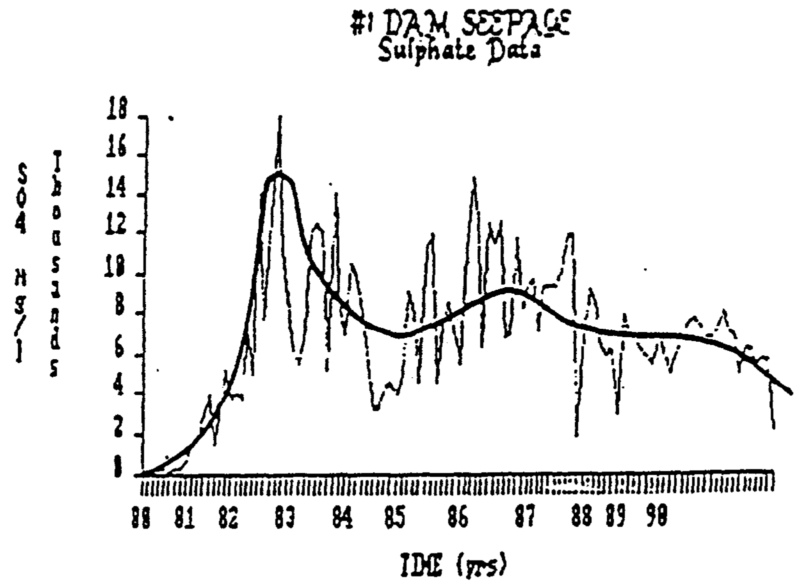
> Over the period 1984-90, acid loading and acidity at the #1 Dam have been essentially constant, as Exhibit 5.6 shows.

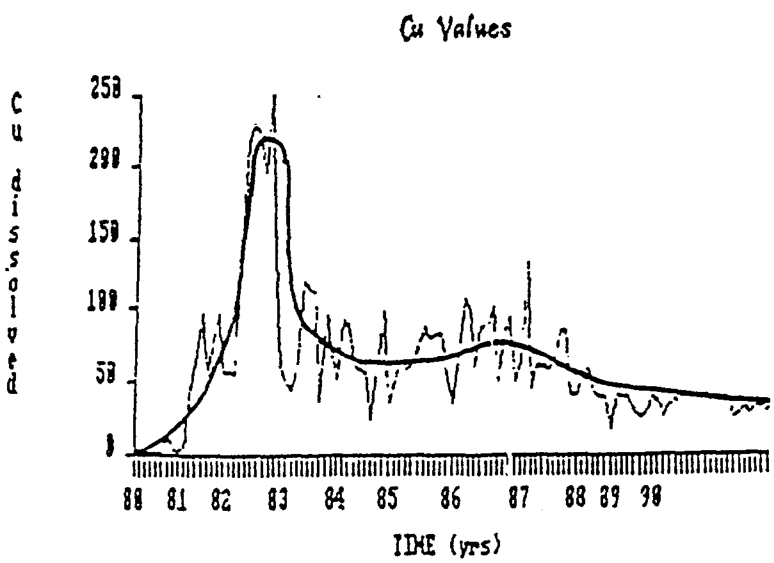
EXHIBIT 5.6
ACID LOADING AND ACIDITY AT THE #1 DAM



> Information is not available on acid loading and acidity at the #1 Dam for the period prior to 1984. However, data is available on copper and sulphate concentration for the period 1980-1990. Exhibit 5.7 shows the pattern. Both these graphs suggest a very rapid release of acid for one to two years in the early 1980s followed by a pattern of steady and much lower acid production. The dam was watered over the 1982/83 period. This may have diluted the concentration levels over that period but it may also have flushed out stored up acidity in the dam.

EXHIBIT 5.7
SULPHATE AND COPPER CONCENTRATIONS AT THE #1 DAM





CHAPTER SIX

ACID NEUTRALIZATION

Introduction

> The biggest uncertainty in estimating reclamation costs is the amount of lime required to neutralize AMD. Unfortunately, very little reliable information is available from which to develop an estimate.

> Chapter Five outlines acid loading and lime consumption to date at the mine site. It shows a strong upward trend. However, waste rock is still being added to the dumps and the pattern of waste rock and lime consumption seem to be correlated. At the one stable site, the #1 Dam, acid loading appears to have peaked quickly and has been constant for the last few years.

> Rock from the Southern Tail Pit is in the South East section of the Main Dump. However, most of the waste rock in the dumps is from the Main Zone Pit. The sulphides in the Main Zone rock are more disseminated than in the Southern Tail rock and are slower to react. Therefore, the rate of AMD production in the dumps may be slower than at the #1 Dam.

> The Committee was unable to find extensive information on the time profile of AMD at other mine sites. Limited information from the Britannia site and from computer models of tailings dumps suggest a similar pattern of acid loading over time: a fairly rapid increase in loading to a sharp peak, followed by a slightly less rapid decline, before levelling off for below the observed peak. Exhibit 6.1 shows the evidence reviewed by the Committee. It shows that acid production peaks typically within the first 10 - 20 years and levels off somewhere between years 30 and 60.

> Observations on maximum acidity at other sites range from 46,000 mg/l at Iron Mountain in California to 85,000 mg/l in isolated seeps at Lac Min Doyan in Quebec.

> The Committee has had to use this limited information from the Equity site and elsewhere to project acid loading.

Expected Lime Use With Existing Covers

> The simplified time profile shown in Exhibit 6.2 was used to estimate lime consumption. The profile is described by five parameters: the rate of increase of lime consumption; maximum lime consumption; the number of years that lime consumption remains at the maximum; the rate of decline from the maximum; and, the minimum level of lime consumption.

EXHIBIT 6.1

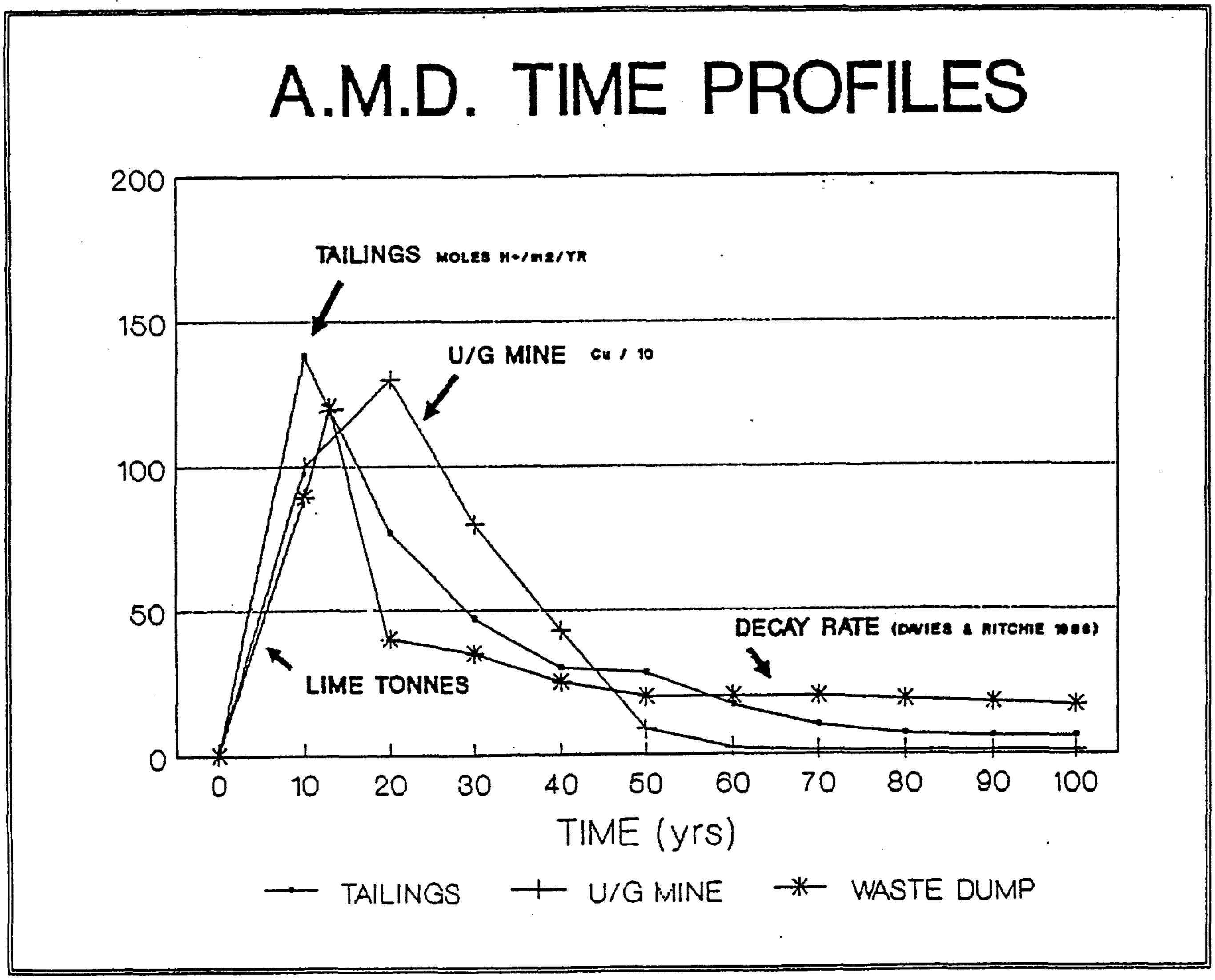
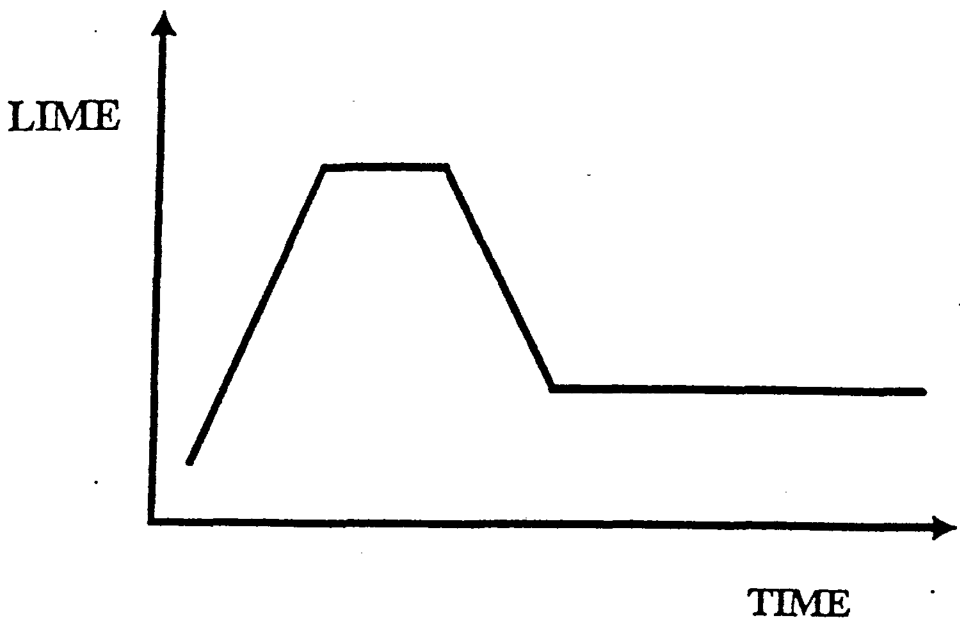

A.M.D. TIME PROFILES
200
150
100
50
0
TAILINGS MOLES H+/m2/YR
U/G MINE Cu / 10
DECAY RATE
DAVIES & RITCHIE
LIME TONNES
0 10 20 30 40 50 60 70 80 90 100
TIME (yrs)
TAILINGS
U/G MINE
WASTE DUMP

EXHIBIT 6.2
TIME PROFILE OF LIME CONSUMPTION



> Using the time profile described above, the Committee has developed three scenarios for lime use with existing covers: minimum, most likely and maximum. The time profile of each of these is shown in Exhibit 6.3. The difference between the three scenarios is characterized by the various parameters of the time profile. The Exhibit shows, also, the annual average lime consumption over the first 100 year period.

EXHIBIT 6.3
PROJECTED LIME CONSUMPTION WITH EXISTING COVERS (100 years)

	Minimum	Most Likely	Maximum
Rate of Increase (%)	10	10	10
Peak Lime (tonnes)	10,000	12,000	15,000
Peak Period (years)	2	2	5
Rate of Decline (%)	10	6	4
Low-level Lime (tonnes)	2,000	2,500	3,500
Annual Average Use of Lime (tonnes)	2,650	3,780	5,980

> The parameters of these curves were developed as follows:

Rate of Increase

All scenarios use a 10% rate of increase, close to the observed rate over the last 3-4 years.

Peak Lime Consumption

Peak lime consumption is derived from assumptions about maximum acidity levels at the various waste sites. Exhibit 6.4 shows an example of the calculation used. The peak lime consumption of 12,000 tonnes for the most likely case was based on:

- the expectation that lime consumption will peak within 4-5 years after the company stops adding waste rock to the dumps.

- the expectation that acidity will peak around 40,000 mg/l, which is the maximum observed to date in a one month period at the Main Dump site.

The minimum scenario assumes that acid production will peak quickly after waste is no longer added to the dump. The maximum scenario assumes that acidity will peak around 60,000 mg/l.

Peak Period

The peak period is expected to be relatively short based on experience from the #1 Dam site and the data from other sites. The slower reacting Main Zone rock in the dumps may extend the peak period. The range of estimates used is one to five years.

Rate of Decline

Evidence from other sites suggested a range of estimates for the rate of decline from peak lime consumption to low-level lime consumption. The Committee settled on 6% as the rate of decline for the most likely scenario based on their reading of this evidence and the fact that the period of decline would be approximately 25 years, i.e., approximately twice as long as the period taken to reach the maximum. For the minimum scenario, the rate of decline is expected to parallel the rate of increase (10%). A gradual decline (4%) over 40 years is assumed for the maximum scenario.

Low-level Lime Consumption

Estimates of low-level lime consumption are based on expected acidity levels. Acidity levels were derived in two ways:

- by observing that the ratio of minimum to maximum acidity in the graphs shows in Exhibit 6.1 is approximately 1:5.

- by estimating the acid level at various sites based on observed acidity levels today. For the most likely case the minimum acidity level was assumed to be 6,000 mg/l, the same acidity level observed at the #1 Dam today.

EXHIBIT 6.4
MAXIMUM LIME CONSUMPTION - MOST LIKELY SCENARIO

Main Dump	
Precipitation (m^3)	400,000
Infiltration (%)	37
Infiltrate (m^3)	148,000
Acidity (mg/l)	40,000
Acid Loading (tonnes)	5,920
Bessemer Dump	
Precipitation (m^3)	421,000
Infiltration (%)	53
Infiltrate (m^3)	223,000
Acidity (mg/l)	40,000
Acid Loading (tonnes)	8,920
#1 Dam Seepage	
Infiltrate (m^3)	130,000
Acidity (mg/l)	6,000
Acid Loading (tonnes)	780
Total Loading (tonnes)	15,620
Lime Required (tonnes)	11,000 *

* Note: 12,000 tonnes is the estimate actually used in the most likely scenario.

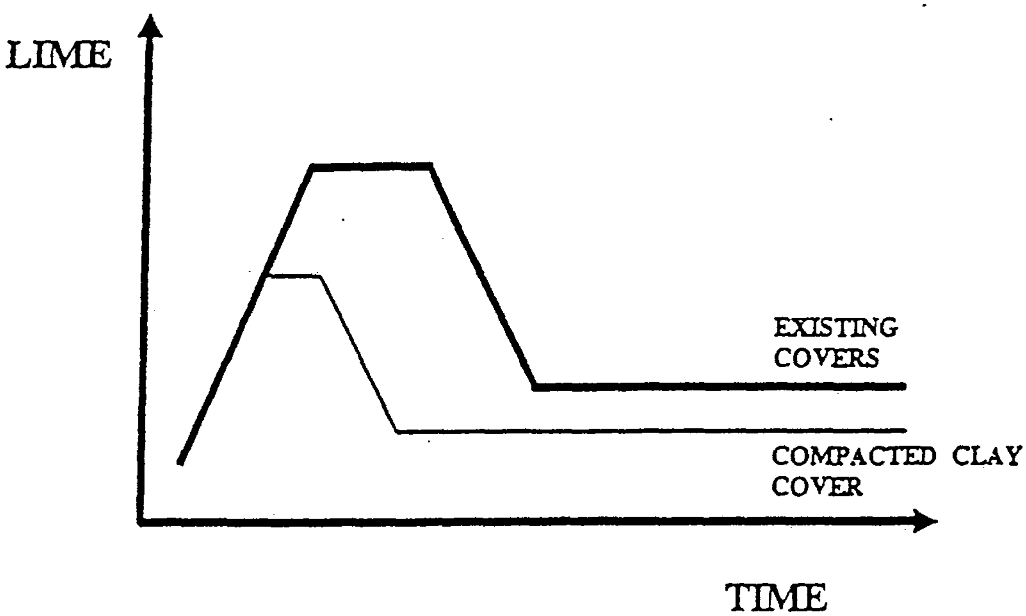
Expected Lime Use With Compacted Clay Cover

> At present the dump sites are only partially covered. Additional covers could reduce the amount of AMD produced and, therefore, the lime required.

> Studies from other sites have shown that properly constructed and maintained till covers can significantly reduce the amount of oxygen and water that enter the dump and, therefore, the amount of AMD produced.

> Exhibit 6.5 compares the time profile of lime consumptions before and after a compacted clay cover.

EXHIBIT 6.5
TIME PROFILE - IMPACT OF COMPACTED CLAY COVER



> As with the existing cover situation, the Committee projected three scenarios of lime use with a compacted clay cover: minimum, most likely and maximum. The parameters of these time profiles are shown in Exhibit 6.6.

EXHIBIT 6.6
PROJECTED LIME CONSUMPTION WITH COMPACTED CLAY COVER

	Minimum	Most Likely	Maximum
Rate of Increase (%)	10	10	10
Peak Lime (tonnes)	7,500	8,500	10,000
Peak Period (years)	1	3	5
Rate of Decline (%)	10	10	10
Low-level Lime (tonnes)	600	800	1,200
Annual Average Use of Lime (tonnes)	1,080	1,470	2,270

> The parameters of these curves were developed as follows:

Rate of Increase

All scenarios use a 10% rate of increase, close to the observed rate over the last 3-4 years.

Peak Lime Consumption

The most likely scenario assumes acidity will peak at the time the cover is applied. The maximum scenario assumes a slight delay in achieving the benefits of the cover as stored up acidity is flushed from the dump. The minimum scenario is based on the actual acidity level in 1991.

Peak Period

The estimated length of the peak period is also related to different assumptions about the amount of stored acid in the dump that will have to be captured and treated before the full effects of the cover are seen.

Rate of Decline

All scenarios use the same rate of decline. It is expected to be faster than the rate of decline in the most-likely scenario without a compacted clay cover.

Low-level Lime Consumption

The compacted clay cover is expected to be very efficient in limiting infiltration of water and oxygen into the dumps. Therefore, low-level lime consumption is expected to be much lower than without the cover. In the most likely scenario, low level lime consumption was calculated by assuming an infiltration rate of 10% and an acidity level of approximately 10,000 mg/l. The minimum and maximum scenarios assume lower and higher levels of acidity.

It is possible that the cover could reduce the lime consumption to a very low level (e.g. 100 - 500 tonnes a year) but the calculation of cost (in present value terms) is not very sensitive to changes in the assumption about low-level lime use.

Synthetic Cover

> The Committee considered modelling the impact of a synthetic cover. However, the density of the proposed clay cover is such that a synthetic cover is unlikely to provide a significant further reduction in oxygen diffusion and water infiltration. Since a synthetic cover would be difficult to install on a 20% slope and, possibly difficult to maintain (finding and repairing holes), a compacted clay cover is felt to be as effective as a synthetic cover.

Maximum Theoretical Acid Production

> The Committee tried to estimate the maximum theoretical amount of acid that could be produced in the dumps. However, a reasonable estimate must take into account the distribution of reactive material in the dumps, the proportion that can be expected to oxidize, and the amount of acid that would not be flushed from the dumps. The Committee did not have sufficient information on these characteristics from which to make a reliable estimate of maximum acid production over the life of the dump. The estimates produced covered such a wide range that the Committee did not have sufficient confidence in them to include them in this report.

CHAPTER SEVEN

POST CLOSURE RECLAMATION COSTS

Introduction

> Post-closure reclamation costs can be divided into three elements:

- > **Fixed Costs:** - those that will have to be incurred regardless of the volume of AMD to be collected and treated. They include the cost of sludge disposal into the pit and road maintenance.

- > **Variable Costs:** - those associated with collecting, pumping, and treating AMD.

- > **Lime Costs:** - the cost of reagent used in the neutralization process.

> The Committee agreed with the Company's estimate of fixed costs of $406,000. Details are shown in Exhibit 7.1

> The Committee agreed to $0.13 per m^3 as the variable cost of collecting AMD and $138 per tonne as the unit cost of lime. The cost of purchased lime is lower than estimates used in earlier studies. It is based on a long term (10 year) offer of supply from Texada Lime.

> Using these cost assumptions and the lime consumption scenarios developed in Chapter Six, the Committee has agreed to the cost projections shown in Exhibits 7.2 and 7.3. The costs are presented in two forms: the **present value** of annual operating costs over 100 years using a 3% real discount rate; and, the **equivalent annual cost** which is the stream of constant annual costs that would give the same present value. The annual cost by year for each scenario is included in the Appendices.

> The cost calculations do not have to make an allowance for inflation because the present value calculation uses a **real** discount rate rather than a **nominal** discount rate. The costs are in 1993 dollars.

> Given the considerable uncertainty surrounding these estimates, the Committee has not been able to assign probabilities to these estimates.

EXHIBIT 7.1
FIXED COSTS

		$,000
Reclamation Maintenance		
	- Salaries	55
	- Other	23
Effluent Collection		
	- Salaries	23
Effluent Treatment		
	- Salaries	45
Water Monitoring		
	- Salaries	35
	- Other	55
Sludge Handling		
	- Salaries	24
	- Other	46
Powerline		20
Road		20
Transportation and Equipment Operation		60
		406

Cost Estimates - Existing Covers

> Exhibit 7.2 shows the projected costs for three scenarios assuming no additional covers are placed on the dumps. In present value terms costs range from a minimum of $34.2 million to a maximum of $56.6 million, with a most likely estimate of $42.5 million.

> The range of equivalent annual costs is from $1,050,000 to $1,739,000, with a most likely estimate of $1,307,000.

EXHIBIT 7.2
COST PROJECTIONS - EXISTING COVERS

Present Value ($ million)	Minimum	Most Likely	Maximum
Fixed	13.2	13.2	13.2
Variable	4.1	4.1	4.1
Lime	16.9	25.2	39.3
Total Cost	34.2	42.5	56.6
Equivalent Annual Cost ($000)			
Fixed	406	406	406
Variable	127	127	127
Lime	517	774	1,206
Total Cost	1,050	1,307	1,739

Cost Estimates - Compacted Clay Cover

> Exhibit 7.3 shows cost estimates assuming waste dumps are recontoured and covered with compacted clay till prior to closure. The cover reduces variable costs and lime costs significantly but fixed costs remain unchanged.

EXHIBIT 7.3
COST PROJECTIONS - COMPACTED CLAY COVER

Present Value ($ million)	Minimum	Most Likely	Maximum
Fixed	13.2	13.2	13.2
Variable	1.2	1.2	1.2
Lime	8.4	11.5	17.7
Total Cost	22.8	25.9	32.1
Equivalent Annual Cost ($000)			
Fixed	406	406	406
Variable	37	37	37
Lime	256	352	542
Total Cost	699	795	985

> Costs estimates with a clay cover range from $22.8 million to $32.1 million in present value terms, with a most likely estimate of $25.9 million.

> The range of equivalent annual costs is from $699,000 to $985,000, with a most likely estimate of $795,000.

> These estimates do not include the costs of installing the clay cover. They do, however, allow for the ongoing maintenance of the cover to ensure its continued integrity.[4]

Other Impacts on Cost

> The Company is looking to further reduce unit lime costs by installing a lime calcining plant that will process lime from the Company's own limestone deposits. This proposal may reduce lime costs by as much as 20% (excluding the capital cost of constructing the plant).[5]

[4]A decision will have to be taken at some point as to whether or not the compacted clay cover should itself be covered with a layer of loose till. This additional cover would increase pre-closure costs but would reduce ongoing maintenance costs. However, it is uncertain at this time whether the additional cover would be an effective method of ensuring the integrity of the clay cover.

[5]The feasibility of Installing and Operating a lime calcining plant for the purposes of reducing operating costs at Equity Silver Mines Ltd. - Internal Company Report, February 1991.

CHAPTER EIGHT

FURTHER RESEARCH

Acid Loading

> Despite the work of the Committee, considerable uncertainty remains over the amount of AMD that will be produced each year at the Equity site. Also, the probable impact of a compacted clay cover on acidity and infiltration into the dumps needs to be understood better. For these reasons, the Company has commissioned SENES Consultants Ltd. to develop a computer model of the acid generation in the waste dumps and to use that model to simulate:

- a time profile of acid loading
- the impact of a compacted clay cover on acid loading

Full terms of reference are included in the appendices. The study is scheduled to be completed by August 1991.

> Government members of the Committee have provided comments on the terms of reference. SENES has offered to meet with the Committee to discuss the methodology and the results as they become available.

Stability of the Pit Wall

> Failure of sections of the Southern Tail Pit walls led to an increase in acid producing rock in the pit. The walls of the Main Zone Pit are known to be more stable than those of the Southern Tail Pit. Nevertheless, the Committee has requested a geotechnical report on the stability of the walls of the Main Zone Pit. The report will be prepared by Mr. Chuck Brawner who is under contract to the Ministry of Energy, Mines and Petroleum Resources. His report will be completed by May 1991.

APPENDICES

Appendix A

Financial Simulations
Existing Covers

Lime Consumption and Present Value – Exist. Covers – Minimum

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.73	$1.600	
1992	8.50	$1.706	
1993	9.35	$1.824	$1.824
1994	10.00	$1.913	$1.857
1995	10.00	$1.913	$1.803
1996	9.00	$1.775	$1.624
1997	8.10	$1.651	$1.467
1998	7.29	$1.539	$1.328
1999	6.56	$1.438	$1.205
2000	5.90	$1.348	$1.096
2001	5.31	$1.266	$1.000
2002	4.78	$1.193	$0.914
2003	4.30	$1.127	$0.839
2004	3.87	$1.068	$0.771
2005	3.49	$1.014	$0.711
2006	3.14	$0.966	$0.658
2007	2.82	$0.923	$0.610
2008	2.54	$0.884	$0.567
2009	2.29	$0.849	$0.529
2010	2.06	$0.817	$0.494
2011	2.00	$0.809	$0.475
2012	2.00	$0.809	$0.461
2013	2.00	$0.809	$0.448
2014	2.00	$0.809	$0.435
2015	2.00	$0.809	$0.422
2016	2.00	$0.809	$0.410
2017	2.00	$0.809	$0.398
2018	2.00	$0.809	$0.386
2019	2.00	$0.809	$0.375
2020	2.00	$0.809	$0.364
2021	2.00	$0.809	$0.354
2022	2.00	$0.809	$0.343
2023	2.00	$0.809	$0.333
2024	2.00	$0.809	$0.324
2025	2.00	$0.809	$0.314
2026	2.00	$0.809	$0.305
2027	2.00	$0.809	$0.296

Lime Consumption and Present Value – Exist. Covers – Minimum

2028	2.00	$0.809	$0.288
2029	2.00	$0.809	$0.279
2030	2.00	$0.809	$0.271
2031	2.00	$0.809	$0.263
2032	2.00	$0.809	$0.255
2033	2.00	$0.809	$0.248
2034	2.00	$0.809	$0.241
2035	2.00	$0.809	$0.234
2036	2.00	$0.809	$0.227
2037	2.00	$0.809	$0.220
2038	2.00	$0.809	$0.214
2039	2.00	$0.809	$0.208
2040	2.00	$0.809	$0.202
2041	2.00	$0.809	$0.196
2042	2.00	$0.809	$0.190
2043	2.00	$0.809	$0.185
2044	2.00	$0.809	$0.179
2045	2.00	$0.809	$0.174
2046	2.00	$0.809	$0.169
2047	2.00	$0.809	$0.164
2048	2.00	$0.809	$0.159
2049	2.00	$0.809	$0.155
2050	2.00	$0.809	$0.150
2051	2.00	$0.809	$0.146
2052	2.00	$0.809	$0.141
2053	2.00	$0.809	$0.137
2054	2.00	$0.809	$0.133
2055	2.00	$0.809	$0.129
2056	2.00	$0.809	$0.126
2057	2.00	$0.809	$0.122
2058	2.00	$0.809	$0.118
2059	2.00	$0.809	$0.115
2060	2.00	$0.809	$0.112
2061	2.00	$0.809	$0.108
2062	2.00	$0.809	$0.105
2063	2.00	$0.809	$0.102
2064	2.00	$0.809	$0.099
2065	2.00	$0.809	$0.096
2066	2.00	$0.809	$0.094
2067	2.00	$0.809	$0.091
2068	2.00	$0.809	$0.088
2069	2.00	$0.809	$0.086

Lime Consumption and Present Value – Exist. Covers – Minimum

2070	2.00	$0.809	$0.083	
2071	2.00	$0.809	$0.081	
2072	2.00	$0.809	$0.078	
2073	2.00	$0.809	$0.076	
2074	2.00	$0.809	$0.074	
2075	2.00	$0.809	$0.072	
2076	2.00	$0.809	$0.070	
2077	2.00	$0.809	$0.068	
2078	2.00	$0.809	$0.066	
2079	2.00	$0.809	$0.064	
2080	2.00	$0.809	$0.062	
2081	2.00	$0.809	$0.060	
2082	2.00	$0.809	$0.058	
2083	2.00	$0.809	$0.057	
2084	2.00	$0.809	$0.055	
2085	2.00	$0.809	$0.053	
2086	2.00	$0.809	$0.052	
2087	2.00	$0.809	$0.050	
2088	2.00	$0.809	$0.049	
2089	2.00	$0.809	$0.047	
2090	2.00	$0.809	$0.046	
2091	2.00	$0.809	$0.045	
2092	2.00	$0.809	$0.043	
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Total	265	$89.8	$34.2	
Equiv. annual cost				$1,049,784
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Slope up	10%			
Peak lime	10.00			
Peak period	2			
Slope down	10%			
Low Lime	2.00			
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Cost Factors				
Fixed	$406,000			
Variable	$127,000			
Total	$533,000			
Lime	$138			

Lime Consumption and Present Value – Exist. Covers – Most Likely

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.73	$1.600	
1992	8.50	$1.706	
1993	9.35	$1.824	$1.824
1994	10.29	$1.953	$1.896
1995	11.32	$2.095	$1.975
1996	12.00	$2.189	$2.003
1997	12.00	$2.189	$1.945
1998	11.28	$2.090	$1.803
1999	10.60	$1.996	$1.672
2000	9.97	$1.908	$1.552
2001	9.37	$1.826	$1.441
2002	8.81	$1.748	$1.340
2003	8.28	$1.675	$1.247
2004	7.78	$1.607	$1.161
2005	7.31	$1.542	$1.082
2006	6.88	$1.482	$1.009
2007	6.46	$1.425	$0.942
2008	6.08	$1.371	$0.880
2009	5.71	$1.321	$0.823
2010	5.37	$1.274	$0.771
2011	5.05	$1.229	$0.722
2012	4.74	$1.188	$0.677
2013	4.46	$1.148	$0.636
2014	4.19	$1.111	$0.597
2015	3.94	$1.077	$0.562
2016	3.70	$1.044	$0.529
2017	3.48	$1.013	$0.499
2018	3.27	$0.985	$0.470
2019	3.08	$0.957	$0.444
2020	2.89	$0.932	$0.420
2021	2.72	$0.908	$0.397
2022	2.55	$0.886	$0.376
2023	2.50	$0.878	$0.362
2024	2.50	$0.878	$0.351
2025	2.50	$0.878	$0.341
2026	2.50	$0.878	$0.331
2027	2.50	$0.878	$0.321

2028	2.50	$0.878	$0.312
2029	2.50	$0.878	$0.303
2030	2.50	$0.878	$0.294
2031	2.50	$0.878	$0.286
2032	2.50	$0.878	$0.277
2033	2.50	$0.878	$0.269
2034	2.50	$0.878	$0.261
2035	2.50	$0.878	$0.254
2036	2.50	$0.878	$0.246
2037	2.50	$0.878	$0.239
2038	2.50	$0.878	$0.232
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
2041	2.50	$0.878	$0.212
2042	2.50	$0.878	$0.206
2043	2.50	$0.878	$0.200
2044	2.50	$0.878	$0.194
2045	2.50	$0.878	$0.189
2046	2.50	$0.878	$0.183
2047	2.50	$0.878	$0.178
2048	2.50	$0.878	$0.173
2049	2.50	$0.878	$0.168
2050	2.50	$0.878	$0.163
2051	2.50	$0.878	$0.158
2052	2.50	$0.878	$0.153
2053	2.50	$0.878	$0.149
2054	2.50	$0.878	$0.145
2055	2.50	$0.878	$0.140
2056	2.50	$0.878	$0.136
2057	2.50	$0.878	$0.132
2058	2.50	$0.878	$0.129
2059	2.50	$0.878	$0.125
2060	2.50	$0.878	$0.121
2061	2.50	$0.878	$0.118
2062	2.50	$0.878	$0.114
2063	2.50	$0.878	$0.111
2064	2.50	$0.878	$0.108
2065	2.50	$0.878	$0.105
2066	2.50	$0.878	$0.101
2067	2.50	$0.878	$0.099
2068	2.50	$0.878	$0.096
2069	2.50	$0.878	$0.093

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Lime Consumption and Present Value – Exist. Covers – Most Likely

2070	2.50	$0.878	$0.090	
2071	2.50	$0.878	$0.088	
2072	2.50	$0.878	$0.085	
2073	2.50	$0.878	$0.083	
2074	2.50	$0.878	$0.080	
2075	2.50	$0.878	$0.078	
2076	2.50	$0.878	$0.076	
2077	2.50	$0.878	$0.073	
2078	2.50	$0.878	$0.071	
2079	2.50	$0.878	$0.069	
2080	2.50	$0.878	$0.067	
2081	2.50	$0.878	$0.065	
2082	2.50	$0.878	$0.063	
2083	2.50	$0.878	$0.061	
2084	2.50	$0.878	$0.060	
2085	2.50	$0.878	$0.058	
2086	2.50	$0.878	$0.056	
2087	2.50	$0.878	$0.055	
2088	2.50	$0.878	$0.053	
2089	2.50	$0.878	$0.051	
2090	2.50	$0.878	$0.050	
2091	2.50	$0.878	$0.048	
2092	2.50	$0.878	$0.047	
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Total	378	$105.5	$42.5	
Equiv. annual cost				$1,307,155
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Slope up	10%			
Peak lime	12.00			
Peak period	2			
Slope down	6%			
Low Lime	2.50			
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Cost Factors				
Fixed	$406,000			
Variable	$127,000			
Total	$533,000			
Lime	$138			

Lime Consumption and Present Value – Exist. Covers – Maximum

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.73	$1.600	
1992	8.50	$1.706	
1993	9.35	$1.824	$1.824
1994	10.29	$1.953	$1.896
1995	11.32	$2.095	$1.975
1996	12.45	$2.251	$2.060
1997	13.69	$2.423	$2.153
1998	15.00	$2.603	$2.245
1999	15.00	$2.603	$2.180
2000	15.00	$2.603	$2.116
2001	15.00	$2.603	$2.055
2002	15.00	$2.603	$1.995
2003	14.40	$2.520	$1.875
2004	13.82	$2.441	$1.763
2005	13.27	$2.364	$1.658
2006	12.74	$2.291	$1.560
2007	12.23	$2.221	$1.468
2008	11.74	$2.153	$1.382
2009	11.27	$2.088	$1.301
2010	10.82	$2.026	$1.226
2011	10.39	$1.967	$1.155
2012	9.97	$1.909	$1.089
2013	9.57	$1.854	$1.027
2014	9.19	$1.801	$0.968
2015	8.82	$1.751	$0.914
2016	8.47	$1.702	$0.862
2017	8.13	$1.655	$0.814
2018	7.81	$1.610	$0.769
2019	7.49	$1.567	$0.727
2020	7.19	$1.526	$0.687
2021	6.91	$1.486	$0.650
2022	6.63	$1.448	$0.614
2023	6.36	$1.411	$0.581
2024	6.11	$1.376	$0.550
2025	5.87	$1.342	$0.521
2026	5.63	$1.310	$0.494
2027	5.41	$1.279	$0.468

Lime Consumption and Present Value – Exist. Covers – Maximum

2028	5.19	$1.249	$0.444
2029	4.98	$1.221	$0.421
2030	4.78	$1.193	$0.400
2031	4.59	$1.167	$0.379
2032	4.41	$1.141	$0.360
2033	4.23	$1.117	$0.342
2034	4.06	$1.094	$0.325
2035	3.90	$1.071	$0.310
2036	3.74	$1.050	$0.294
2037	3.59	$1.029	$0.280
2038	3.50	$1.016	$0.269
2039	3.50	$1.016	$0.261
2040	3.50	$1.016	$0.253
2041	3.50	$1.016	$0.246
2042	3.50	$1.016	$0.239
2043	3.50	$1.016	$0.232
2044	3.50	$1.016	$0.225
2045	3.50	$1.016	$0.218
2046	3.50	$1.016	$0.212
2047	3.50	$1.016	$0.206
2048	3.50	$1.016	$0.200
2049	3.50	$1.016	$0.194
2050	3.50	$1.016	$0.188
2051	3.50	$1.016	$0.183
2052	3.50	$1.016	$0.178
2053	3.50	$1.016	$0.172
2054	3.50	$1.016	$0.167
2055	3.50	$1.016	$0.163
2056	3.50	$1.016	$0.158
2057	3.50	$1.016	$0.153
2058	3.50	$1.016	$0.149
2059	3.50	$1.016	$0.144
2060	3.50	$1.016	$0.140
2061	3.50	$1.016	$0.136
2062	3.50	$1.016	$0.132
2063	3.50	$1.016	$0.128
2064	3.50	$1.016	$0.125
2065	3.50	$1.016	$0.121
2066	3.50	$1.016	$0.117
2067	3.50	$1.016	$0.114
2068	3.50	$1.016	$0.111
2069	3.50	$1.016	$0.107

Lime Consumption and Present Value -- Exist. Covers -- Maximum

2070	3.50	$1.016	$0.104	
2071	3.50	$1.016	$0.101	
2072	3.50	$1.016	$0.098	
2073	3.50	$1.016	$0.095	
2074	3.50	$1.016	$0.093	
2075	3.50	$1.016	$0.090	
2076	3.50	$1.016	$0.087	
2077	3.50	$1.016	$0.085	
2078	3.50	$1.016	$0.082	
2079	3.50	$1.016	$0.080	
2080	3.50	$1.016	$0.078	
2081	3.50	$1.016	$0.075	
2082	3.50	$1.016	$0.073	
2083	3.50	$1.016	$0.071	
2084	3.50	$1.016	$0.069	
2085	3.50	$1.016	$0.067	
2086	3.50	$1.016	$0.065	
2087	3.50	$1.016	$0.063	
2088	3.50	$1.016	$0.061	
2089	3.50	$1.016	$0.060	
2090	3.50	$1.016	$0.058	
2091	3.50	$1.016	$0.056	
2092	3.50	$1.016	$0.054	
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Total	598	$135.9	$56.6	
Equiv. annual cost				$1,738,718
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Slope up	10%			
Peak lime	15.00			
Peak period	5			
Slope down	4%			
Low Lime	3.50			
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Cost Factors				
Fixed	$406,000			
Variable	$127,000			
Total	$533,000			
Lime	$138			

Appendix B

Financial Simulations
Compacted Clay Cover

Lime Consumption and Present Value – Clay Cover – Minimum

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.50	$1.478	
1992	7.50	$1.478	
1993	6.75	$1.375	$1.375
1994	6.08	$1.281	$1.244
1995	5.47	$1.198	$1.129
1996	4.92	$1.122	$1.027
1997	4.43	$1.054	$0.937
1998	3.99	$0.993	$0.857
1999	3.59	$0.938	$0.786
2000	3.23	$0.889	$0.722
2001	2.91	$0.844	$0.666
2002	2.62	$0.804	$0.616
2003	2.35	$0.768	$0.571
2004	2.12	$0.735	$0.531
2005	1.91	$0.706	$0.495
2006	1.72	$0.680	$0.463
2007	1.54	$0.656	$0.434
2008	1.39	$0.635	$0.407
2009	1.25	$0.616	$0.384
2010	1.13	$0.598	$0.362
2011	1.01	$0.583	$0.342
2012	0.91	$0.569	$0.324
2013	0.82	$0.556	$0.308
2014	0.74	$0.545	$0.293
2015	0.66	$0.535	$0.279
2016	0.60	$0.526	$0.266
2017	0.60	$0.526	$0.259
2018	0.60	$0.526	$0.251
2019	0.60	$0.526	$0.244
2020	0.60	$0.526	$0.237
2021	0.60	$0.526	$0.230
2022	0.60	$0.526	$0.223
2023	0.60	$0.526	$0.217
2024	0.60	$0.526	$0.210
2025	0.60	$0.526	$0.204
2026	0.60	$0.526	$0.198
2027	0.60	$0.526	$0.192

Lime Consumption and Present Value – Clay Cover – Minimum

2028	0.60	$0.526	$0.187
2029	0.60	$0.526	$0.181
2030	0.60	$0.526	$0.176
2031	0.60	$0.526	$0.171
2032	0.60	$0.526	$0.166
2033	0.60	$0.526	$0.161
2034	0.60	$0.526	$0.156
2035	0.60	$0.526	$0.152
2036	0.60	$0.526	$0.148
2037	0.60	$0.526	$0.143
2038	0.60	$0.526	$0.139
2039	0.60	$0.526	$0.135
2040	0.60	$0.526	$0.131
2041	0.60	$0.526	$0.127
2042	0.60	$0.526	$0.124
2043	0.60	$0.526	$0.120
2044	0.60	$0.526	$0.116
2045	0.60	$0.526	$0.113
2046	0.60	$0.526	$0.110
2047	0.60	$0.526	$0.107
2048	0.60	$0.526	$0.103
2049	0.60	$0.526	$0.100
2050	0.60	$0.526	$0.098
2051	0.60	$0.526	$0.095
2052	0.60	$0.526	$0.092
2053	0.60	$0.526	$0.089
2054	0.60	$0.526	$0.087
2055	0.60	$0.526	$0.084
2056	0.60	$0.526	$0.082
2057	0.60	$0.526	$0.079
2058	0.60	$0.526	$0.077
2059	0.60	$0.526	$0.075
2060	0.60	$0.526	$0.073
2061	0.60	$0.526	$0.070
2062	0.60	$0.526	$0.068
2063	0.60	$0.526	$0.066
2064	0.60	$0.526	$0.064
2065	0.60	$0.526	$0.063
2066	0.60	$0.526	$0.061
2067	0.60	$0.526	$0.059
2068	0.60	$0.526	$0.057
2069	0.60	$0.526	$0.056

Lime Consumption and Present Value – Clay Cover – Minimum

2070	0.60	$0.526	$0.054
2071	0.60	$0.526	$0.052
2072	0.60	$0.526	$0.051
2073	0.60	$0.526	$0.049
2074	0.60	$0.526	$0.048
2075	0.60	$0.526	$0.047
2076	0.60	$0.526	$0.045
2077	0.60	$0.526	$0.044
2078	0.60	$0.526	$0.043
2079	0.60	$0.526	$0.041
2080	0.60	$0.526	$0.040
2081	0.60	$0.526	$0.039
2082	0.60	$0.526	$0.038
2083	0.60	$0.526	$0.037
2084	0.60	$0.526	$0.036
2085	0.60	$0.526	$0.035
2086	0.60	$0.526	$0.034
2087	0.60	$0.526	$0.033
2088	0.60	$0.526	$0.032
2089	0.60	$0.526	$0.031
2090	0.60	$0.526	$0.030
2091	0.60	$0.526	$0.029
2092	0.60	$0.526	$0.028

Total	108	$59.2	$22.8	
Equiv. annual cost				$699,289

Slope up	10%
Peak lime	7.50
Peak period	1
Slope down	10%
Low Lime	0.60

Cost Factors

Fixed	$406,000
Variable	$37,000
Total	$443,000
Lime	$138

Lime Consumption and Present Value – Clay Cover – Most Likely

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.73	$1.510	
1992	8.50	$1.616	
1993	8.50	$1.616	$1.616
1994	8.50	$1.616	$1.569
1995	7.65	$1.499	$1.413
1996	6.89	$1.393	$1.275
1997	6.20	$1.298	$1.153
1998	5.58	$1.213	$1.046
1999	5.02	$1.136	$0.951
2000	4.52	$1.066	$0.867
2001	4.07	$1.004	$0.793
2002	3.66	$0.948	$0.727
2003	3.29	$0.897	$0.668
2004	2.96	$0.852	$0.616
2005	2.67	$0.811	$0.569
2006	2.40	$0.774	$0.527
2007	2.16	$0.741	$0.490
2008	1.94	$0.711	$0.457
2009	1.75	$0.685	$0.427
2010	1.58	$0.660	$0.400
2011	1.42	$0.639	$0.375
2012	1.28	$0.619	$0.353
2013	1.15	$0.601	$0.333
2014	1.03	$0.586	$0.315
2015	0.93	$0.571	$0.298
2016	0.84	$0.559	$0.283
2017	0.80	$0.553	$0.272
2018	0.80	$0.553	$0.264
2019	0.80	$0.553	$0.257
2020	0.80	$0.553	$0.249
2021	0.80	$0.553	$0.242
2022	0.80	$0.553	$0.235
2023	0.80	$0.553	$0.228
2024	0.80	$0.553	$0.221
2025	0.80	$0.553	$0.215
2026	0.80	$0.553	$0.209
2027	0.80	$0.553	$0.203

Lime Consumption and Present Value – Clay Cover – Most Likely

2028	0.80	$0.553	$0.197
2029	0.80	$0.553	$0.191
2030	0.80	$0.553	$0.185
2031	0.80	$0.553	$0.180
2032	0.80	$0.553	$0.175
2033	0.80	$0.553	$0.170
2034	0.80	$0.553	$0.165
2035	0.80	$0.553	$0.160
2036	0.80	$0.553	$0.155
2037	0.80	$0.553	$0.151
2038	0.80	$0.553	$0.146
2039	0.80	$0.553	$0.142
2040	0.80	$0.553	$0.138
2041	0.80	$0.553	$0.134
2042	0.80	$0.553	$0.130
2043	0.80	$0.553	$0.126
2044	0.80	$0.553	$0.123
2045	0.80	$0.553	$0.119
2046	0.80	$0.553	$0.116
2047	0.80	$0.553	$0.112
2048	0.80	$0.553	$0.109
2049	0.80	$0.553	$0.106
2050	0.80	$0.553	$0.103
2051	0.80	$0.553	$0.100
2052	0.80	$0.553	$0.097
2053	0.80	$0.553	$0.094
2054	0.80	$0.553	$0.091
2055	0.80	$0.553	$0.089
2056	0.80	$0.553	$0.086
2057	0.80	$0.553	$0.083
2058	0.80	$0.553	$0.081
2059	0.80	$0.553	$0.079
2060	0.80	$0.553	$0.076
2061	0.80	$0.553	$0.074
2062	0.80	$0.553	$0.072
2063	0.80	$0.553	$0.070
2064	0.80	$0.553	$0.068
2065	0.80	$0.553	$0.066
2066	0.80	$0.553	$0.064
2067	0.80	$0.553	$0.062
2068	0.80	$0.553	$0.060
2069	0.80	$0.553	$0.059

Lime Consumption and Present Value – Clay Cover – Most Likely

2070	0.80	$0.553	$0.057	
2071	0.80	$0.553	$0.055	
2072	0.80	$0.553	$0.054	
2073	0.80	$0.553	$0.052	
2074	0.80	$0.553	$0.050	
2075	0.80	$0.553	$0.049	
2076	0.80	$0.553	$0.048	
2077	0.80	$0.553	$0.046	
2078	0.80	$0.553	$0.045	
2079	0.80	$0.553	$0.044	
2080	0.80	$0.553	$0.042	
2081	0.80	$0.553	$0.041	
2082	0.80	$0.553	$0.040	
2083	0.80	$0.553	$0.039	
2084	0.80	$0.553	$0.038	
2085	0.80	$0.553	$0.036	
2086	0.80	$0.553	$0.035	
2087	0.80	$0.553	$0.034	
2088	0.80	$0.553	$0.033	
2089	0.80	$0.553	$0.032	
2090	0.80	$0.553	$0.031	
2091	0.80	$0.553	$0.031	
2092	0.80	$0.553	$0.030	
Total	147	$64.6	$25.9	
Equiv. annual cost				$795,054
Slope up	10%			
Peak lime	8.50			
Peak period	3			
Slope down	10%			
Low Lime	0.80			

Cost Factors	
Fixed	$406,000
Variable	$37,000
Total	$443,000
Lime	$138

Lime Consumption and Present Value – Clay Cover – Maximum

Year	lime ('000 tonnes)	cost ($m)	P.V. ($m)
1988	5.09		
1989	6.54		
1990	7.03		
1991	7.73	$1.510	
1992	8.50	$1.616	
1993	9.35	$1.734	$1.734
1994	10.00	$1.823	$1.770
1995	10.00	$1.823	$1.718
1996	10.00	$1.823	$1.668
1997	10.00	$1.823	$1.620
1998	10.00	$1.823	$1.573
1999	9.00	$1.685	$1.411
2000	8.10	$1.561	$1.269
2001	7.29	$1.449	$1.144
2002	6.56	$1.348	$1.033
2003	5.90	$1.258	$0.936
2004	5.31	$1.176	$0.850
2005	4.78	$1.103	$0.774
2006	4.30	$1.037	$0.706
2007	3.87	$0.978	$0.646
2008	3.49	$0.924	$0.593
2009	3.14	$0.876	$0.546
2010	2.82	$0.833	$0.504
2011	2.54	$0.794	$0.466
2012	2.29	$0.759	$0.433
2013	2.06	$0.727	$0.403
2014	1.85	$0.699	$0.376
2015	1.67	$0.673	$0.351
2016	1.50	$0.650	$0.329
2017	1.35	$0.629	$0.310
2018	1.22	$0.611	$0.292
2019	1.20	$0.609	$0.282
2020	1.20	$0.609	$0.274
2021	1.20	$0.609	$0.266
2022	1.20	$0.609	$0.258
2023	1.20	$0.609	$0.251
2024	1.20	$0.609	$0.243
2025	1.20	$0.609	$0.236
2026	1.20	$0.609	$0.229
2027	1.20	$0.609	$0.223

Lime Consumption and Present Value – Clay Cover – Maximum

2028	1.20	$0.609	$0.216
2029	1.20	$0.609	$0.210
2030	1.20	$0.609	$0.204
2031	1.20	$0.609	$0.198
2032	1.20	$0.609	$0.192
2033	1.20	$0.609	$0.187
2034	1.20	$0.609	$0.181
2035	1.20	$0.609	$0.176
2036	1.20	$0.609	$0.171
2037	1.20	$0.609	$0.166
2038	1.20	$0.609	$0.161
2039	1.20	$0.609	$0.156
2040	1.20	$0.609	$0.152
2041	1.20	$0.609	$0.147
2042	1.20	$0.609	$0.143
2043	1.20	$0.609	$0.139
2044	1.20	$0.609	$0.135
2045	1.20	$0.609	$0.131
2046	1.20	$0.609	$0.127
2047	1.20	$0.609	$0.123
2048	1.20	$0.609	$0.120
2049	1.20	$0.609	$0.116
2050	1.20	$0.609	$0.113
2051	1.20	$0.609	$0.110
2052	1.20	$0.609	$0.106
2053	1.20	$0.609	$0.103
2054	1.20	$0.609	$0.100
2055	1.20	$0.609	$0.097
2056	1.20	$0.609	$0.095
2057	1.20	$0.609	$0.092
2058	1.20	$0.609	$0.089
2059	1.20	$0.609	$0.087
2060	1.20	$0.609	$0.084
2061	1.20	$0.609	$0.082
2062	1.20	$0.609	$0.079
2063	1.20	$0.609	$0.077
2064	1.20	$0.609	$0.075
2065	1.20	$0.609	$0.072
2066	1.20	$0.609	$0.070
2067	1.20	$0.609	$0.068
2068	1.20	$0.609	$0.066
2069	1.20	$0.609	$0.064

Lime Consumption and Present Value – Clay Cover – Maximum

2070	1.20	$0.609	$0.062	
2071	1.20	$0.609	$0.061	
2072	1.20	$0.609	$0.059	
2073	1.20	$0.609	$0.057	
2074	1.20	$0.609	$0.056	
2075	1.20	$0.609	$0.054	
2076	1.20	$0.609	$0.052	
2077	1.20	$0.609	$0.051	
2078	1.20	$0.609	$0.049	
2079	1.20	$0.609	$0.048	
2080	1.20	$0.609	$0.047	
2081	1.20	$0.609	$0.045	
2082	1.20	$0.609	$0.044	
2083	1.20	$0.609	$0.043	
2084	1.20	$0.609	$0.041	
2085	1.20	$0.609	$0.040	
2086	1.20	$0.609	$0.039	
2087	1.20	$0.609	$0.038	
2088	1.20	$0.609	$0.037	
2089	1.20	$0.609	$0.036	
2090	1.20	$0.609	$0.035	
2091	1.20	$0.609	$0.034	
2092	1.20	$0.609	$0.033	
---------	------------	--------	--------	
Total	227	$75.7	$32.1	
Equiv. annual cost				$984,918
---------	------------	--------	--------	
Slope up	10%			
Peak lime	10.00			
Peak period	5			
Slope down	10%			
Low Lime	1.20			
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Cost Factors				
Fixed	$406,000			
Variable	$37,000			
Total	$443,000			
Lime	$138			

Appendix C

Letter from Mr. G.L. Freer
Ministry of Transportation and Highways

Province of
British Columbia

Lakes Highway District
Box 288
Burns Lake, B.C.
V0J 1E0

692-7161

February 5, 1991

Equity Silver
Box 1450
Houston, B.C.
V0J 1Z0

Attn: B. Robertson
General Manager

Dear Mr. Robertson:

Thank you for your enquiry regarding the status of maintenance on the Equity Silver Mine road leading from Houston. I apologize for the delay in getting you a definitive answer to this issue.

The Ministry will continue to be responsible for the road maintenance on Equity Road. With the information the Ministry has regarding potential traffic to the site after closure of the mine, the standard of maintenance will be reduced to an appropriate level. This will be determined as we get more information on potential usage.

Should winter access not be necessary, the maintenance could conceivably become the responsibility of the Ministry of Forests.

I trust this answers your questions at this point. I would be pleased to clarify any points for the Ministry of Environment or yourself at your convenience.

Yours truly,

G.L. Freer
District Manager

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EQUITY SILVER MINES LIMITED

REPORT OF THE 1995
TECHNICAL COMMITTEE

February 21, 1996

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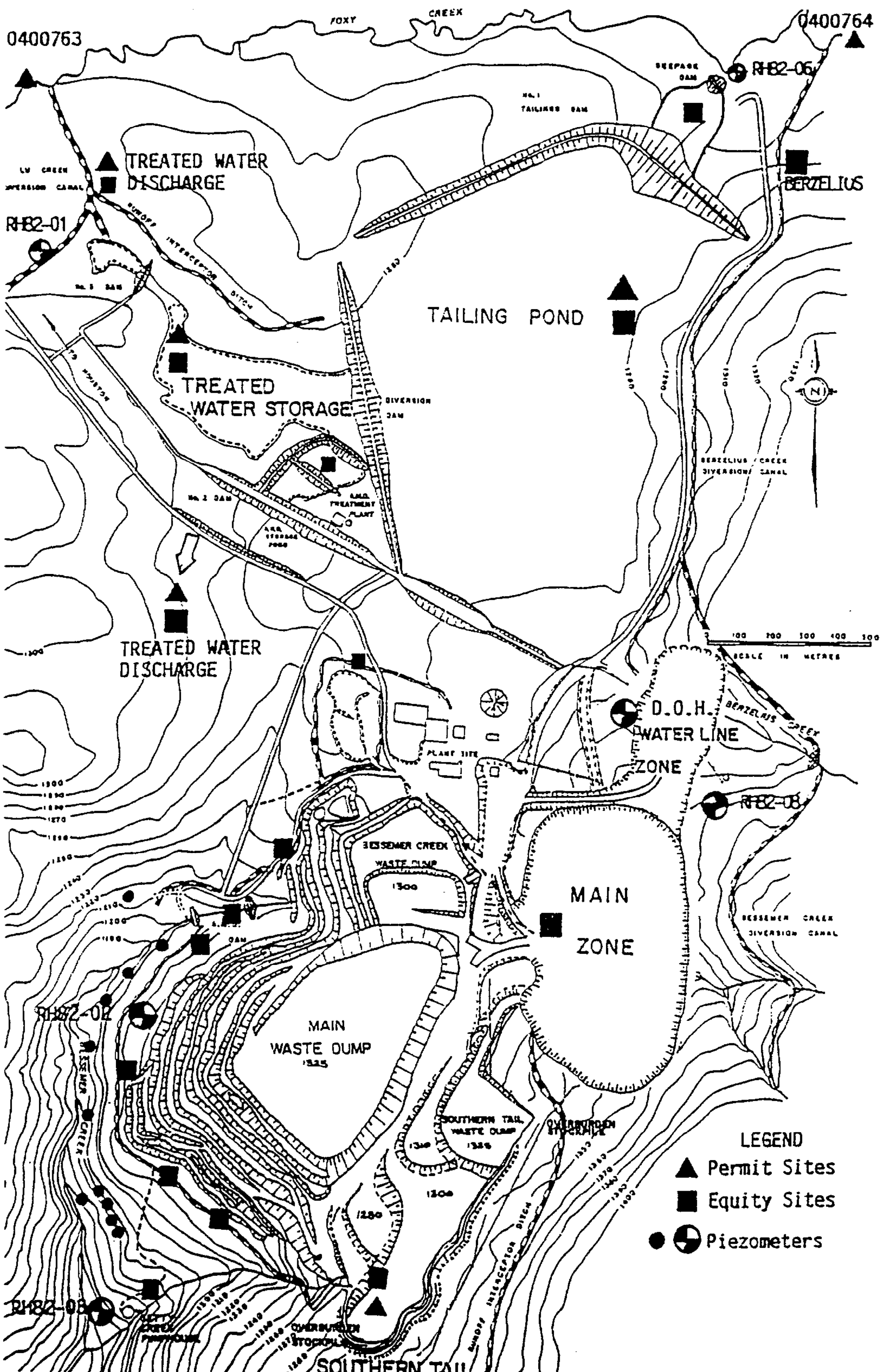
EQUITY SILVER MINES LIMITED

MINESITE LAYOUT WITH SAMPLE SITES



CHAPTER ONE
INTRODUCTION

- In 1995 Placer Dome Canada Limited ("The Company") purchased all the outstanding shares of Equity Silver Mines Limited ("Equity") owned by minority shareholders. On January 1, 1996 Equity was amalgamated with the Company (a wholly owned subsidiary of Placer Dome Inc., a publicly traded international mining company.)

- The Company owns a property approximately 30km southeast of Houston B.C. that was the site of an operating silver-gold-copper mine from 1980 - 1993. The property contains three major waste dumps that together contain 76 million tonnes of waste rock. The waste rock produces acid rock drainage (ARD) that is collected and treated by the Company. Because ARD is expected to be produced for many years, the Company is required to provide financial security in accordance with section 10 of the *Mines Act*, in an amount and form acceptable to the government.

- In 1992, the Ministry of Energy, Mines and Petroleum Resources revised the Company's Reclamation Permit to require it to maintain security as follows:
  - » $32 million for the treatment of acid rock drainage.
  - » $3.3 million for the placement of a till cover over the waste dumps that reduces infiltration to 10% of precipitation.
  - » $2.17 million for plant site reclamation, construction of a permanent spillway for tailings and water control structures; and additional reclamation work.

- The $32 million figure was the upper bound of the cost estimates prepared by the 1991 Technical Committee in their report dated March 31, 1991.

- The 1992 Reclamation Permit called for a review of required security in 1995.

- In 1995 a new technical committee was established to develop revised long-term cost estimates based on experience to date, and to make recommendations of the level of required security. The Committee was composed of representatives of the Company, the Ministry of Environment, Lands and Parks, the Ministry of Energy, Mines and Petroleum Resources, and a representative of the Equity Silver Mine Public Surveillance Committee. The group was assisted by an independent consultant who acted as facilitator to the Committee. The Committee met five times over a period of seven months.

- This document presents the results of the Committee's work. Agreement with the Committee's conclusions is indicated by the signatures of Committee members on the following page.

Equity Silver Mines Ltd./Placer Dome Ltd.

Keith Ferguson

Bruce Nicol

Mike Aziz

Ministry of Environment, Lands and Parks

Frank Rhebergen

Gordon Ford

Ministry of Energy, Mines and Petroleum Resources

John Errington

Duane Anderson

Surveillance Committee

Glenda Ferris

CHAPTER TWO
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

PROJECTIONS OF ACID LOADING AND LIME REQUIREMENTS

- Lime consumption peaked in 1990 at 6,500 tonnes. Since then lime consumption, adjusted for annual variations in precipitation has fallen steadily. In 1995 lime consumption was less than 3,500 tonnes. The reduction in lime consumption can be attributed to several factors including the placement of compacted till covers on the dumps.

- The Committee recognizes that, to date, acid loading and lime consumption have been far below the levels projected by the 1991 Technical Committee, and that the till cover has had an effect in reducing acid loading. However, the Committee recognizes that it remains very difficult to forecast future lime consumption with confidence.

- Efforts at modelling the observed pattern of lime consumption have been partially successful but the accuracy of these models in predicting lime consumption has yet to be tested. The Committee has had to make its projections in the face of limited information on the amount of acid loading stored in the waste dumps, the effectiveness of the till cover over time, and the potential for additional acid generation. Nevertheless, the Committee had more data than was available to the 1991 Committee.

- The Committee has made two projections, a 'base' projection and a more 'conservative' projection, that should be used in setting the amount of security required from the Company.

- The 'base' projection assumes that:

  » The till cover will continue to be an effective barrier to the passage of water and oxygen and the rate of production of acid will be constrained by the rate of infiltration of precipitation into the dumps. Water infiltration will be 5% of precipitation.

  » Annual average precipitation level will be 562 mm.

  » New acid loading will be generated in the dump at acidity concentrations equal to current observed levels (approximately 35,000 mg/l).

  » Acid loading stored in the dumps as the result of earlier infiltration will drain from the dumps over a period of 10-15 years.

» Lime efficiency will remain at the average level achieved over the past few years.

» Lime consumption will not fall below 1,233 tonnes per year.

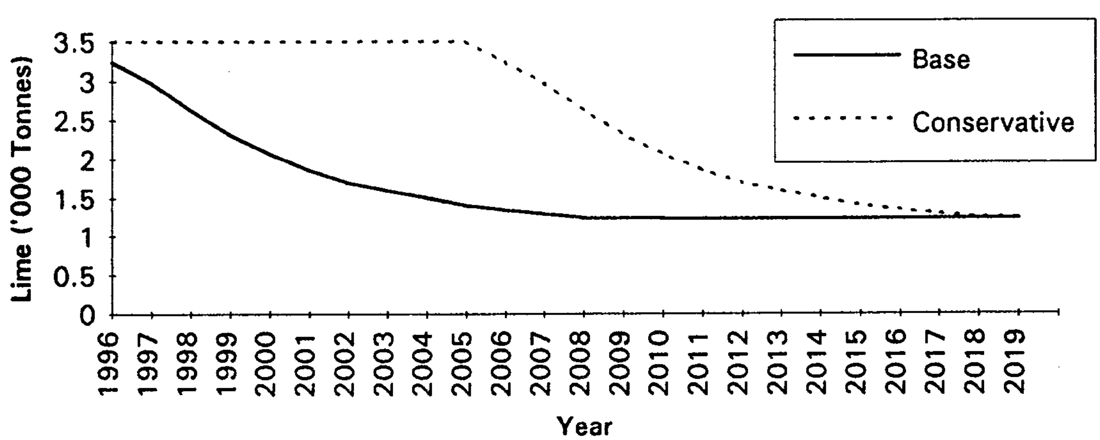
These assumptions generate the pattern of lime consumption shown in Exhibit 2.1.

EXHIBIT 2.1
PROJECTED LIME CONSUMPTION -- BASE PROJECTION

Year	Lime (Tonnes)	Year	Lime (Tonnes)
1996	3,243	2004	1,503
1997	2,974	2005	1,409
1998	2,624	2006	1,347
1999	2,319	2007	1,294
2000	2,067	2008	1,248
2001	1,860	2009	1,240
2002	1,698	2010	1,235
2003	1,599	2011	1,233

- The 'conservative' estimate assumes no reduction in lime consumption for 10 years (i.e. lime consumption of 3,500 tonnes per year) followed by the same pattern of decline projected in the base case. Exhibit 2.2 compares the two projections.

EXHIBIT 2.2
ALTERNATIVE LIME PROJECTIONS



COSTS

- Annual fixed and pumping costs are estimated to be $520,000 based on the normalized average of reclamation spending over the past 5 years, plus an additional $10,000 for a geotechnical review and $10,000 for emergency work.

- The cost of lime is assumed to be $160 per tonne based on the current contract price.

- Provision is made for periodic costs as follows:

Type of Expenditure	Expected Timing	Expected Cost
Major Equipment Repairs	Every five years (starting year 2000)	$50,000 per year
Special Studies	At years 2, 6, and 9	$20,000 per year
Additional Sumps	At years 3 and 6	$30,000 per year
Cover Repairs	Major repairs of system at year 10	$250,000
Cover Repairs	Subsequent repairs every 10 years	$100,000 per year

DISCOUNT RATE

- The required level of security should be based on the present value of 100 years of projected costs using a real discount rate of 4.25% for the first 25 years and 3.5% for the remaining 75 years.

REQUIRED SECURITY

- In 1996, the Company should be required to post security of $21.7 million. This amount is calculated using the cost and discount rate assumptions listed above and using the 'base' projection of lime consumption -- see Exhibit 2.3.

- The Company should increase the security to $24.0 million if actual annual lime consumption in any year is more than 20% higher than that projected for the year in the 'base' projection. This higher figure is the amount of security that is required to cover the costs associated with the 'conservative' lime projection -- see Exhibit 2.4.

EXHIBIT 2.3
BASE PROJECTION

Present Value of Reclamation Cost
(No inflation and real discount rate)

Year	Lime	Lime Cost		Fixed & Var. Cost		Periodic Costs		Total Cost	
	('000 tonnes)	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)
1995	3.500								
1996	3.243	$0.52	$0.52	$0.52	$0.52			$1.04	$1.04
1997	2.974	$0.48	$0.46	$0.52	$0.50	$0.02	$0.02	$1.02	$0.97
1998	2.624	$0.42	$0.39	$0.52	$0.48	$0.03	$0.03	$0.97	$0.89
1999	2.319	$0.37	$0.33	$0.52	$0.46			$0.89	$0.79
2000	2.067	$0.33	$0.28	$0.52	$0.44	$0.05	$0.04	$0.90	$0.76
2001	1.860	$0.30	$0.24	$0.52	$0.42	$0.05	$0.04	$0.87	$0.70
2002	1.698	$0.27	$0.21	$0.52	$0.41			$0.79	$0.62
2003	1.599	$0.26	$0.19	$0.52	$0.39			$0.78	$0.58
2004	1.503	$0.24	$0.17	$0.52	$0.37	$0.02	$0.01	$0.78	$0.56
2005	1.409	$0.23	$0.16	$0.52	$0.36	$0.05	$0.03	$0.80	$0.55
2006	1.347	$0.22	$0.14	$0.52	$0.34	$0.25	$0.16	$0.99	$0.65
2007	1.294	$0.21	$0.13	$0.52	$0.33			$0.73	$0.46
2008	1.248	$0.20	$0.12	$0.52	$0.32			$0.72	$0.44
	----------	----------	----------	----------	----------	----------	----------	----------	----------
2089	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.72	$0.02
Total	132	$21.19	$6.71	$52.00	$14.23	$2.17	$0.68	$75.36	$21.61

EXHIBIT 2.4
MORE CONSERVATIVE PROJECTION

Present Value of Reclamation Cost
(No inflation and real discount rate)

Year	Lime ('000 tonnes)	Lime Cost Annual ($m)	Lime Cost P.V. ($m)	Fixed & Var. Cost Annual ($m)	Fixed & Var. Cost P.V. ($m)	Periodic Costs Annual ($m)	Periodic Costs P.V. ($m)	Total Cost Annual ($m)	Total Cost P.V. ($m)
1995	3.500								
1996	3.500	$0.56	$0.56	$0.52	$0.52			$1.08	$1.08
1997	3.500	$0.56	$0.54	$0.52	$0.50	$0.02	$0.02	$1.10	$1.06
1998	3.500	$0.56	$0.52	$0.52	$0.48	$0.03	$0.03	$1.11	$1.02
1999	3.500	$0.56	$0.49	$0.52	$0.46			$1.08	$0.95
2000	3.500	$0.56	$0.47	$0.52	$0.44	$0.05	$0.04	$1.13	$0.96
2001	3.500	$0.56	$0.45	$0.52	$0.42	$0.05	$0.04	$1.13	$0.92
2002	3.500	$0.56	$0.44	$0.52	$0.41			$1.08	$0.84
2003	3.500	$0.56	$0.42	$0.52	$0.39			$1.08	$0.81
2004	3.500	$0.56	$0.40	$0.52	$0.37	$0.02	$0.01	$1.10	$0.79
2005	3.243	$0.52	$0.36	$0.52	$0.36	$0.05	$0.03	$1.09	$0.75
2006	2.974	$0.48	$0.31	$0.52	$0.34	$0.25	$0.16	$1.25	$0.82
2007	2.624	$0.42	$0.27	$0.52	$0.33			$0.94	$0.59
2008	2.319	$0.37	$0.23	$0.52	$0.32			$0.89	$0.54
	----------	----------	----------	----------	----------	----------	----------	----------	----------
2089	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.72	$0.02
Total	153	$24.46	$9.08	$52.00	$14.23	$2.17	$0.68	$78.63	$23.98

- The Government and the Company will reopen discussions **on a priority basis** to identify a further increase in the required amount of security if actual lime consumption in any year exceeds 4,200 tonnes (i.e. 20% higher than the 'conservative' projection).

- The Company should post additional security of $330,000 to cover additional acid generation from the Southern Tail Dump if the concentration of acidity in any month at that site exceeds 500 mg/litre (i.e. additional security sufficient to generate a real return of $12,000 per year).

ADJUSTMENT OF SECURITY FOR INFLATION

- The amount of security should be reviewed and adjusted annually for inflation. The first adjustment should be made when cumulative inflation from July 1, 1995, exceeds 10%. Thereafter, the security should be increased annually by the annual rate of inflation. (Unless this adjustment is required within 6 months of the date on the next formal review.) Inflation is to be measured by the British Columbia Consumer Price Index B.C.C.P.I.

DATE OF NEXT REVIEW

- The next formal review of reclamation security should commence prior to June 30, 2000. The review date could be brought forward by up to two years if either party requests an early review.

- The Ministry of Energy, Mines and Petroleum Resources will continue to monitor the financial health of Placer Dome Inc. and should call for an even earlier review if they have reason to be concerned about the financial health of the parent corporation of the Company. It will ask the Company to provide, on a quarterly basis, Placer Dome Inc.'s shareholder report and the status of its bond ratings.

RISK FACTORS

- The Company will maintain a program of active monitoring and preventive maintenance that will help minimize the risk factors identified in the report.

- The Reclamation Permit should include reference to the identified risk factors, require future reviews of security to take into account the risk factors, and be clear that the Company is responsible for covering all post closure site maintenance costs associated with these risk factors.

RETENTION OF SPECIAL SECURITY

- The Government should retain $1 million in special security pending successful completion of site reclamation.

CONSULTATION

- The Committee recommends that:

  » Proposed amendments to the Reclamation Permit be circulated to the Equity Silver Mine Public Surveillance Committee for review and comment.

  » The results of the Ministry of Energy, Mines and Petroleum Resource's annual review of the Permit for the Equity mines will be forwarded to the Equity Silver Public Surveillance Committee. This review will include the following:

    - actual and forecast lime consumption and trends with assessment of any material variances.

    - actual and forecast costs and trends, by area, and determination of material variances.

    - Inflation and financial asset returns in the last year. If appropriate, current expectations regarding future inflation and returns will be discussed.

    - Placer Dome Inc.'s audited annual financial statements to determine the company's continued ability to fund long term mine reclamation and provide appropriate security at the Equity mine.

    - The ratings, and their trends, assigned by the recognized credit rating agencies to corporate debt issued by Placer Dome Inc.

CHAPTER THREE
DEVELOPMENTS SINCE 1991

RECLAMATION WORK AT THE SITE

- Mining at the site concluded in 1993. At the conclusion of mining the waste dumps contained 76m tonnes of waste rock -- See Exhibit 3.1

EXHIBIT 3.1
AMOUNT OF WASTE ROCK IN THE DUMPS

	Waste Rock (Tonnes)	Area of Dump (Ha)
Southern Tail Dump	17,500,000	41
Main Dump	43,100,000	48
Bessemer Dump	16,000,000	28
Total	76,000,000	110

- Over the period 1990 and 1994, the Company installed compacted clay covers on the Southern Tail, Bessemer, and Main Dumps. Previously they have been partially covered by loose till. Exhibit 3.2 shows the percentage of the surface area of the dumps covered in each year by type of cover.

- In 1994 the Company started to dismantle and remove the plant site. After the site is cleared, it will be covered with a compacted till cover. This reclamation work is expected to be finished in 1996.

ACIDITY, ACID LOADING, AND PRECIPITATION

- Average acidity of ARD treated peaked in 1991 at 11,500 mg/litre and has declined since then to a level around 7,000 mg/litre.

- The volume of ARD treated has generally fluctuated with the level of precipitation. Annual precipitation levels have varied widely, and the form of precipitation has fluctuated from year to year. In 1995, the Equity site experienced one storm event with a 1 in 200 year intensity but lasting for less than one hour.[1]

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1 The collection system successfully handled the storm event.

EXHIBIT 3.2
PERCENTAGE OF DUMPS COVERED *

Year	Southern Tail			Main Dump			Bessemer Dump		
	No Cover	Loose Cover	Compacted Cover	No Cover	Loose Cover	Compacted Cover	No Cover	Loose Cover	Compacted Cover
1988	69%	31%		42%	58%		92%	8%	
1989	69%	31%		42%	58%		82%	18%	
1990	27%	31%	42%	35%	65%		82%	18%	
1991			100%	25%	7%	68%	64%	3%	33%
1992				7%		93%	64%	3%	33%
1993				5%		95%	48%		52%
1994						100%			100%

- In 1994, the Company began collecting and treating all of the seepage from the Southern Tail Dump and the #1 Dam. The volume of ARD treated has declined by 10-20% from the peak in 1990. Exhibit 3.3 summarizes the trends in acidity, acid loading and precipitation.

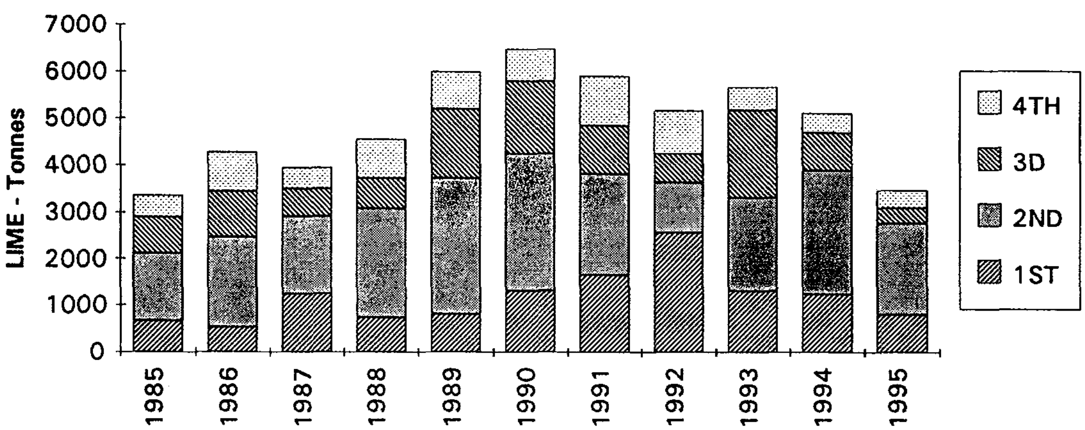
EXHIBIT 3.3
ACIDITY, ACID LOADING, AND PRECIPITATION

Year	ARD Treated m3	Lime Consumed kg	Average Acidity mg/l	Average Plant EFF. %	Annual Precipitation mm
1985	596,365	3,360,045			409.5
1986	909,939	4,274,676			504.4
1987	834,626	3,946,107	7,993		527.3
1988	840,719	4,551,110	10,241		556.3
1989	637,878	5,998,000	9,975	84.2	661.0
1990	1,001,810	6,488,000	8,161	85.3	589.1
1991	767,643	5,916,740	11,474	86.7	555.2
1992	817,880	5,164,270	8,953	88.6	557.0
1993	897,843	5,681,380	9,286	84.4	620.8
1994	970,648	5,124,480	7,595	87.4	871.9
1995	840,706	3,479,897	6,404	93.7	627.0
AVG:	827,535	5,050,481	9,210	86.1	585.3

LIME CONSUMPTION

- Lime consumed in neutralizing ARD peaked in 1990 at 6,500 tonnes. Between 1991 and 1994 lime consumption has been in the range of 5-6,000 tonnes. Lime consumption has shown a marked decrease in 1995 and was less than 3,500 tonnes for the year as a whole. Exhibit 3.4 shows the pattern of lime consumption over the last ten years.

EXHIBIT 3.4
LIME CONSUMPTION OVER PAST TEN YEARS -- BY QUARTER

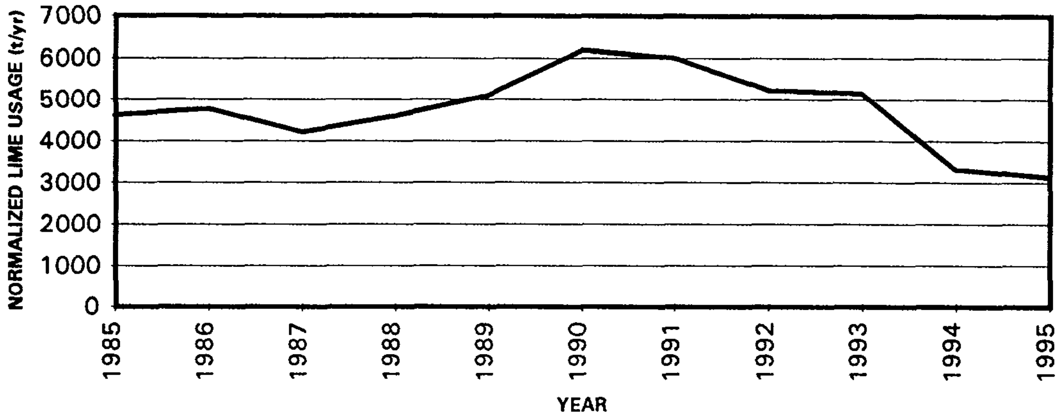


- Because the volume of ARD treated is influenced by the amount of precipitation in any year, the downward trend in lime consumption is obscured by annual variations in precipitation. Exhibit 3.5 shows the trend in annual lime consumption adjusted for the variation in precipitation levels.

UNIVERSITY OF SASKATCHEWAN RESEARCH STUDIES

- The Company has entered into an arrangement with the University of Saskatchewan to conduct research into the effectiveness of the compacted till covers in limiting acid production in the dumps. This research includes on site collection of data and computer modelling of various physical processes within the dumps.

EXHIBIT 3.5
NORMALIZED LIME USEAGE



- The University documented some of their findings in a report dated August 1995.[2] The main purpose of that study was to assess the effectiveness of the cover as a barrier to the transmission of water and oxygen to the underlying rock waste material. The report concluded that the soil cover is performing as designed based on the following observations:

  » The compacted till cover maintains a high degree of saturation and, therefore, should act as a barrier to oxygen transfer. (Even at the hot spots on the South West Face of the Main Dump.)

  » The measured gaseous oxygen concentrations in the dumps have been decreasing.

  » The average measured infiltration from the 12 lysimeters over the period October 1992 to August 1993 was 4%.

  » The hydraulic gradient in the soil cover system is predominately upward.

  » The oxygen concentrations within the dump are not influenced by air temperature, wind speed, or wind direction.

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2 "A Report on the Performance of the Engineering Soil Cover System at Equity Silver Mines Ltd." by Unsaturated Soils Group, Department of Civil Engineering, University of Saskatchewan dated August, 1995.

» Predictive modelling based on field observations, suggests a water infiltration rate of 3%, and an annual oxygen flux of less than 2%, compared to an uncovered dump.

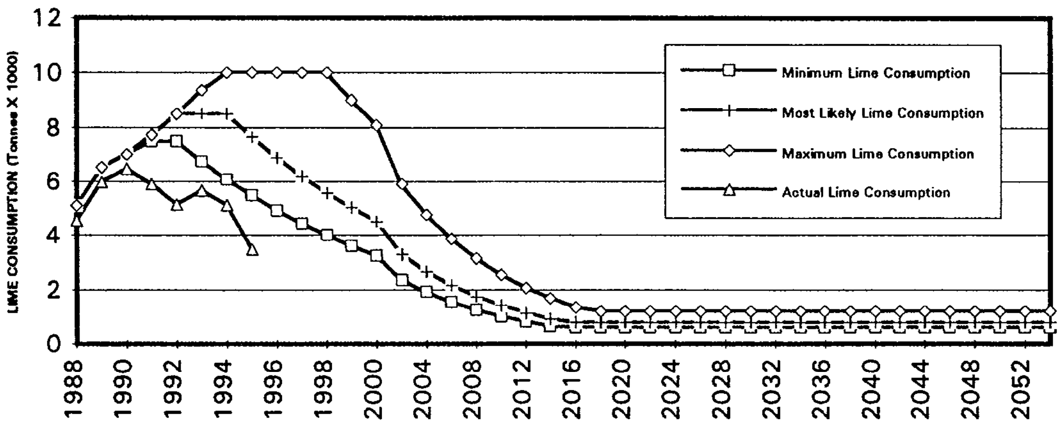
» The temperature in the compacted layer does not drop below freezing. The upper non compacted layer together with snow cover provide freeze/thaw protection to the compacted cover.

CHAPTER FOUR
ESTIMATES OF ACID LOADING AND LIME REQUIREMENTS

COMPARISON TO 1991 PROJECTIONS

- Acid loading and lime consumption to date have been below even the 'minimum' levels projected by the 1991 Technical Committee. Exhibit 4.1 compares actual lime consumption with the three projections made in 1991.

EXHIBIT 4.1
LIME CONSUMPTION PREDICTION



EXPLAINING THE REDUCTION IN ACID LOADING TO DATE

- The Company attributes the reduction in acidity to the placement of an effective till cover and the consequent reduction in the infiltration of water and oxygen. They point to the downward trend in acidity and acid loading, and the University of Saskatchewan study on the integrity of the till cover, as evidence of the success of the cover.[3]

[3] See previous Chapter.

- The Company has attempted to model the acid generation process in the dumps using a 'water balance' model. This model estimates the production of ARD based on assumed infiltration rates of water into the dumps and assumed levels of acidity within the dumps. The model has been applied to the 1990-1995 period[4]. It takes into account variations in precipitation over the period and reflects the gradual placement of the compacted till cover.

- The model assumes that the rate of infiltration is reduced to 5% as a result of the compacted cover but the concentration of acidity in the runoff increases as a result of the lower flow. Overall, however, acid loading declines. Exhibit 4.2 illustrates the assumptions used in the model for the Main Dump. The Company believes the parameters in the model are reasonable because the assumptions are consistent with field observations and University of Saskatchewan predictions[5] on infiltration rates, and acid concentrations at individual seeps.

EXHIBIT 4.2
WATER BALANCE MODEL ASSUMPTIONS - MAIN DUMP

	No Cover	Loose Till Cover	Compacted Till Cover
Infiltration Rate (%)	60%	18%	5%
Acid Concentration (mg/l)	25,000	25,000	35,000

- The model also attempts to replicate drainage rate of the ARD stored in the dumps. The Company believes that the dumps are holding and gradually releasing a considerable volume of ARD that was generated while the dumps were only partially covered. The drainage rate used in the model (10-15 years) is based on a University of Saskatchewan study.[6]

- The model has been partially successful in replicating the pattern of observed acid loading and lime consumption. The fit is good for the Main Dump. It is less so for the Bessemer Dump and a 'base' adjustment is required to replicate the actual loading.[7] Exhibit 4.4 compares total actual lime consumption with that predicted by the model.

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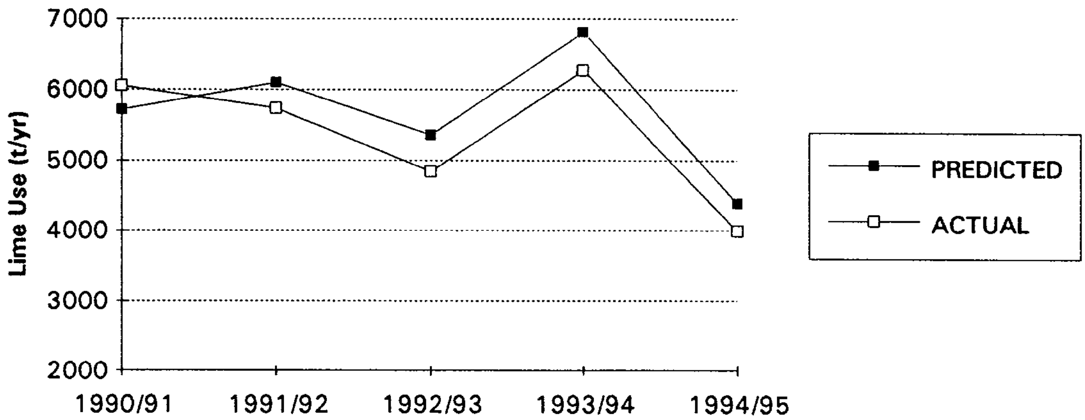
4 Appendix B provides details of the model.
5 See Chapter Three.
6 Discharge flux analysis of Equity Silver Mine's Main Waste Rock Dump by Lori Newman, University of Saskatchewan.
7 Acid is also generated at other sites but the loading is small.

EXHIBIT 4.4
ACTUAL AND PREDICTED LIME USE



- Some members of the Committee expressed doubts about the usefulness of the water balance model because:

  » It uses rather simplistic assumptions
  » It has been fitted to a very small number of observations
  » It does not replicate actual experience without base flow adjustments

- Some members also expressed a lack of confidence in modelling generally because other modelling efforts to date have predicted much sharper reductions in ARD than have been observed.[8] They pointed out, also, that little is known about the physical and chemical processes occurring in the dumps.

- Some members questioned the assumption of decreased chemical activity in the dump given the fact that temperature probes still show reasonably high readings. The Company pointed out that the rate of decline will be gradual. They asked the University of Saskatchewan to model the expected time profile of temperature reduction in the dumps.[9] That study concluded that the waste rock

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[8] Other modelling efforts include those by Steffen Robertson and Kirsten, 1995. "Review of Environmental Liability and Geological Resources Equity Silver Mine - Summary Document" prepared for Special Committee of the Board of Directors Equity Mines Limited, Appendix G of Equity Mines Limited, Information Circular dated June 2, 1995; and,
Senes, 1991. "Acid Generation Modelling Equity Silver Waste Rock Dumps" report to Equity Silver Mines Limited, December 1991.

[9] Thermal analysis of Equity Silver Mine's Waste Rock Dump by Greg Newman, University of Saskatchewan.

can store significant thermal energy for extended periods of time even if no further chemical reaction takes place. The sheer mass of the dumps causes the heat to be released gradually.

- While not all Committee members endorse the particular model developed by the Company, they were in general agreement that the observed decline in acid loading since 1991 is attributable to the placement of the till cover and that the decline is greater than predicted by the 1991 Committee.

PREDICTIONS OF ACID LOADING AND LIME CONSUMPTION

- Forecasting acid loading and lime consumption remains very difficult because of limited actual experience with the till cover in place and only partial success in modelling experience of ARD to date.

- The Company has used its water balance model to predict lime consumption for the next 10-15 years. Their estimate, called the 'base' projection, is shown in Exhibit 4.5.

EXHIBIT 4.5
PROJECTED LIME CONSUMPTION -- BASE PROJECTION

Year	Lime (Tonnes)	Year	Lime (Tonnes)
1996	3,243	2004	1,503
1997	2,974	2005	1,409
1998	2,624	2006	1,347
1999	2,319	2007	1,294
2000	2,067	2008	1,248
2001	1,860	2009	1,240
2002	1,698	2010	1,235
2003	1,599	2011	1,233

- The 'base' projection assumes that:

  » The till cover will continue to be an effective barrier to the passage of water and oxygen and the rate of production of acid will be constrained by the rate of infiltration of precipitation into the dumps. Water infiltration will be 5% of precipitation.

  » The plant site will be covered with a compacted till cover and will reduce the rate of infiltration into the Bessemer Dump.

» Annual average precipitation level will be 562mm.

» New acid loading will be generated in the dump at acidity concentrations equal to current observed levels (approximately 35,000 mg/l in the Main Dump).

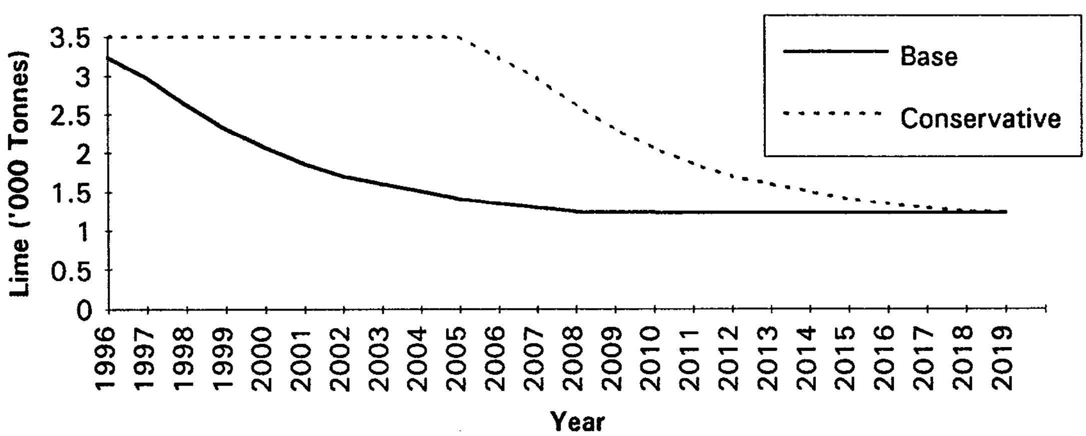
» Acid loading stored in the dumps as the result of earlier infiltration will drain from the dumps over a period of 10-15 years.

» Lime efficiency will remain at the average level achieved over the past few years.

» Lime consumption will not fall below 1,233 tonnes per year.

- The Committee accepted the Company's projections as a reasonable estimate of future lime consumption, given the uncertainties. However, the Committee identified, also, a more conservative projection of lime consumption -- one that assumes that the cover has had its full impact and that loading will not decline further until the chemical reaction in the dump begins to slow down. This 'conservative' projection estimates an unchanged level of lime consumption for 10 years, followed by a gradual decline over 10 years to the same minimum level estimated by the Company. Exhibit 4.6 compares the two projections.

EXHIBIT 4.6
ALTERNATIVE LIME PROJECTIONS



- At the minimum level, lime consumption is assumed to be 1,233 tonnes per year. This is the same level projected by the 1991 Committee in its most conservative forecast of lime consumption.

- The Committee was not able to attach probabilities to the two projections of lime consumption.

- These projections do not take into account the possibility of additional acid production in the Southern Tail pit discharge and the Main Zone Pit. Nor do they include the possibility of increased ARD flow caused by additional groundwater flows through the dumps as the Main Zone Pit fills. These and other risk factors are discussed in Chapter Six.

IMPLICATIONS FOR SECURITY

- The purchase of lime is a major component in the cost of post closure site maintenance work on the site. In 1995 it accounted for 40% of total post closure site maintenance costs. In previous years, the percentage was even higher. Therefore, forecasting lime requirements is a major element in forecasting ongoing costs and, therefore, the size of the security.

- The Committee agrees that it is no longer reasonable to base security on the projections made by the 1991 Committee. Instead the Committee is satisfied that the security should be based on the Company's projection of lime consumption (the base projection) provided safeguards are included in case actual lime consumption exceeds the projected amount. *Therefore, the Committee recommends that:*

  » *The Company should be required to post security based on the 'base projection' of lime consumption.*

  » *The Company should increase the amount of security if actual annual lime consumption in any year is more than 20% higher than that projected for the year in the 'base projection'. In that case, security should be increased to an amount based on the lime estimates in the 'conservative' lime projection.*[10]

  » *The Government and the Company will reopen discussions* ***on a priority basis*** *to identify a further increase in the required amount of security if actual lime consumption in any year exceeds 4,200 tonnes (i.e. 20% higher than the 'conservative' projection).*

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10 For example, if lime use in 1997 exceeds 3568.8 tonnes (i.e. 120% of 2,974 tonnes), the amount of required security will increase to an amount based on the conservative projection. See Chapter Seven for the amount of required security.

CHAPTER FIVE
COST FACTORS

- Expected reclamation costs have been divided into two groups:

  » Annual operating costs
  » Periodic costs

- Annual operating costs are further divided into:

  » **Fixed Costs** - those that will have to be incurred regardless of the volume of ARD collected and treated.

  » **Variable Costs** - those associated with collecting, pumping, and treating ARD.

  » **Lime Costs** - the cost of reagent used to neutralize the acid.

FIXED AND VARIABLE COSTS

- The Company provided actual reclamation costs incurred over the period 1987-1995.[11] Based on these costs the Company has projected annual fixed and variable costs of approximately $500,000. Details of these estimates are shown by category of expenditure in Exhibit 5.1. Projected fixed costs for certain categories, particularly those associated with salaries, are slightly lower than those incurred in recent years because the level of ongoing staffing and supervision will decline as the plant-site reclamation work is concluded. The projections allow for 3.5 full time staff positions on site year round.

- The Committee agrees that the estimates of fixed and variable costs provided by the Company are reasonable and should be sufficient to cover the routine annual monitoring, maintenance and treatment costs on the site other than the cost of reagent. The Committee asked, however, that the annual estimates be increased by $10,000 to cover the cost of an annual geotechnical review and by a further $10,000 as a contingency against the need to conduct emergency repair work on site.

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11 Historical costs are provided in Appendix C.

EXHIBIT 5.1
PROJECTED FIXED AND VARIABLE COSTS

CATEGORY	PROJECTED COST
FIXED	
100 - Supervision	12,000
120 - Salaries Operating	104,500
130 - Salaries Repair and Maintenance	69,700
400 - Services Purchased	55,800
413 - Salary Overhead	29,000
415 - Road Maintenance	6,000
416 - Building Heat	5,000
500 - Equipment - including related salaries	49,000
Miscellaneous Overhead	30,000
Sub-Total	**$361,000**
VARIABLE	
200 - Supplies	31,000
224 - Pumps & Pipe	11,600
510 - Power	100,000
Sub-Total	**$142,600**
TOTAL:	**$503,600**

- *Therefore, the Committee recommends that annual fixed and variable costs of $520,000 be used in the calculation of required security.*

- The cost estimates are calculated in constant 1995 dollars. No allowance is made for inflation because the present value calculations use a **real** discount rate not a **nominal** discount rate.[12]

- These estimated fixed and variable costs are similar to those used by the 1991 Technical Committee.

LIME COSTS

- The cost of lime will depend on volume of acid that needs to be neutralized. The Company has a long term contract with Texada Lime. The current price is $160 per tonne and, under the contract, the price increases annually at the same rate as the BC Consumer Price Index.

[12] See Chapter Seven.

PERIODIC COSTS

- In addition to annual operating costs, the Company may incur periodic costs associated with equipment maintenance and repair of the till cover. Exhibit 5.2 summarizes the Company's estimates of periodic costs.

EXHIBIT 5.2
PERIODIC COSTS

Type of Expenditure	Expected Timing	Expected Cost
Major Equipment Repairs	Every five years (starting year 2000)	$50,000 per year
Special Studies	At years 2, 6, and 9	$20,000 per year
Additional Sumps	At years 3 and 6	$30,000 per year
Cover Repairs	Major repairs of system at year 10	$250,000
Cover Repairs	Subsequent repairs every 10 years	$100,000 per year

- *The Committee recommends that these periodic cost estimates be included in the calculation of required security.*

ROAD MAINTENANCE

- In 1991 the Ministry of Highways indicated that it will be responsible for maintaining the access road to the Equity site. There has been no indication that this will change.[13] However, the maintenance/snow clearing standard of the road has been downgraded.

- There is a possibility that the road could be further downgraded to a forest service road some time in the future. If that happens, the users of the road would be expected to contribute to its cost. However, the Company is now a relatively minor user of the road and any future share of the cost would be much lower than the full cost of maintenance. *Therefore, the Committee recommends that no amount be included in the cost estimates for off site road maintenance.*

[13] The Ministry of Transportation and Highways has given verbal assurance on continuation of the current status (based on a conversation with Mr. Ron Pelensky of the Lakes Highway District in 1994).

SUMMARY OF COSTS

- Exhibits 5.3 and 5.4 detail the Committee's estimates of annual reclamation costs, broken down into lime costs, fixed and variable costs, and periodic costs. Lime costs are based on the lime projections discussed in Chapter Four. Exhibit 5.3 presents cost estimates using the 'base' projection of lime consumption. Exhibit 5.4 presents the costs associated with the 'conservative' projection.

EXHIBIT 5.3
ESTIMATED RECLAMATION COSTS - BASE PROJECTION

Year	Lime Use ('000 tonnes)	Lime Cost ($m)	Fixed & Var. Cost ($m)	Periodic Costs ($m)	Total Cost ($m)
1995	3.500				
1996	3.243	$0.52	$0.52		$1.04
1997	2.974	$0.48	$0.52	$0.02	$1.02
1998	2.624	$0.42	$0.52	$0.03	$0.97
1999	2.319	$0.37	$0.52		$0.89
2000	2.067	$0.33	$0.52	$0.05	$0.90
2001	1.860	$0.30	$0.52	$0.05	$0.87
2002	1.698	$0.27	$0.52		$0.79
2003	1.599	$0.26	$0.52		$0.78
2004	1.503	$0.24	$0.52	$0.02	$0.78
2005	1.409	$0.23	$0.52	$0.05	$0.80
2006	1.347	$0.22	$0.52	$0.25	$0.99
2007	1.294	$0.21	$0.52		$0.73
2008	1.248	$0.20	$0.52		$0.72
	----------	----------	----------	----------	----------
2089	1.233	$0.20	$0.52		$0.72
2090	1.233	$0.20	$0.52	$0.05	$0.77
2091	1.233	$0.20	$0.52		$0.72
2092	1.233	$0.20	$0.52		$0.72
2093	1.233	$0.20	$0.52		$0.72
2094	1.233	$0.20	$0.52		$0.72
2095	1.233	$0.20	$0.52	$0.05	$0.77
Total	132	$21.19	$52.00	$2.17	$75.36

EXHIBIT 5.4
ESTIMATED RECLAMATION COSTS - CONSERVATIVE PROJECTION

Year	Lime ('000 tonnes)	Lime Cost ($m)	Fixed & Var. Cost ($m)	Periodic Costs ($m)	Total Cost ($m)
1995	3.500				
1996	3.500	$0.56	$0.52		$1.08
1997	3.500	$0.56	$0.52	$0.02	$1.10
1998	3.500	$0.56	$0.52	$0.03	$1.11
1999	3.500	$0.56	$0.52		$1.08
2000	3.500	$0.56	$0.52	$0.05	$1.13
2001	3.500	$0.56	$0.52	$0.05	$1.13
2002	3.500	$0.56	$0.52		$1.08
2003	3.500	$0.56	$0.52		$1.08
2004	3.500	$0.56	$0.52	$0.02	$1.10
2005	3.243	$0.52	$0.52	$0.05	$1.09
2006	2.974	$0.48	$0.52	$0.25	$1.25
2007	2.624	$0.42	$0.52		$0.94
2008	2.319	$0.37	$0.52		$0.89
	----------	----------	----------	----------	----------
2089	1.233	$0.20	$0.52		$0.72
2090	1.233	$0.20	$0.52	$0.05	$0.77
2091	1.233	$0.20	$0.52		$0.72
2092	1.233	$0.20	$0.52		$0.72
2093	1.233	$0.20	$0.52		$0.72
2094	1.233	$0.20	$0.52		$0.72
2095	1.233	$0.20	$0.52	$0.05	$0.72
Total	153	$24.46	$52.00	$2.17	$78.63

CHAPTER SIX
RISK FACTORS

- The Committee identified several risk factors that could lead to higher reclamation costs than those outlined in previous chapters. They are:

  - » Ground water bypassing the collection system
  - » Uncontrolled release of ARD because of a failure of the collection system
  - » Additional acid loading at particular sites
  - » The effect of flooding of the Main Zone Pit on the volume of ARD produced in the dumps
  - » Failure of the integrity of the till cover
  - » The impact of climate change on precipitation and storm events
  - » Catastrophic failure of major structures

- The Company prepared an assessment of each of these risk factors which is summarized in Exhibit 6.1. It includes an assessment of the severity of each risk factor, the likelihood of occurrence, compensating and mitigating strategies that can be used to limit the risk.

- For some of the risk factors, such as ground water bypassing the collection system and failure of the collection system, the Committee was in general agreement with the assessment provided by the Company and the conclusion that the risk could be adequately mitigated through routine inspection and maintenance, and by adequate back-up systems.

- The Company stated that maintaining the integrity of the till cover will be a high priority.

- On other issues some members of the Committee disagreed with the Company's assessment. For example, there were widely differing views about the impact filling the Main Zone Pit will have on passage of ground water through the dumps. Some members are very concerned that the change in water level in the Pit could markedly increase ground water flows through the dumps and thereby substantially increase the volume of ARD that has to be collected and treated. The Committee agreed, however, that the situation will have to be closely monitored and that the Company will have to take appropriate action should a problem arise e.g. by maintaining an appropriate water level in the Pit.

EXHIBIT 6.1
EQUITY SILVER MINES - RISK FACTORS

COMPONENT	FAILURE MODES	CONSEQUENCES None - Severe (0-3)	COMMENTS	FAILURE LIKELIHOOD High - Remote (-1 to -5)	COMMENTS	COMPENSATING FACTORS (Protection Now)	OVERALL RISK	POSSIBLE ADDITIONAL MEASURES
Groundwater bypass Collection System	Undetected Seepage : New outside system	1 - 2	Depending on volume lost & concentration - Possible non compl.	-3	No new seeps detected from profile or piezos in last 7 yrs	Creek profiles, piezo monitoring, extensive collection	-1.5	Continue monitoring for early warning of new seeps - Install new sumps if required
	Deep seep under current collection system	1 - 2	Depends on vol & conc - high dilution if mixes with other gdwtr	-4	Piezos around dumps show no contam except Getty - No sign of deep seep in creek profile	Piezo & creek monitoring	-2.5	Continue monitoring -Qrtly samples at Getty piezo - Install new sumps or pumpback wells if required
	Failure of existing collection system to collect gdwtr (SW corner)	2	Probable non compliance if over long period - Moderate env. damage	-3/-4	System has worked well for past 5 yrs since upgrade	System has backups in SW corner - Routine inspections	-1.0	Continue monitoring creeks & piezos - Would take time to cause env. problem
Uncontrolled Release Due to a Failure of Collection System	Collection ditch failure (slough, ice, siltation)	2 - 3	High conc of metals & acidity with low, moderate, & high flow rates	-3	No major failures since ditches constructed - Periodic buildup of ice	Daily inspections, Regular maintenance, 200 yr storm capacity, Secondary backup ditch	-0.5	Good backup in ditch system - Possibly upgrade backup on south side - Continue inspections
	Excessive precipitation affecting ditches & ponds	2	Dilution of ARD & high creek flow dilution	-4	Entire system successfully handled 1:200 storm in 1994	Secondary ditch system- Backup pumps in major pump stations - Excess capacity in ponds	-2.0	System well covered for high ppt. - Increase inspections during heavy rain periods - Spare pumps on auto
	Dam Failure (ARD Ponds)	3	Could lose entire pond- High conc & flow - Difficult to repair	-5	Dams are overdesigned for pond size - Earthquake only real threat to integrity	Dams inspected by geotech annually - Emergency spillway for high level	-2.0	Keep ponds as low as possible w/o freezing intake - Reduces load on dam & vol. lost if failure
	Pump Failure (Enough to severely affect volume)	2 - 3	If all pumps failed in a pumphouse for a long duration the dam could be overtopped (spillway)	-4	Redundancy in every major pumphouse in case 1 or 2 pumps not working	Back up pumps - Preventative maintenance - Millwright & electrician on staff - Pumps on auto - Daily inspections	-1.5	Ensure pumps in good working order (PM)

EXHIBIT 6.1
EQUITY SILVER MINES - RISK FACTORS (Continued)

COMPONENT	FAILURE MODES	CONSEQUENCES None - Severe (0-3)	COMMENTS	FAILURE LIKELIHOOD High - Remote (-1 to -5)	COMMENTS	COMPENSATING FACTORS (Protection Now)	OVERALL RISK	POSSIBLE ADDITIONAL MEASURES
Uncontrolled Release Due to a Failure of Collection System (Continued)	Pipeline Failure	2	Highly contaminated - loss confined to ditch	-3	Periodic breaks due to freezing or joint separation - Ditches collect ARD	Using highly rated Sclair for all ARD pipelines - Pressure indicators on lines - Backup ditches and pipelines	-1.0	Continue regular inspections
	Power Failure (extended)	2 - 3	Lose power long enough to allow overflow of ponds	-3	Extended power loss during period of high flow	Backup generator for Main pond - Portable gen online shortly for other pump stations - Extra storage - Electrician on staff	-0.5	Get portable generator on line - Test generators monthly - Keep ponds as low as possible
	High Level Alarm Fails to Activate	2	Complete alarm/level failure - Pumps not activated for extended period of time - Possibly overtop dams	-3	Would have to occur during high flow period to overtop dam	Daily pond/pumphouse checks - Pumps on manual during high flow periods - Alarm activated for high, low, or power outage	-1.0	Continue daily checks - Check alarm system regularly
	Fire in Pumphouse	2 - 3	Damage electrical controls & possibly pumps	-4	Block buildings - Could have electrical fire	Can start pumps w/o control panel	-1.5	Keep combustibles out of pumphouses
Additional Acid Load	S.T. pit - discharge becomes more acidic	1	5 million tonnes under cover - wouldn't produce much acidity - Increased cost if large change in acidity	-4	Sulphate steady, Alkalinity increasing - Not likely to go further acidic soon if ever	Acidity very low <10 mg/L - Would have to increase 2 orders of magnitude to effect cost - Low vol. rock under cover - small load	-3.0	Continue to monitor trends
	Main Zone pit - becomes acidic	1 - 2	Flushing of exposed pit walls turn pit water acidic - Elevated metals & flow - Increased cost	-4	Alkaline groundwater & excess lime in sludge - Decreasing exposure	Two studies concluded pit would not turn acidic - If does turn acidic would be high vol low contam - Present quality good	-2.5	Continue to monitor - Possible to fast fill if required

EXHIBIT 6.1
EQUITY SILVER MINES - RISK FACTORS (Continued)

COMPONENT	FAILURE MODES	CONSEQUENCES None - Severe (0-3)	COMMENTS	FAILURE LIKELIHOOD High - Remote (-1 to -5)	COMMENTS	COMPENSATING FACTORS (Protection Now)	OVERALL RISK	POSSIBLE ADDITIONAL MEASURES
Main Zone Pit Flooding - Effects on ARD collection system	Increase flow in ARD collection system (Main dump)	1	Minimal flow predicted - Moderate contamination along base - Possibly dilute existing flows - Could increase cost	-3	Pit won't fill for 15 years - Minimal increase w/ fractures covered	K.C. study predicted increase of 1.2 l/sec over present levels - Covered fractured bedrock w/ till to reduce migration	-2.0	If problem can pump down level of pit below migration level
Till Cover Integrity	Maintaining Compaction	2	Widespread loss of compaction - Increased oxygen & water infil. - Increased cost	-4	Compacted layer protected by upper layer - monitoring to date shows no effects on compaction	Uncompacted upper layer acts as protection - U of Sask study predicts minimal loss of compaction	-2.0	Could repair small - moderate areas - Widespread loss would be difficult to repair
	Settling of Dump	1 - 2	Depending on size of area affected - Could increase cost	-4	Dump monitoring has shown very little settling	Monitoring targets on dump - Visual inspection of cover for large scale cracks due to settling	-2.5	Could repair settled area if identified - Try to inspect entire dump surface annually
Climate Change	Increased precipitation as storm events	1 - 2	Depends on increase in ppt levels - Could increase cost if significant ppt increase	-4?	Could get more storms but no overall increase - Could get less total ppt/yr - Possible increase in runoff if storm events	Dump cover will shed storm events effectively - Collection system designed for 1:200 storm event - 1994 1:200 storm event	-2.5	Ensure ponds kept low for extra capacity in case of storms - Erosion protection for dump runoff ditches where required - Divert unnecessary watersheds
Catastrophic Failure	Section of Waste Dump	2	Lose large section of dump cover due to dump instability - Possibly slough in Main ARD ditch	-5	No large scale movements on dumps since construction at 20 degree slope	Monitoring survey targets on dump to detect movement - Secondary ARD collection if Main blocked	-3.0	Set up more targets on dump - continue monitoring regularly
	Pit Wall (Main Zone or Waterline)	1 - 2	Major pit wall slide (above water level) - Expose more acid rock to oxidation - Increase contam flush to pit - Increase treat cost	-4	Pit walls have been stable with only small scale failures - Would have to occur above water level to affect water quality	Most of the exposed pit wall will be non acid generating at final water elev. - Reduces risk of increased acid prod from failure	-2.5	

EXHIBIT 6.1
EQUITY SILVER MINES - RISK FACTORS (Continued)

COMPONENT	FAILURE MODES	CONSEQUENCES None - Severe (0-3)	COMMENTS	FAILURE LIKELIHOOD High - Remote (-1 to -5)	COMMENTS	COMPENSATING FACTORS (Protection Now)	OVERALL RISK	POSSIBLE ADDITIONAL MEASURES
Catastrophic Failure (Continued)	Tailings Dam	3	Major tailings dam failure - Loss of tailings to Diversion pond or Foxy creek	-5	No indication of significant dam movement in past - Adequate safety factor in design & operation	Annual geotech inspections & stability analyses - Emergency spillway - Regular monitoring of survey monuments	-2.0	Continue inspections and monitoring

DEGREE OF SAFETY	DESCRIPTION	HAZARD RATING
Safe	No environmental damage.	0
Marginal	Minor environmental damage. Possible non-compliance. Associated costs less than $100,000	1
Unsafe	Definite non-compliance and environmental damage. Possible charges. Costs between $100,000 - $2,000,000.	2
Very Unsafe	Severe Environmental damage. Non-Compliance and charges. Costs over $2,000,000.	3

DESCRIPTION	FREQUENCY	RATING (P)
Highly Likely	1 or >/yr	-1
Very Likely	1/ 2 - 5 yrs	-2
Likely	1/ 6 - 15 yrs	-3
Remote	1/ 16 - 35 yrs	-4
Very Unlikely	1/ 35 or >	-5

- On climate change, also, the Committee members had differing views about the likely changes, their probability of occurrence, and their impact.

- Some issues, such as failure of the tailings dam, were considered by the Committee to be of very low probability.

- The uncertainty of these risk factors, both their likelihood of occurrence and the cost of taking compensating action, make it difficult to include an estimate of expected cost in the calculation of required security. For some, the Committee agreed that sufficient funds have been included in the cost estimates to cover necessary maintenance work on the collection system and till cover. For others, the Committee recognized that it is extremely difficult at this time to convert the risks into expected costs.

- The Committee recognizes that the amount of security may have to be increased if, at a later time, any of these risk factors becomes more pronounced and results in substantially increased post closure site maintenance costs.

- *The Committee recommends, therefore, that the Reclamation Permit include reference to these risk factors, require future reviews of security to take into account the risk factors, and be clear that the Company is responsible for covering all post closure site maintenance costs associated with these risk factors.*

- *The Committee recommends that the Company should post additional security if the concentration of acidity at the Southern Tail Dump in any month exceeds 500 mg/l. The additional security should be sufficient to generate a real return of $12,000 per year.*

CHAPTER SEVEN
THE DISCOUNT RATE AND REQUIRED SECURITY

CHOICE OF DISCOUNT RATE

- The size of the required security is calculated by taking the stream of expected annual costs over the next 100 years and discounting them to a present value. The resulting figure is the amount of capital that would generate a stream of income sufficient to cover the expected reclamation costs.

- The present value calculation can be done using real or nominal discount rates. If nominal rates are used, annual cost estimates need to be adjusted each year by the expected rate of inflation. If real rates are used, the rate of inflation does not have to be predicted. Historically, real rates of return have been more stable than inflation rates. *The Committee recommends use of a real discount rate because of the difficulty of forecasting inflation rates over a long period.*

- The discount rate chosen should be one that the government could reasonably expect to earn on invested capital should the Company default on its obligation and the security becomes the only source of income for ongoing reclamation purposes. Traditionally, the discount rate used for this calculation has been the rate that could be earned on low risk investment instruments, usually short-term government securities. In 1991, a real discount rate of 3% was used to calculate the required security.

- The discount rate used in the present value calculation has a significant impact on the amount of security required. Exhibit 7.1 compares the present value of a stream of annual costs of $1 million using different real discount rates

EXHIBIT 7.1
PRESENT VALUE CALCULATIONS USING ALTERNATIVE DISCOUNT RATES

Real Discount Rate	Annual Cost $m	Present Value* $m
3%	1	32.5
4%	1	25.5
5%	1	20.8

* Present value over 100 years assuming no discounting in the first year.

- The Committee reviewed a variety of evidence that suggests that 3%, the real rate of return used in 1991, is too low a rate to be used in the present value calculation:

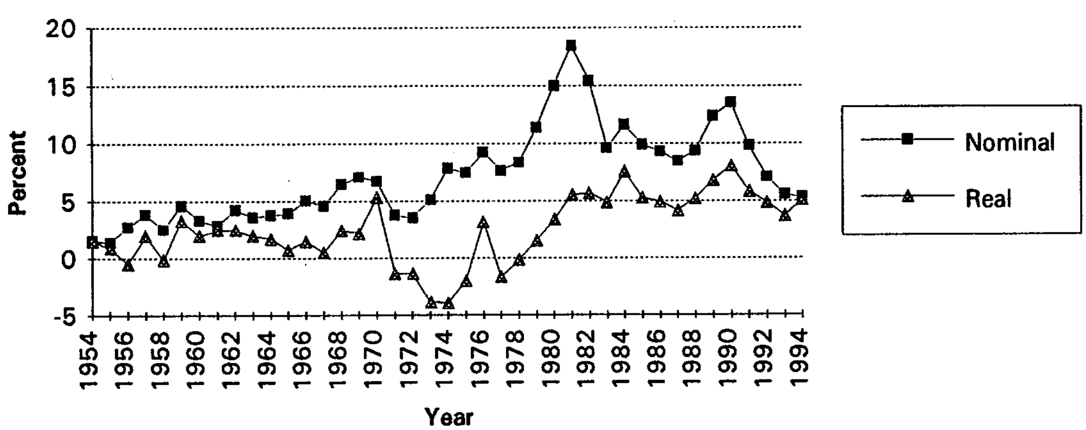
  » The real rate of return on government securities has steadily increased over the past 20 years as a result of the globalization of capital markets, the increased amount of government debt outstanding and market sensitivity to negative real returns on government securities in the 1970s. Exhibit 7.2 illustrates the trend for Government of Canada 90 day Treasury Bills.

  » In 1991, the Government of Canada issued real rate of return bonds for the first time, offering a face value of 4.25% and a thirty year term. Since then, they have traded at prices that yield a market return of between 3.4% and 5.1%. They are currently trading around 4.7%.

  » Government actuaries have increased the real rates that they use in estimating the contributions required to sustain public sector pension plans.

Based on this evidence, the Committee believes that the long term real rate of return should be increased from 3 to 3.5%.

EXHIBIT 7.2
REAL RATES VS NOMINAL RATES -- 90 DAY T-BILLS



- The Committee recognizes also that real rates are currently higher than this long term level and are likely to remain there for some time. However, there is considerable uncertainty about how long these higher rates will last. Therefore, the Committee recommends a split discount rate be used for the present value calculation, one that uses 3.5% as the long term rate but recognizes that a higher return can be earned in the near term. Exhibit 7.3 shows the impact on the present value calculation of using split 4.25%/3.5% rates for different periods at the higher rate.

EXHIBIT 7.3
PRESENT VALUE CALCULATIONS USING SPLIT DISCOUNT RATES

Period at Rate of 4.25%	Period at Rate of 3.5%	Annual Cost $m	Present Value $m
0 years	100 years	1	28.62
5 years	95 years	1	28.56
30 years	70 years	1	27.08
50 years	50 years	1	25.82

- Given that the Government of Canada has issued real bonds with a remaining term of 25 years, the Committee suggests that this term be used as the period of a higher discount rate. *The Committee recommends therefore:*

  » *Use of a discount rate of 4.25% for the first 25 years; and,*

  » *Use of a 3.5% rate thereafter.*

SIZE OF REQUIRED SECURITY

- The size of the required security is calculated using the annual cost estimates presented in Exhibits 5.3 and 5.4 of Chapter Five and converting them to a present value using the discount rates outlined above. Exhibits 7.4 and 7.5 summarize the calculations for the 'base' projection and the 'conservative' projection.[14]

[14] Appendix A provides the information for each year of the 1996-2095 period.

EXHIBIT 7.4
PRESENT VALUE OF COSTS -- BASE PROJECTION

Year	Lime Cost Annual ($m)	Lime Cost P.V. ($m)	Fixed & Var. Cost Annual ($m)	Fixed & Var. Cost P.V. ($m)	Periodic Costs Annual ($m)	Periodic Costs P.V. ($m)	Total Cost Annual ($m)	Total Cost P.V. ($m)
1995								
1996	$0.52	$0.52	$0.52	$0.52			$1.04	$1.04
1997	$0.48	$0.46	$0.52	$0.50	$0.02	$0.02	$1.02	$0.97
1998	$0.42	$0.39	$0.52	$0.48	$0.03	$0.03	$0.97	$0.89
1999	$0.37	$0.33	$0.52	$0.46			$0.89	$0.79
2000	$0.33	$0.28	$0.52	$0.44	$0.05	$0.04	$0.90	$0.76
2001	$0.30	$0.24	$0.52	$0.42	$0.05	$0.04	$0.87	$0.70
2002	$0.27	$0.21	$0.52	$0.41			$0.79	$0.62
2003	$0.26	$0.19	$0.52	$0.39			$0.78	$0.58
2004	$0.24	$0.17	$0.52	$0.37	$0.02	$0.01	$0.78	$0.56
2005	$0.23	$0.16	$0.52	$0.36	$0.05	$0.03	$0.80	$0.55
2006	$0.22	$0.14	$0.52	$0.34	$0.25	$0.16	$0.99	$0.65
2007	$0.21	$0.13	$0.52	$0.33			$0.73	$0.46
2008	$0.20	$0.12	$0.52	$0.32			$0.72	$0.44
	------------	-----------	------------	-----------	------------	------------	-----------	------------
2089	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.72	$0.02
Total	$21.19	$6.71	$52.00	$14.23	$2.17	$0.68	$75.36	$21.61

EXHIBIT 7.5
PRESENT VALUE OF COSTS -- CONSERVATIVE PROJECTION

Year	Lime Cost		Fixed & Var. Cost		Periodic Costs		Total Cost	
	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)	Annual ($m)	P.V. ($m)
1995								
1996	$0.56	$0.56	$0.52	$0.52			$1.08	$1.08
1997	$0.56	$0.54	$0.52	$0.50	$0.02	$0.02	$1.10	$1.06
1998	$0.56	$0.52	$0.52	$0.48	$0.03	$0.03	$1.11	$1.02
1999	$0.56	$0.49	$0.52	$0.46			$1.08	$0.95
2000	$0.56	$0.47	$0.52	$0.44	$0.05	$0.04	$1.13	$0.96
2001	$0.56	$0.45	$0.52	$0.42	$0.05	$0.04	$1.13	$0.92
2002	$0.56	$0.44	$0.52	$0.41			$1.08	$0.84
2003	$0.56	$0.42	$0.52	$0.39			$1.08	$0.81
2004	$0.56	$0.40	$0.52	$0.37	$0.02	$0.01	$1.10	$0.79
2005	$0.52	$0.36	$0.52	$0.36	$0.05	$0.03	$1.09	$0.75
2006	$0.48	$0.31	$0.52	$0.34	$0.25	$0.16	$1.25	$0.82
2007	$0.42	$0.27	$0.52	$0.33			$0.94	$0.59
2008	$0.37	$0.23	$0.52	$0.32			$0.89	$0.54
	------------	-----------	------------	-----------	------------	------------	-----------	------------
2089	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.72	$0.02
Total	$24.46	$9.08	$52.00	$14.23	$2.17	$0.68	$78.63	$23.98

CHAPTER EIGHT
OTHER ISSUES

PERIOD OF REVIEW

- Given the fact that considerable uncertainty still exists about future ARD loading and the cost of treatment, the Committee believes the amount of security should be reviewed periodically at intervals no longer than five years. It should be possible also for either the Government or the Company to request an acceleration in the timing of the review.

- Given the uncertainty over the cost of reclamation and the possibility that the Company may have to increase the amount of security in the future if reclamation costs increase, the Ministry of Energy, Mines and Petroleum Resources needs to monitor the financial health of the Company and its ability to add security should it be required.

- *The Committee recommends, therefore, that:*

  » *The next formal review of reclamation security should commence prior to June 30, 2000. The review date could be brought forward by up to two years if either party requests an early review.*

  » *The Ministry of Energy, Mines and Petroleum Resources continue to monitor the financial health of Placer Dome Inc. and should call for an even earlier review if they have reason to be concerned about the financial health of the parent corporation of the Company. It will ask the Company to provide, on a quarterly basis, Placer Dome Inc.'s shareholder report, and the status of its bond ratings.*

INFLATION ADJUSTMENT OF THE SECURITY

- The current provisions of the reclamation permit require the amount of security be increased each year by the rate of inflation. If this adjustment were not made, the real value of the security would decline over time.

- If the rate of inflation is relatively low, however, the required annual adjustments are quite small and require the Company to incur the costs of changing the Letter of Credit provided by its financial institution.

- Because the annual rate of inflation is low, the Committee is supportive of less frequent inflation adjustments, provided a suitable safeguard is included in case the rate of inflation should increase. The Committee supports the concept of a threshold and agrees that no adjustment be required until inflation has eroded the real value of security by 10%.

- *Therefore, the Committee recommends that: the amount of security should be reviewed and adjusted annually for inflation. The first adjustment should be made when cumulative inflation from July 1, 1995, exceeds 10%.*[15] *Thereafter, the security should be increased annually by the rate of inflation. (Unless this adjustment is required within 6 months of the date on the next formal review.) Inflation is to be measured by the British Columbia Consumer Price Index (B.C.C.P.I.).*

RETENTION OF SPECIAL SECURITY

- The current reclamation permit requires the Company to maintain additional security of $3.3 million pending completion of a compacted till cover on the waste dumps. Given the work that has been completed, *the Committee recommends that this security no longer be required.*

- The current permit also requires the Company to provide an additional $2.17 million pending plant site reclamation; construction of a permanent spillway for tailings and water control structures; and other reclamation work detailed in the Company's decommissioning plan. *The Committee recommends that additional security of $1 million be retained for site reclamation until the work is completed.*

CONSULTATION

- The Committee recommends that:

  » Proposed amendments to the Reclamation Permit be circulated to the Equity Silver Mine Public Surveillance Committee for review and comments.

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[15] The 1995 date is recommended because cost estimates are in 1995 dollars.

» The results of the Ministry of Energy, Mines and Petroleum Resource's annual review of the Permit for the Equity mines will be forwarded to the Equity Silver Public Surveillance Committee. This review will include the following:

- actual and forecast lime consumption and trends with assessment of any material variances.
- actual and forecast costs and trends, by area, and determination of material variances.
- Inflation and financial asset returns in the last year. If appropriate, current expectations regarding future inflation and returns will be discussed.
- Placer Dome Inc.'s audited annual financial statements to determine the company's continued ability to fund long term mine reclamation and provide appropriate security at the Equity mine.
- The ratings, and their trends, assigned by the recognized credit rating agencies to corporate debt issued by Placer Dome Inc.

APPENDIX A
DETAILS OF PRESENT VALUE CALCULATIONS

Base Projection

Present Value of Reclamation Cost
(No inflation and real discount rate)

Year	lime ('000 tonnes	Lime Cost Annual ($m)	Lime Cost P.V. ($m)	Fixed & Var. Cost Annual ($m)	Fixed & Var. Cost P.V. ($m)	Periodic Costs Annual ($m)	Periodic Costs P.V. ($m)	Total Cost Annual ($m)	Total Cost P.V. ($m)
1995	3.500								
1996	3.243	$0.52	$0.52	$0.52	$0.52			$1.04	$1.04
1997	2.974	$0.48	$0.46	$0.52	$0.50	$0.02	$0.02	$1.02	$0.97
1998	2.624	$0.42	$0.39	$0.52	$0.48	$0.03	$0.03	$0.97	$0.89
1999	2.319	$0.37	$0.33	$0.52	$0.46			$0.89	$0.79
2000	2.067	$0.33	$0.28	$0.52	$0.44	$0.05	$0.04	$0.90	$0.76
2001	1.860	$0.30	$0.24	$0.52	$0.42	$0.05	$0.04	$0.87	$0.70
2002	1.698	$0.27	$0.21	$0.52	$0.41			$0.79	$0.62
2003	1.599	$0.26	$0.19	$0.52	$0.39			$0.78	$0.58
2004	1.503	$0.24	$0.17	$0.52	$0.37	$0.02	$0.01	$0.78	$0.56
2005	1.409	$0.23	$0.16	$0.52	$0.36	$0.05	$0.03	$0.80	$0.55
2006	1.347	$0.22	$0.14	$0.52	$0.34	$0.25	$0.16	$0.99	$0.65
2007	1.294	$0.21	$0.13	$0.52	$0.33			$0.73	$0.46
2008	1.248	$0.20	$0.12	$0.52	$0.32			$0.72	$0.44
2009	1.240	$0.20	$0.12	$0.52	$0.30			$0.72	$0.42
2010	1.235	$0.20	$0.11	$0.52	$0.29	$0.05	$0.03	$0.77	$0.43
2011	1.233	$0.20	$0.11	$0.52	$0.28			$0.72	$0.38
2012	1.233	$0.20	$0.10	$0.52	$0.27			$0.72	$0.37
2013	1.233	$0.20	$0.10	$0.52	$0.26			$0.72	$0.35
2014	1.233	$0.20	$0.09	$0.52	$0.25			$0.72	$0.34
2015	1.233	$0.20	$0.09	$0.52	$0.24	$0.05	$0.02	$0.77	$0.35
2016	1.233	$0.20	$0.09	$0.52	$0.23	$0.10	$0.04	$0.82	$0.36
2017	1.233	$0.20	$0.08	$0.52	$0.22			$0.72	$0.30
2018	1.233	$0.20	$0.08	$0.52	$0.21			$0.72	$0.29
2019	1.233	$0.20	$0.08	$0.52	$0.20			$0.72	$0.28
2020	1.233	$0.20	$0.07	$0.52	$0.19	$0.05	$0.02	$0.77	$0.28
2021	1.233	$0.20	$0.07	$0.52	$0.18			$0.72	$0.25
2022	1.233	$0.20	$0.08	$0.52	$0.21			$0.72	$0.29
2023	1.233	$0.20	$0.08	$0.52	$0.21			$0.72	$0.28
2024	1.233	$0.20	$0.08	$0.52	$0.20			$0.72	$0.27
2025	1.233	$0.20	$0.07	$0.52	$0.19	$0.05	$0.02	$0.77	$0.28
2026	1.233	$0.20	$0.07	$0.52	$0.19	$0.10	$0.04	$0.82	$0.29
2027	1.233	$0.20	$0.07	$0.52	$0.18			$0.72	$0.25
2028	1.233	$0.20	$0.07	$0.52	$0.17			$0.72	$0.24
2029	1.233	$0.20	$0.06	$0.52	$0.17			$0.72	$0.23
2030	1.233	$0.20	$0.06	$0.52	$0.16	$0.05	$0.02	$0.77	$0.24
2031	1.233	$0.20	$0.06	$0.52	$0.16			$0.72	$0.22
2032	1.233	$0.20	$0.06	$0.52	$0.15			$0.72	$0.21
2033	1.233	$0.20	$0.06	$0.52	$0.15			$0.72	$0.20
2034	1.233	$0.20	$0.05	$0.52	$0.14			$0.72	$0.19
2035	1.233	$0.20	$0.05	$0.52	$0.14	$0.05	$0.01	$0.77	$0.20
2036	1.233	$0.20	$0.05	$0.52	$0.13	$0.10	$0.03	$0.82	$0.21
2037	1.233	$0.20	$0.05	$0.52	$0.13			$0.72	$0.18
2038	1.233	$0.20	$0.05	$0.52	$0.12			$0.72	$0.17
2039	1.233	$0.20	$0.04	$0.52	$0.12			$0.72	$0.16
2040	1.233	$0.20	$0.04	$0.52	$0.11	$0.05	$0.01	$0.77	$0.17
2041	1.233	$0.20	$0.04	$0.52	$0.11			$0.72	$0.15
2042	1.233	$0.20	$0.04	$0.52	$0.11			$0.72	$0.15
2043	1.233	$0.20	$0.04	$0.52	$0.10			$0.72	$0.14

2044	1.233	$0.20	$0.04	$0.52	$0.10			$0.72	$0.14
2045	1.233	$0.20	$0.04	$0.52	$0.10	$0.05	$0.01	$0.77	$0.14
2046	1.233	$0.20	$0.04	$0.52	$0.09	$0.10	$0.02	$0.82	$0.15
2047	1.233	$0.20	$0.03	$0.52	$0.09			$0.72	$0.12
2048	1.233	$0.20	$0.03	$0.52	$0.09			$0.72	$0.12
2049	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.12
2050	1.233	$0.20	$0.03	$0.52	$0.08	$0.05	$0.01	$0.77	$0.12
2051	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.11
2052	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.10
2053	1.233	$0.20	$0.03	$0.52	$0.07			$0.72	$0.10
2054	1.233	$0.20	$0.03	$0.52	$0.07			$0.72	$0.10
2055	1.233	$0.20	$0.03	$0.52	$0.07	$0.05	$0.01	$0.77	$0.10
2056	1.233	$0.20	$0.03	$0.52	$0.07	$0.10	$0.01	$0.82	$0.10
2057	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.09
2058	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2059	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2060	1.233	$0.20	$0.02	$0.52	$0.06	$0.05	$0.01	$0.77	$0.08
2061	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2062	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2063	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2064	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2065	1.233	$0.20	$0.02	$0.52	$0.05	$0.05	$0.00	$0.77	$0.07
2066	1.233	$0.20	$0.02	$0.52	$0.05	$0.10	$0.01	$0.82	$0.07
2067	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.06
2068	1.233	$0.20	$0.02	$0.52	$0.04			$0.72	$0.06
2069	1.233	$0.20	$0.02	$0.52	$0.04			$0.72	$0.06
2070	1.233	$0.20	$0.02	$0.52	$0.04	$0.05	$0.00	$0.77	$0.06
2071	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2072	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2073	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2074	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2075	1.233	$0.20	$0.01	$0.52	$0.03	$0.05	$0.00	$0.77	$0.05
2076	1.233	$0.20	$0.01	$0.52	$0.03	$0.10	$0.01	$0.82	$0.05
2077	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2078	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2079	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2080	1.233	$0.20	$0.01	$0.52	$0.03	$0.05	$0.00	$0.77	$0.04
2081	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2082	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2083	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2084	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.03
2085	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.04
2086	1.233	$0.20	$0.01	$0.52	$0.02	$0.10	$0.00	$0.82	$0.04
2087	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2088	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2089	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
Total	132	$21.19	$6.71	$52.00	$14.23	$2.17	$0.68	$75.36	$21.61

More Conservative Projection

Present Value of Reclamation Cost
(No inflation and real discount rate)

Year	lime ('000 tonnes	Lime Cost Annual ($m)	Lime Cost P.V. ($m)	Fixed & Var. Cost Annual ($m)	Fixed & Var. Cost P.V. ($m)	Periodic Costs Annual ($m)	Periodic Costs P.V. ($m)	Total Cost Annual ($m)	Total Cost P.V. ($m)
1995	3.500								
1996	3.500	$0.56	$0.56	$0.52	$0.52			$1.08	$1.08
1997	3.500	$0.56	$0.54	$0.52	$0.50	$0.02	$0.02	$1.10	$1.06
1998	3.500	$0.56	$0.52	$0.52	$0.48	$0.03	$0.03	$1.11	$1.02
1999	3.500	$0.56	$0.49	$0.52	$0.46			$1.08	$0.95
2000	3.500	$0.56	$0.47	$0.52	$0.44	$0.05	$0.04	$1.13	$0.96
2001	3.500	$0.56	$0.45	$0.52	$0.42	$0.05	$0.04	$1.13	$0.92
2002	3.500	$0.56	$0.44	$0.52	$0.41			$1.08	$0.84
2003	3.500	$0.56	$0.42	$0.52	$0.39			$1.08	$0.81
2004	3.500	$0.56	$0.40	$0.52	$0.37	$0.02	$0.01	$1.10	$0.79
2005	3.243	$0.52	$0.36	$0.52	$0.36	$0.05	$0.03	$1.09	$0.75
2006	2.974	$0.48	$0.31	$0.52	$0.34	$0.25	$0.16	$1.25	$0.82
2007	2.624	$0.42	$0.27	$0.52	$0.33			$0.94	$0.59
2008	2.319	$0.37	$0.23	$0.52	$0.32			$0.89	$0.54
2009	2.067	$0.33	$0.19	$0.52	$0.30			$0.85	$0.50
2010	1.860	$0.30	$0.17	$0.52	$0.29	$0.05	$0.03	$0.87	$0.48
2011	1.698	$0.27	$0.15	$0.52	$0.28			$0.79	$0.42
2012	1.599	$0.26	$0.13	$0.52	$0.27			$0.78	$0.40
2013	1.503	$0.24	$0.12	$0.52	$0.26			$0.76	$0.37
2014	1.409	$0.23	$0.11	$0.52	$0.25			$0.75	$0.35
2015	1.347	$0.22	$0.10	$0.52	$0.24	$0.05	$0.02	$0.79	$0.36
2016	1.294	$0.21	$0.09	$0.52	$0.23	$0.10	$0.04	$0.83	$0.36
2017	1.248	$0.20	$0.08	$0.52	$0.22			$0.72	$0.30
2018	1.240	$0.20	$0.08	$0.52	$0.21			$0.72	$0.29
2019	1.235	$0.20	$0.08	$0.52	$0.20			$0.72	$0.28
2020	1.233	$0.20	$0.07	$0.52	$0.19	$0.05	$0.02	$0.77	$0.28
2021	1.233	$0.20	$0.07	$0.52	$0.18			$0.72	$0.25
2022	1.233	$0.20	$0.08	$0.52	$0.21			$0.72	$0.29
2023	1.233	$0.20	$0.08	$0.52	$0.21			$0.72	$0.28
2024	1.233	$0.20	$0.08	$0.52	$0.20			$0.72	$0.27
2025	1.233	$0.20	$0.07	$0.52	$0.19	$0.05	$0.02	$0.77	$0.28
2026	1.233	$0.20	$0.07	$0.52	$0.19	$0.10	$0.04	$0.82	$0.29
2027	1.233	$0.20	$0.07	$0.52	$0.18			$0.72	$0.25
2028	1.233	$0.20	$0.07	$0.52	$0.17			$0.72	$0.24
2029	1.233	$0.20	$0.06	$0.52	$0.17			$0.72	$0.23
2030	1.233	$0.20	$0.06	$0.52	$0.16	$0.05	$0.02	$0.77	$0.24
2031	1.233	$0.20	$0.06	$0.52	$0.16			$0.72	$0.22
2032	1.233	$0.20	$0.06	$0.52	$0.15			$0.72	$0.21
2033	1.233	$0.20	$0.06	$0.52	$0.15			$0.72	$0.20
2034	1.233	$0.20	$0.05	$0.52	$0.14			$0.72	$0.19
2035	1.233	$0.20	$0.05	$0.52	$0.14	$0.05	$0.01	$0.77	$0.20
2036	1.233	$0.20	$0.05	$0.52	$0.13	$0.10	$0.03	$0.82	$0.21
2037	1.233	$0.20	$0.05	$0.52	$0.13			$0.72	$0.18
2038	1.233	$0.20	$0.05	$0.52	$0.12			$0.72	$0.17
2039	1.233	$0.20	$0.04	$0.52	$0.12			$0.72	$0.16
2040	1.233	$0.20	$0.04	$0.52	$0.11	$0.05	$0.01	$0.77	$0.17
2041	1.233	$0.20	$0.04	$0.52	$0.11			$0.72	$0.15
2042	1.233	$0.20	$0.04	$0.52	$0.11			$0.72	$0.15
2043	1.233	$0.20	$0.04	$0.52	$0.10			$0.72	$0.14

2044	1.233	$0.20	$0.04	$0.52	$0.10			$0.72	$0.14
2045	1.233	$0.20	$0.04	$0.52	$0.10	$0.05	$0.01	$0.77	$0.14
2046	1.233	$0.20	$0.04	$0.52	$0.09	$0.10	$0.02	$0.82	$0.15
2047	1.233	$0.20	$0.03	$0.52	$0.09			$0.72	$0.12
2048	1.233	$0.20	$0.03	$0.52	$0.09			$0.72	$0.12
2049	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.12
2050	1.233	$0.20	$0.03	$0.52	$0.08	$0.05	$0.01	$0.77	$0.12
2051	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.11
2052	1.233	$0.20	$0.03	$0.52	$0.08			$0.72	$0.10
2053	1.233	$0.20	$0.03	$0.52	$0.07			$0.72	$0.10
2054	1.233	$0.20	$0.03	$0.52	$0.07			$0.72	$0.10
2055	1.233	$0.20	$0.03	$0.52	$0.07	$0.05	$0.01	$0.77	$0.10
2056	1.233	$0.20	$0.03	$0.52	$0.07	$0.10	$0.01	$0.82	$0.10
2057	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.09
2058	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2059	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2060	1.233	$0.20	$0.02	$0.52	$0.06	$0.05	$0.01	$0.77	$0.08
2061	1.233	$0.20	$0.02	$0.52	$0.06			$0.72	$0.08
2062	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2063	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2064	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.07
2065	1.233	$0.20	$0.02	$0.52	$0.05	$0.05	$0.00	$0.77	$0.07
2066	1.233	$0.20	$0.02	$0.52	$0.05	$0.10	$0.01	$0.82	$0.07
2067	1.233	$0.20	$0.02	$0.52	$0.05			$0.72	$0.06
2068	1.233	$0.20	$0.02	$0.52	$0.04			$0.72	$0.06
2069	1.233	$0.20	$0.02	$0.52	$0.04			$0.72	$0.06
2070	1.233	$0.20	$0.02	$0.52	$0.04	$0.05	$0.00	$0.77	$0.06
2071	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2072	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2073	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2074	1.233	$0.20	$0.01	$0.52	$0.04			$0.72	$0.05
2075	1.233	$0.20	$0.01	$0.52	$0.03	$0.05	$0.00	$0.77	$0.05
2076	1.233	$0.20	$0.01	$0.52	$0.03	$0.10	$0.01	$0.82	$0.05
2077	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2078	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2079	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2080	1.233	$0.20	$0.01	$0.52	$0.03	$0.05	$0.00	$0.77	$0.04
2081	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2082	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2083	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.04
2084	1.233	$0.20	$0.01	$0.52	$0.03			$0.72	$0.03
2085	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.04
2086	1.233	$0.20	$0.01	$0.52	$0.02	$0.10	$0.00	$0.82	$0.04
2087	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2088	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2089	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2090	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
2091	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2092	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2093	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.03
2094	1.233	$0.20	$0.01	$0.52	$0.02			$0.72	$0.02
2095	1.233	$0.20	$0.01	$0.52	$0.02	$0.05	$0.00	$0.77	$0.03
Total	$153	$24.46	$9.08	$52.00	$14.23	$2.17	$0.68	$78.63	$23.98

APPENDIX B
DETAILS OF WATER BALANCE MODEL

REVISED MODEL OF LIME REQUIREMENTS FOR EQUITY

NEW ELEMENTS

Several improvements and refinements have been made to this model:

- Incorporation of internal drainage based on the results of University of Saskatchewan modelling.
- Consideration of infiltration that would occur while covers were being installed (July to September).
- Refinement of treatment efficiencies
- Consideration of trends in acidity production from Getty Creek and No. 1 Dam.
- Use of refined actual flow estimates and acidities from the various sources.

APPROACH

Main Dump

- The internal drainage rate obtained from the University of Saskatchewan was adjusted since the U of S used a shorter width (490 m) compared to the actual dump size used in the model (700 m) (Table 1). The infiltration due at a 5% rate was deducted to obtain an internal drainage rate. Linear equations were fitted to the points to allow predictions. The dump is predicted to drain within about 13 years from installation of the cover (Figure 1).
- The internal drainage rate was then distributed according to the time since the cover was installed for each element (Table 2). The drainage rates shown in Figure 1 are for the end of the year. Therefore a half year was deducted for each time value to obtain an average drainage for the period. The total internal drainage was obtained by summing the value for each element.
- An overall water balance was prepared as for the previous model except the year was divided into separate July to September and October to June periods (Table 3). The former considers infiltration while the cover was installed and takes the mid-point of the cover size. The internal drainage was added to the infiltration for the two periods to obtain a total calculated flow. Runoff coefficients were adjusted to get a reasonable agreement to the actual flow.

- The acidity concentration was calculated as per the previous model. The internal drainage was assumed to have the same acidity concentration as that for a covered portion of the dump. This seems reasonable since it is assumed to begin after the cover is installed. Acidity concentrations were adjusted to obtain a reasonable fit to actual data.

Bessemer Dump and Plantsite

- The internal drainage was calculated for the Bessemer Dump using the relationship developed for the main dump and adjusted for the dump width (600 m) (Table 4 and Figure 2). The plantsite internal drainage was assumed to be one-third of that for the Bessemer Dump since the plantsite waste rock is not as thick. The internal drainage was distributed in the same manner as for the Main Dump except for two elements of the plantsite cover (Table 5). Those elements (6 and 2 ha) will only received a 0.3 m uncompacted cover. The internal drainage rate was set at the lower full year reflecting a lower expected drainage. This is approximate but since the plantsite contributes relatively little acidity is not critical.

- The water balance for the Bessemer Dump and Plantsite was constructed in a similar manner to the Main Dump (Table 6). A baseflow was added to reach a balance. The baseflow was smaller than in the previous model. The baseflow was normalized to precipitation to obtain a long-term value (Table 7). The average for the last four years assuming average precipitation (562 mm) would have been 250,258 m^3. That value was assumed to remain constant for future years. This is probably conservative.

- Acidity concentrations were calculated as per the Main Dump model. Possible increases in the acidity due to disturbing the Bessemer low grade were incorporated as per the previous model. However, for this model, the acidity was assumed to originate primarily from the uncovered area. Therefore the increase in acidity concentration was normalized for the sizes of the uncovered areas. The increasing acidity concentration was also applied to the internal drainage from the Bessemer Dump.

No. 1 Dam Seepage

- The trend in No.1 dam seepage acidity was analyzed to obtain the long-term rates (Table 8). The estimated lime requirements were normalized for precipitation. Results indicate an average reduction over the last five years of 24% per year. That value was used to predict future levels.

Getty Creek

- The same method used for the No. 1 dam seepage was used for Getty Creek. However the normalized lime requirements were relatively constant until 1993/94 then decreased rapidly for the last two years (Table 9). The average reduction of 33% over the last two years was used for the future. This may not be conservative but in any case Getty Creek contributes very little acidity.

Conversion of Acidities to Lime Requirements

- Actual average acidities and lime requirements were analyzed to obtain treatment efficiencies (Table 10). The ratio of lime use to acidity loading was calculated for the various years. The plant is generally becoming more efficient presumably because of increased operator attention. The average ratio for the last four years in 0.69 which was used for future years.

RESULTS

- The predicted lime requirements are shown in Table 11. The total predicted lime use agrees with the actual use reasonably well except for 1990/91. Except for that year, the trend in predicted lime use is consistent with actual lime use (Figure 3). The predicted lime use is slightly above the actual indicating the predicted may be conservative. The predicted future lime use assuming an average annual precipitation of 562 mm is also shown. The long-term lime requirements are predicted to be about 1230 tonnes/year according to the revised model.

- Predictions over 100 years are shown in Table 12. The Most Likely #2 and Committee Maximum estimates together with three empirical curves (7% decrease, $Time^{-1/2}$ from 3500 tonnes and $Time^{-1/2}$ from 6000 tonnes, are also shown for comparison.

KEY INPUT DATA FOR WATER AND CONTAMINANT BALANCE				
Predicted Long-Term Precipitation		562		
Runoff/Infiltration Coeff.	Uncovered	0.6		
	0.7UC	0.18		
	0.5C+0.3UC	0.05		
	Outside Dump	0.5		
		Main	Bessemer	Plantsite
Acidity Concentration	Uncovered	25000	17000	100
	0.7UC	25000	12000	1000
	0.5C+0.3UC	35000	10000	2000
	Outside Dump	100	100	
	Baseflow		4000	
Lime Efficiency	1990/1991	0.79	actual 1990	
	1991/1992	0.67	actual 1991	
	1992/1993	0.71	actual 1992	
	1993/1994	0.68	actual 1993	
	1994/1995	0.70	actual 1994	
		0.60	actual 1995 to date	
	Long-Term	0.69		

Table 1 INTERNAL DRAINAGE FROM MAIN DUMP

Year from	to	Total Flow (m3)	Infiltratio (m3)	Internal Drainage Calculated (m3)	Predicted (m3)	Slope	Intercept
	0	1.56E+05	1.50E+04	1.41E+05			
0	1	1.13E+05	1.50E+04	9.80E+04	9.80E+04	-42998	140992
1	5	5.52E+04	1.50E+04	4.02E+04	4.02E+04	-14460	112454
5	10	2.93E+04	1.50E+04	1.42E+04	1.42E+04	-5188	66090
10	15	6.85E+03	1.50E+04	-8.19E+03	-8.19E+03	-4481	59019

TABLE 2 DISTRIBUTION OF INTERNAL DRAINAGE FROM MAIN DUMP

Year	Cover Area (ha)				Cover Element (ha)						Total Drainage (m3)
	Uncovered	0.7 UC	0.5C+0.3UC		6	35	2	8	1	3	
1990/91	19	36	0	Time	2.5	2.5					
	14	41	0	Drainage (m3)	8324	48556					5.69E+04
1991/92	13	23	19	Time	3.5	3.5	0.5				
	12	6	37	Drainage (m3)	6746	39354	4345				5.04E+04
1992/93	8	3	44	Time	4.5	4.5	1.5	0.5			
	4	0	51	Drainage (m3)	5169	30152	3300	17381			5.60E+04
1993/94	4	0	51	Time	5.5	5.5	2.5	1.5	0.5		
	3	0	52	Drainage (m3)	4097	23901	2775	13202	2173		4.61E+04
1994/95	1	0	54	Time	6.5	6.5	3.5	2.5	1.5	0.5	
	0	0	55	Drainage (m3)	3531	20599	2249	11099	1650	6518	4.56E+04
1995/96	0	0	55	Time	7.5	7.5	4.5	3.5	2.5	1.5	
				Drainage (m3)	2965	17298	1723	8995	1387	4951	3.73E+04
1996/97				Time	8.5	8.5	5.5	4.5	3.5	2.5	
				Drainage (m3)	2399	13997	1366	6892	1124	4162	2.99E+04
1997/98				Time	9.5	9.5	6.5	5.5	4.5	3.5	
				Drainage (m3)	1834	10696	1177	5463	861	3373	2.34E+04
1998/99				Time	10.5	10.5	7.5	6.5	5.5	4.5	
				Drainage (m3)	1306	7619	988	4708	683	2584	1.79E+04
1999/2000				Time	11.5	11.5	8.5	7.5	6.5	5.5	
				Drainage (m3)	817	4768	800	3954	589	2049	1.30E+04
2000/2001				Time	12.5	12.5	9.5	8.5	7.5	6.5	
				Drainage (m3)	329	1917	611	3199	494	1766	8.32E+03
2001/2002				Time	13.5	13.5	10.5	9.5	8.5	7.5	
				Drainage (m3)	0	0	435	2445	400	1483	4.76E+03
2002/2003				Time			11.5	10.5	9.5	8.5	
				Drainage (m3)			272	1742	306	1200	3.52E+03
2003/2004				Time			12.5	11.5	10.5	9.5	
				Drainage (m3)			110	1090	218	917	2.33E+03
2004/2005				Time			13.5	12.5	11.5	10.5	
				Drainage (m3)			0	438	136	653	1.23E+03
2005/2006				Time			0	13.5	12.5	11.5	
				Drainage (m3)				0	55	409	4.63E+02
2006/2007				Time			0	0	13.5	12.5	2.60E+01
				Drainage (m3)					0	164	
											3.97E+05
										13.5	
										0	8.84E+05

TABLE 3 WATER AND ACIDITY BALANCE MODEL FOR MAIN DUMP

Year	Period	Precip. mm	Cover** Uncovered ha	0.7 UC ha	0.5C+0.3UC ha	Weighted Run. Coeff.***	Calculated Flow+ m3	Base Flow++ m3
1990/91	July to Sept.	108	19	36	0	0.36	26718	
	Oct. to June	289	14	41	0	0.33	65336	
	Drainage						56880	
1991/92	July to Sept.	124	13	23	19	0.29	24437	
	Oct. to June	545	12	6	37	0.24	91933	
	Drainage						50446	
1992/93	July to Sept.	119	8	3	44	0.21	16911	
	Oct. to June	496	4	0	51	0.17	57662	
	Drainage						56003	
1993/94	July to Sept.	175	4	0	51	0.17	20321	
	Oct. to June	565	3	0	52	0.16	62513	
	Drainage						46147	
1994/95	July to Sept.	221	1	0	54	0.14	21937	
	Oct. to June	453	0	0	55	0.14	42556	
	Drainage						45646	
1995/96	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						37320	
1996/97	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						29941	
1997/98	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						23404	
1998/99	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						17890	
1999/2000	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						12977	
2000/2001	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						8316	
2001/2002	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						4763	
2002/2003	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						3519	
2003/2004	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						2334	
2004/2005	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						1227	
2005/2006	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						463	
2006/2007	July to Sept.	562	0	0	55	0.14	52749	
	Oct. to June							
	Drainage						0	

Year	Period	Total Pred. Flow m3	Actual Flow m3	Flow Difference %	Predicted Acidity+++ mg/L	Actual Acidity mg/L	Acidity Difference (%)	Predicted Acid. Loa tonnes	Actual Acid Load tonnes	Load Difference
1990/91	July to Sept.	26718			18097					
	Oct. to June	65336			17481					
	Total	148934	148219	0	24282	26275	-8	3616	3797	-5
1991/92	July to Sept.	24437			16897					
	Oct. to June	91933			16146					
	Total	166815	141912	18	21957	22956	-4	3663	3225	14
1992/93	July to Sept.	16911			14625					
	Oct. to June	57662			12906					
	Total	130575	116683	12	22631	21065	7	2955	2484	19
1993/94	July to Sept.	20321			12906					
	Oct. to June	62513			12360					
	Total	128981	119837	8	20546	23581	-13	2650	2978	-11
1994/95	July to Sept.	21937			11082					
	Oct. to June	42556			10329					
	Total	110139	113530	-3	20704	23915	-13	2280	2683	-15
1995/96	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	90069			20551			1851		
1996/97	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	82690			19262			1593		
1997/98	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	76154			17911			1364		
1998/99	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	70639			16577			1171		
1999/2000	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	65726			15200			999		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	61065			13689			836		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	57512			12372			712		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	56269			11872			668		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	55083			11374			627		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	53977			10890			588		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	53213			10544			561		
2000/2001	July to Sept.	52749			10329					
	Oct. to June	0								
	Total	52749			10329			545		

Assumed infiltration/runoff coeff. and acidity:

	coeff	acidity
Uncovered	0 6	25000
0.7UC	0.18	25000
0 5C+0 3UC	0 05	35000
Outside Dump	0 5	100
Base Flow		

TABLE 4 INTERNAL DRAINAGE FROM BESSEMER DUMP

Year from	Year to	Total Flow (m3)	Infiltration (m3)	Internal Drainage Calculated (m3)	Internal Drainage Predicted (m3)	Slope	Intercept
	0	1.34E+05	1.09E+04	1.23E+05			
0	1	9.69E+04	1.09E+04	8.59E+04	8.59E+04	-36855	122804
1	5	4.73E+04	1.09E+04	3.64E+04	3.64E+04	-12395	98343
5	10	2.51E+04	1.09E+04	1.41E+04	1.41E+04	-4447	58603
10	15	5.87E+03	1.09E+04	-5.07E+03	-5.07E+03	-3840	52542

...NTSITE

Year	...ent (ha)	6	13	1	21	Total (m3)	12	6	2	9	7	11	Total (m3)	Grand Total (m3)
1990/91	Time (yr)	3.5												
	Drainage (m3)	6.87E+03				6870							0	6870
1991/92	Time (yr)	4.5	0.5											
	Drainage (m3)	5.32E+03	3.39E+04			39243							0	39243
1992/93	Time (yr)	5.5	1.5											
	Drainage (m3)	4.27E+03	2.59E+04			30187							0	30187
1993/94	Time (yr)	6.5	2.5	0.5										
	Drainage (m3)	3.71E+03	2.19E+04	2.61E+03		28213							0	28213
1994/95	Time (yr)	7.5	3.5	1.5	0.5			0.5		0.5				
	Drainage (m3)	3.16E+03	1.79E+04	1.99E+03	5.48E+04	77810		4.44E+03		6.66E+03			6662	84473
1995/96	Time (yr)	8.5	4.5	2.50	1.5			2	0.5	1.5	0.5			
	Drainage (m3)	2.60E+03	1.38E+04	1.68E+03	4.19E+04	59988		3.13E+03	1.48E+03	5.09E+03	5.18E+03		11753	71741
1996/97	Time (yr)	9.5	5.5	3.5	2.50			3	2	2.50	1.5	0.5		
	Drainage (m3)	2.05E+03	1.11E+04	1.37E+03	3.54E+04	49879		2.60E+03	1.04E+03	4.30E+03	3.96E+03	8.14E+03	17445	67323
1997/98	Time (yr)	10.5	6.5	4.5	3.5			4	3	3.5	2.50	1.5		
	Drainage (m3)	1.53E+03	9.65E+03	1.06E+03	2.89E+04	41099		2.08E+03	8.68E+02	3.51E+03	3.34E+03	6.22E+03	13941	55040
1998/99	Time (yr)	11.5	7.5	5.5	4.5			5	4	4.5	3.5	2.50		
	Drainage (m3)	1.05E+03	8.21E+03	8.54E+02	2.23E+04	32456		1.55E+03	6.92E+02	2.72E+03	2.73E+03	5.25E+03	11392	43848
1999/2000	Time (yr)	12.5	8.5	6.5	5.5			6	5	5.5	4.5	3.5		
	Drainage (m3)	5.67E+02	6.76E+03	7.42E+02	1.79E+04	25998		1.36E+03	5.16E+02	2.18E+03	2.11E+03	4.29E+03	9096	35095
2000/2001	Time (yr)	13.5	9.5	7.5	6.5			7	6	6.5	5.5	4.5		
	Drainage (m3)	0.00E+00	5.32E+03	6.31E+02	1.56E+04	21541		1.17E+03	4.53E+02	1.90E+03	1.70E+03	3.32E+03	7365	28905
2001/2002	Time (yr)		10.5	8.5	7.5			8	7	7.5	6.5	5.5		
	Drainage (m3)		3.97E+03	5.20E+02	1.33E+04	17748		9.80E+02	3.90E+02	1.61E+03	1.47E+03	2.66E+03	6140	23889
2002/2003	Time (yr)		11.5	9.5	8.5			9	8	8.5	7.5	6.5		
	Drainage (m3)		2.72E+03	4.09E+02	1.09E+04	14055		7.91E+02	3.27E+02	1.33E+03	1.25E+03	2.32E+03	5225	19280
2003/2004	Time (yr)		12.5	10.5	9.5			10	9	9.5	8.5	7.5		
	Drainage (m3)		1.47E+03	3.05E+02	8.59E+03	10369		6.02E+02	2.64E+02	1.04E+03	1.03E+03	1.97E+03	4311	14679
2004/2005	Time (yr)		13.5	11.5	10.5			11	10	10.5	9.5	8.5		
	Drainage (m3)		0.00E+00	2.09E+02	6.41E+03	6623		4.38E+02	2.01E+02	7.80E+02	8.12E+02	1.62E+03	3416	10039
2005/2006	Time (yr)			12.5	11.5			12	11	11.5	10.5	9.5		
	Drainage (m3)			1.13E+02	4.40E+03	4511		2.75E+02	1.46E+02	5.35E+02	6.06E+02	1.28E+03	2564	7074
2006/2007	Time (yr)			13.5	12.5			13	12	12.5	11.5	10.5		
	Drainage (m3)			0.00E+00	2.38E+03	2381		1.11E+02	9.16E+01	2.90E+02	4.16E+02	9.53E+02	1750	4131
2007/2008	Time (yr)				13.5				13	13.5	12.5	11.5		
	Drainage (m3)				0.00E+00	0			3.71E+01	0.00E+00	2.25E+02	6.53E+02	916	916
2008/2009	Time (yr)										13.5	12.5		
	Drainage (m3)										0.00E+00	3.54E+02	380	380
2009/2010	Time (yr)										14.5	13.5		
	Drainage (m3)										0.00E+00	5.42E+01	54	54

TABLE 6 WATER AND ACIDITY BALANCE MODEL FOR BESSEMER DUMP AND PLANTSITE

Year	mm	Uncovered ha	0.7UC ha	0.5C+0.3UC ha	Uncovered ha	0.7UC ha	0.5C+0.3UC ha	Run. Coeff.	Flow m3	Base m3	Total Pred. m3	Actual m3	Acidity* Predicted mg/L	Actual mg/L	Difference %	Acidity Load Predicted tonnes	Actual tonnes
1990/1991	108	35	3	0	47	0	0	0.57	58428	506834	728482	728482	6858	6371	-23	3569	4641
	289	35	5	0	47	0	0	0.57	156349				6858				
	Drainage								6870				4899				
1991/1992	124.2	29	5	6	47	0	0	0.53	63094	326211	684331	684331	11975	8364	-6	5401	5724
	544.8	22	5	13	47	0	0	0.49	255784				9992				
	Drainage								39243				7892				
1992/1993	118.7	22	5	13	47	0	0	0.49	55730	273947	592877	592877	10094	8422	-7	4620	4993
	498.3	22	5	13	47	0	0	0.49	233013				10094				
	Drainage								30187				7793				
1993/1994	174.9	21	2	17	47	0	0	0.48	80471	395818	756864	756864	13967	8613	5	6814	6519
	565.2	19	0	21	47	0	0	0.47	252362				13004				
	Drainage								28213				9003				
1994/1995	220.6	10	0	30	40	3	4	0.38	79945	332494	618106	618106	6107	5884	-1	3606	3637
	453.4	0	0	40	32	6	9	0.28	121194				909				
	Drainage								84473				5834				
1995/1996	562	0	0	40	23	8	16	0.23	123865	275546	471152		1126			2667	
	Drainage								71741				5660				
1996/1997	562	0	0	40	12	8	26	0.17	89583	275546	432452		1578			2581	
	Drainage								67323				5968				
1997/1998	562	0	0	40	12	8	26	0.17	89583	275546	420169		1578			2337	
	Drainage								55040				5562				
1998/1999	562	0	0	40	12	8	26	0.17	89583	275546	408977		1578			2114	
	Drainage								43848				5170				
1999/2000	562	0	0	40	12	8	26	0.17	89583	275546	400224		1578			1941	
	Drainage								35095				4849				
2000/2001	562	0	0	40	12	8	26	0.17	89583	275546	394034		1578			1818	
	Drainage								28905				4613				
2001/2002	562	0	0	40	12	8	26	0.17	89583	275546	389018		1578			1718	
	Drainage								23889				4416				
2002/2003	562	0	0	40	12	8	26	0.17	89583	275546	384409		1578			1627	
	Drainage								19280				4231				
2003/2004	562	0	0	40	12	8	26	0.17	89583	275546	379809		1578			1535	
	Drainage								14679				4042				
2004/2005	562	0	0	40	12	8	26	0.17	89583	275546	375188		1578			1443	
	Drainage								10039				3846				
2005/2006	562	0	0	40	12	8	26	0.17	89583	275546	372203		1578			1384	
	Drainage								7074				3719				
2006/2007	562	0	0	40	12	8	26	0.17	89583	275546	369260		1578			1326	
	Drainage								4131				3590				
2007/2008	562	0	0	40	12	8	26	0.17	89583	275546	366045		1578			1262	
	Drainage								916				3447				
2008/2009	562	0	0	40	12	8	26	0.17	89583	275546	365509		1578			1251	
	Drainage								380				3423				
2009/2010	562	0	0	40	12	8	26	0.17	89583	275546	365183		1578			1245	
	Drainage								54				3408				
2010/2011	562	0	0	40	12	8	26	0.17	89583	275546	365129		1578			1244	
	Drainage								0				3406				

* total acidity in bold

Assumed infiltration/runoff coeff. and acidity

Cover Type	Inf/Runoff Coefficient	Acidity (mg/L) Bessemer	Plantsite
Uncovered	0.6	17000	100
0.7UC	0.18	12000	1000
0.5C+0.3UC	0.05	10000	2000
Outside Dump	0.5	100	
Base Flow		4000	

Possible increase in Bessemer Dump loading:

Year	Actual Acid. Conc. (mg/L)	Uncovered Area (ha)	Acid. Conc. Ratio Norm. to area
1990/91	6586	40	1
1991/92	8887	27	2.00
1992/93	8982	27	2.02
1993/94	9151	19	2.93
1994/95*	6296	0	1.99

* taken as average of 4 years

TABLE 7 NORMALIZED BASEFLOW FOR BESSEMER DUMP

Precip (mm)	Base Flow (m3)	Normalized (m3)
397	506834	717483
669	326211	274037
615	273947	250339
740.1	395818	300567
674	332494	277243
	average last 4 years	275546

TABLE 8 TREND IN No. 1 DAM SEEPAGE ACIDITY

	ACIDITY LOADING (kg)				
YEAR	1990/91	1991/92	1992/93	1993/94	1994/95
MONTH					
Jan	60160	57691	32475	46916	21131
Feb	54835	31604	31440	72075	19678
Mar	30874	34527	35353	25650	15763
Apr	35010	32259	39546	22572	17624
May	30942	29104	45232	31495	20344
Jun	27440	32366	31367	24270	18306
Jul	28650	26731	23619	19271	17257
Aug	22197	36171	25555	18449	20290
Sep	26342	56903	25489	23077	16388
Oct	111198	141141	69212	53370	31324
Nov	64487	110043	76379	64200	67461
Dec	29594	50698	78853	24180	21355
Totals					
Acidity (kg)	521729	639238	514520	425525	286921
Acidity (t)	522	639	515	426	287
Act. Lime	414	429	363	290	199
Adj. Lime (t)	370	453	364	301	203
Precip (mm)	397	669	615	740	674
Normalized (t)	523	380	333	229	169
reduction (%)		27	12	31	26
mean red. (%)	24				

Year	Flow (m3)	Acidity (mg/L)	Acid Load (t)	Total Load (t)
1990/91	7800	191	1.5	
	1870	156	0.3	
	950	125	0.1	
	2700	205	0.6	
	1840	306	0.6	
	2500	248	0.6	
	2100	143	0.3	
	2970	195	0.6	
	6150	186	1.1	
	18976	201	3.8	
	12800	150	1.9	
	3100	165	0.5	11.9
1991/92	3967	252	1.0	
	2925	153	0.4	
	4000	114	0.5	
	4000	137	0.5	
	5868	301	1.8	
	4100	383	1.6	
	4800	243	1.2	
	8750	260	2.3	
	28800	330	9.5	
	18950	90	1.7	
	6320	96	0.6	
	4295	130	0.6	21.6
1992/93	4380	131	0.6	
	2710	134	0.4	
	3505	101	0.4	
	7930	218	1.7	
	7600	304	2.3	
	4489	232	1.0	
	3160	192	0.6	
	8340	200	1.7	
	8166	246	2.0	
	23022	158	3.6	
	14032	112	1.6	
	23225	175	4.1	19.9
1993/94	9994	164	1.6	
	9764	143	1.4	
	4192	133	0.6	
	4037	142	0.6	
	6119	172	1.1	
	6300	143	0.9	
	6194	174	1.1	
	4755	119	0.6	
	13284	183	2.4	
	20662	180	3.7	
	8886	110	1.0	
	5035	142	0.7	15.6
	3925	174	0.7	
	2974	164	0.5	
	2231	147	0.3	
	5246	199	1.0	
	2083	167	0.3	
	1697	171	0.3	
	1142	165	0.2	
	1199	138	0.2	
	1893	147	0.3	
	19095	246	4.7	
	6651	144	1.0	
	2182	143	0.3	9.8

Totals	1990/91	1991/92	1992/93	1993/94	1994/95
Acidity Load (t)	12	22	20	16	10
Predicted Lime (t)	9	15	14	11	7
Adjusted Lime (t)	8	15	14	11	7
Precipitation (mm)	397	669	615	740	674
Normalized Lime (t)	12	13	13	8	6
reduction (%)		-8	0	35	31
mean red. (2 years)	33				

TABLE 10 TREATMENT EFFICIENCIES

Year	Flow (m3)	Acidity Conc. (mg/L)	Acidity Load (tonnes)	Lime Use (kg)	Lime Use (t)	Lime/Acid Ratio	Assumed Value	Assumed Years
1990	1001810	8161	8176	6488000	6488	0.79		
1991	767643	11474	8808	5916740	5917	0.67	0.79	1990/1991
1992	817880	8953	7322	5164270	5164	0.71	0.67	1991/1992
1993	897843	9286	8337	5681380	5681	0.68	0.71	1992/1993
1994	970648	7595	7372	5124480	5124	0.70	0.68	1993/1994
1995	719733	7046	5071	3057260	3057	0.60	0.70	1994/1995
						average last 4 years	0.69	

TABLE 11 PREDICTED LIME USE*

Year	Predicted Main	Predicted Bessemer	Predicted Other	Predicted Total	Actual	Difference (%)
1990/1991	2870	2832	9	5712	6056	-6
1991/1992	2461	3628	15	6103	5737	6
1992/1993	2084	3258	14	5357	4840	11
1993/1994	1806	4643	374	6823	6278	9
1994/1995	1585	2507	297	4389	3989	10
1995/1996	1274	1836	133	3243		
1996/1997	1096	1777	100	2974		
1997/1998	939	1609	76	2624		
1998/1999	806	1456	58	2319		
1999/2000	688	1336	44	2067		
2000/2001	575	1251	33	1860		
2001/2002	490	1183	25	1698		
2002/2003	460	1120	19	1599		
2003/2004	431	1057	14	1503		
2004/2005	405	993	11	1409		
2005/2006	386	953	8	1347		
2006/2007	375	913	6	1294		
2007/2008	375	869	5	1248		
2008/2009	375	861	4	1240		
2009/2010	375	857	3	1235		
2010/2011	375	856	2	1233		

* tonnes

TABLE [illegible] PREDICTED LIME REQUIREMENTS FROM MODELS

YEAR	PREDICTED LIME REQUIREMENTS ('000 tonnes)			OTHER EMPIRICAL MODELS ('000 tonnes)		
	Most Likely #2	Committee	New Model	7% Decline	T-1/2 from 3500	T-1/2 from 6000
1988	4.55	5.09				
1989	6.00	6.54				
1990	6.49	7.03				
1991	5.92	7.73				6.0
1992	5.16	8.50				4.2
1993	5.68	9.35				3.5
1994	5.12	10.00				3.0
1995	3.50	10.00	3.24	3.5	3.5	2.7
1996	3.00	10.00	2.97	3.3	2.5	2.4
1997	2.72	10.00	2.62	3.0	2.0	2.3
1998	2.72	10.00	2.32	2.8	1.8	2.1
1999	2.72	9.00	2.07	2.6	1.6	2.0
2000	2.72	8.10	1.86	2.4	1.4	1.9
2001	2.72	7.29	1.70	2.3	1.3	1.8
2002	2.45	6.56	1.60	2.1	1.2	1.7
2003	2.20	5.90	1.50	2.0	1.2	1.7
2004	1.98	5.31	1.41	1.8	1.2	1.6
2005	1.78	4.78	1.35	1.7	1.2	1.5
2006	1.61	4.30	1.29	1.6	1.2	1.5
2007	1.45	3.87	1.25	1.5	1.2	1.5
2008	1.30	3.49	1.24	1.4	1.2	1.4
2009	1.20	3.14	1.23	1.3	1.2	1.4
2010	1.20	2.82	1.23	1.2	1.2	1.3
2011	1.20	2.54	1.23	1.2	1.2	1.3
2012	1.20	2.29	1.23	1.2	1.2	1.3
2013	1.20	2.06	1.23	1.2	1.2	1.3
2014	1.20	1.85	1.23	1.2	1.2	1.2
2015	1.20	1.67	1.23	1.2	1.2	1.2
2016	1.20	1.50	1.23	1.2	1.2	1.2
2017	1.20	1.35	1.23	1.2	1.2	1.2
2018	1.20	1.22	1.23	1.2	1.2	1.2
2019	1.20	1.20	1.23	1.2	1.2	1.2
2020	1.20	1.20	1.23	1.2	1.2	1.2
2021	1.20	1.20	1.23	1.2	1.2	1.2
2022	1.20	1.20	1.23	1.2	1.2	1.2
2023	1.20	1.20	1.23	1.2	1.2	1.2
2024	1.20	1.20	1.23	1.2	1.2	1.2
2025	1.20	1.20	1.23	1.2	1.2	1.2
2026	1.20	1.20	1.23	1.2	1.2	1.2
2027	1.20	1.20	1.23	1.2	1.2	1.2
2028	1.20	1.20	1.23	1.2	1.2	1.2
2029	1.20	1.20	1.23	1.2	1.2	1.2
2030	1.20	1.20	1.23	1.2	1.2	1.2
2031	1.20	1.20	1.23	1.2	1.2	1.2
2032	1.20	1.20	1.23	1.2	1.2	1.2
2033	1.20	1.20	1.23	1.2	1.2	1.2
2034	1.20	1.20	1.23	1.2	1.2	1.2
2035	1.20	1.20	1.23	1.2	1.2	1.2
2036	1.20	1.20	1.23	1.2	1.2	1.2
2037	1.20	1.20	1.23	1.2	1.2	1.2
2038	1.20	1.20	1.23	1.2	1.2	1.2
2039	1.20	1.20	1.23	1.2	1.2	1.2
2040	1.20	1.20	1.23	1.2	1.2	1.2
2041	1.20	1.20	1.23	1.2	1.2	1.2
2042	1.20	1.20	1.23	1.2	1.2	1.2
2043	1.20	1.20	1.23	1.2	1.2	1.2
2044	1.20	1.20	1.23	1.2	1.2	1.2
2045	1.20	1.20	1.23	1.2	1.2	1.2
2046	1.20	1.20	1.23	1.2	1.2	1.2
2047	1.20	1.20	1.23	1.2	1.2	1.2
2048	1.20	1.20	1.23	1.2	1.2	1.2
2049	1.20	1.20	1.23	1.2	1.2	1.2

TABLE 12 PREDICTED LIME REQUIREMENTS FROM MODELS

YEAR	PREDICTED LIME REQUIREMENTS (000 tonnes)			OTHER EMPIRICAL MODELS (000 tonnes)		
	Most Likely #2	Committee	New Model	7% Decline	T-1/2 from 3500	T-1/2 from 6000
2050	1.20	1.20	1.23	1.2	1.2	1.2
2051	1.20	1.20	1.23	1.2	1.2	1.2
2052	1.20	1.20	1.23	1.2	1.2	1.2
2053	1.20	1.20	1.23	1.2	1.2	1.2
2054	1.20	1.20	1.23	1.2	1.2	1.2
2055	1.20	1.20	1.23	1.2	1.2	1.2
2056	1.20	1.20	1.23	1.2	1.2	1.2
2057	1.20	1.20	1.23	1.2	1.2	1.2
2058	1.20	1.20	1.23	1.2	1.2	1.2
2059	1.20	1.20	1.23	1.2	1.2	1.2
2060	1.20	1.20	1.23	1.2	1.2	1.2
2061	1.20	1.20	1.23	1.2	1.2	1.2
2062	1.20	1.20	1.23	1.2	1.2	1.2
2063	1.20	1.20	1.23	1.2	1.2	1.2
2064	1.20	1.20	1.23	1.2	1.2	1.2
2065	1.20	1.20	1.23	1.2	1.2	1.2
2066	1.20	1.20	1.23	1.2	1.2	1.2
2067	1.20	1.20	1.23	1.2	1.2	1.2
2068	1.20	1.20	1.23	1.2	1.2	1.2
2069	1.20	1.20	1.23	1.2	1.2	1.2
2070	1.20	1.20	1.23	1.2	1.2	1.2
2071	1.20	1.20	1.23	1.2	1.2	1.2
2072	1.20	1.20	1.23	1.2	1.2	1.2
2073	1.20	1.20	1.23	1.2	1.2	1.2
2074	1.20	1.20	1.23	1.2	1.2	1.2
2075	1.20	1.20	1.23	1.2	1.2	1.2
2076	1.20	1.20	1.23	1.2	1.2	1.2
2077	1.20	1.20	1.23	1.2	1.2	1.2
2078	1.20	1.20	1.23	1.2	1.2	1.2
2079	1.20	1.20	1.23	1.2	1.2	1.2
2080	1.20	1.20	1.23	1.2	1.2	1.2
2081	1.20	1.20	1.23	1.2	1.2	1.2
2082	1.20	1.20	1.23	1.2	1.2	1.2
2083	1.20	1.20	1.23	1.2	1.2	1.2
2084	1.20	1.20	1.23	1.2	1.2	1.2
2085	1.20	1.20	1.23	1.2	1.2	1.2
2086	1.20	1.20	1.23	1.2	1.2	1.2
2087	1.20	1.20	1.23	1.2	1.2	1.2
2088	1.20	1.20	1.23	1.2	1.2	1.2
2089	1.20	1.20	1.23	1.2	1.2	1.2
2090	1.20	1.20	1.23	1.2	1.2	1.2
2091	1.20	1.20	1.23	1.2	1.2	1.2
2092	1.20	1.20	1.23	1.2	1.2	1.2
2093	1.20	1.20	1.23	1.2	1.2	1.2
2094	1.20	1.20	1.23	1.2	1.2	1.2
Total From 1995	136	210	132	133	126	130
Average From 1995	1.36	2.10	1.32	1.33	1.26	1.30

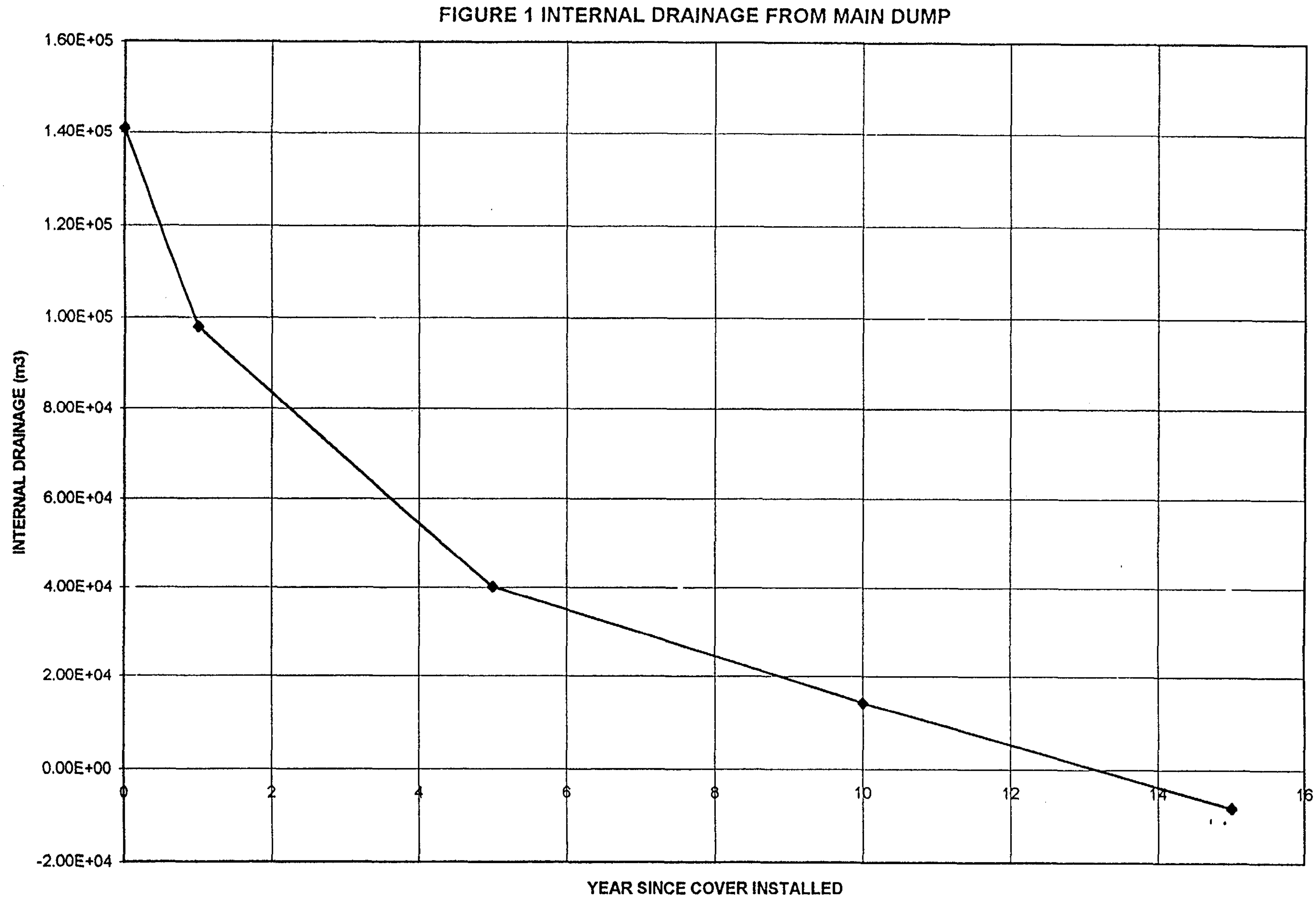


FIGURE 1 INTERNAL DRAINAGE FROM MAIN DUMP
1.60E+05
1.40E+05
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
-2.00E+04
INTERNAL DRAINAGE (m3)
0
2
4
6
8
10
12
14
16
YEAR SINCE COVER INSTALLED

FIGURE 2 PREDICTED INTERNAL DRAINAGE FROM BESSEMER DUMP

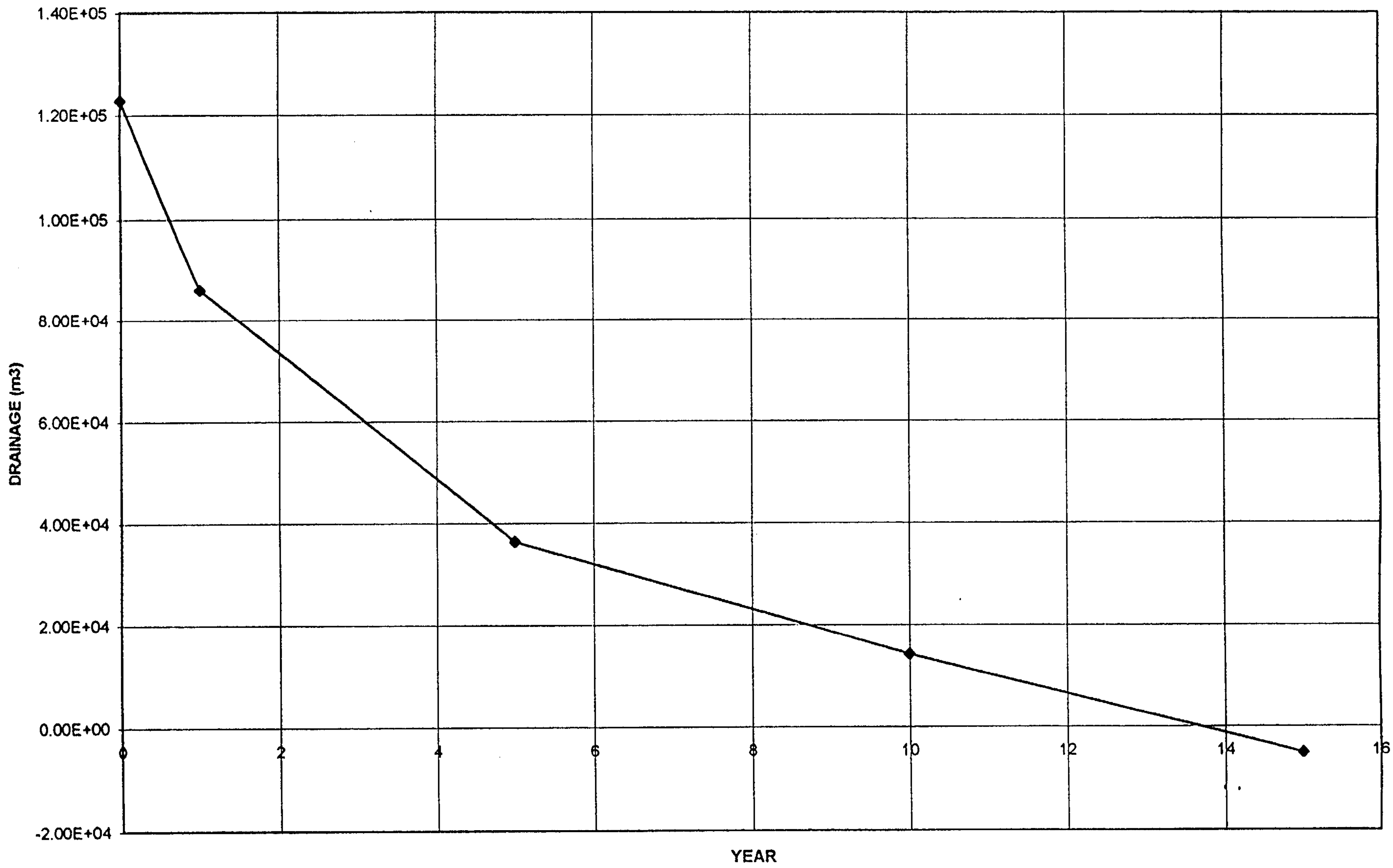
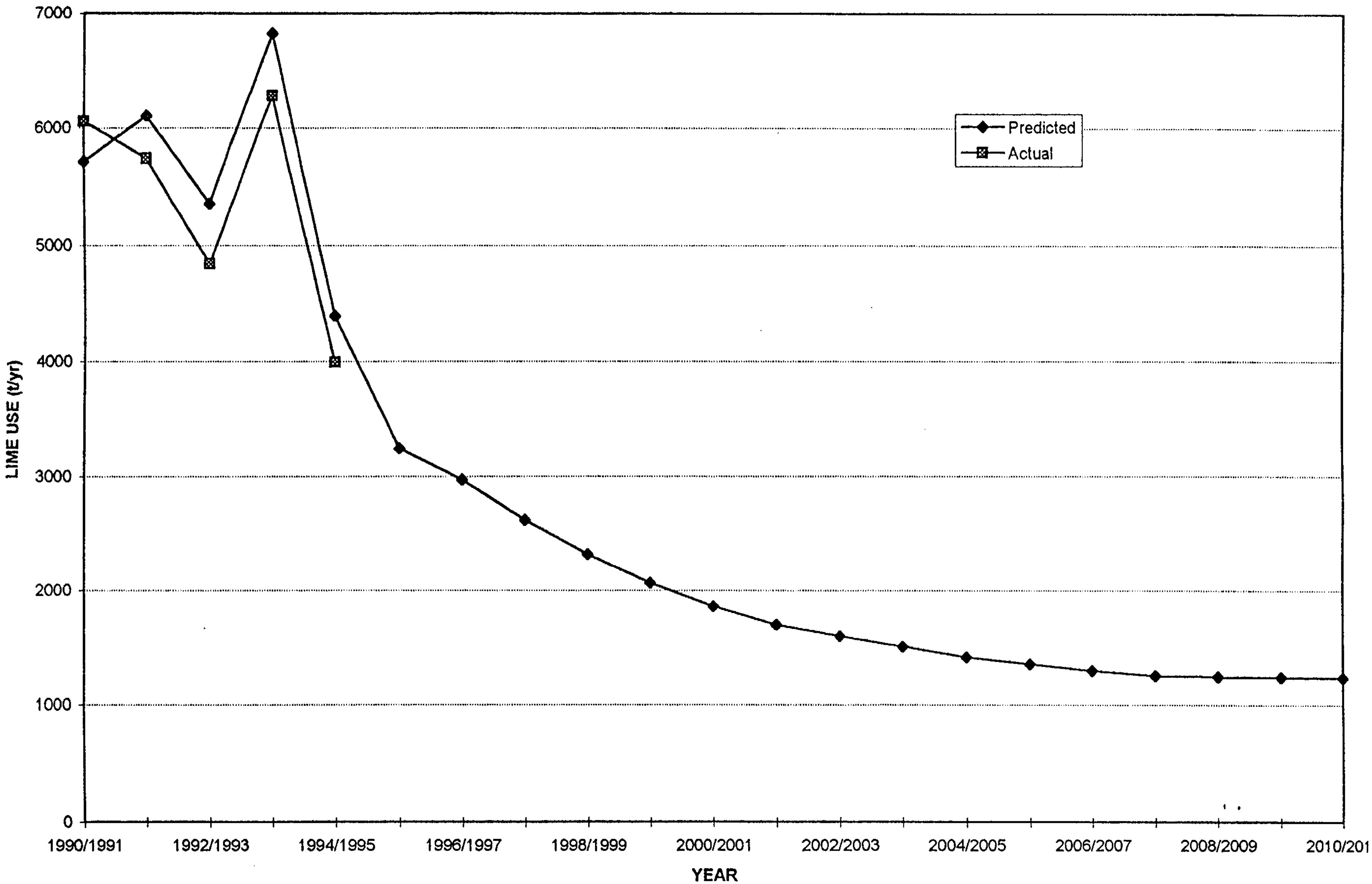


FIGURE 3 ACTUAL AND PREDICTED TOTAL LIME USE



APPENDIX C
RECLAMATION COSTS 1987-95

DETAILED ENVIRONMENTAL COSTS
1987-1995

CODE	1987	1988	1989	1990	1991	1992	1993	1994	1995(June)	1995	AVG (87-94)
A.M.D. PUMPED M3	914800	841884	834100	1043800	808075	831578	928002	1054830	655792		
A.M.D. TREATED M3	861000	825562	642162	1010700	770770	817888	898000	970650	635763		
RECLAMATION/ENV.-515											
120-SAL. OPER	65595	41774	30900	28200	48700	29600	25800	24100	13300	26780	28069
130-SAL. R&M	2599	1427	1000	2200	1500	1900	700		100	200	1100
200-SUPPLIES	14178	18768	7200	8900	14500	21000	800	8100	200	3060	8080
400-SERV. PURCHASED	4786	4733	500	20600	15300	10700	1900	1500	300	3595	7698
500-EQUIP.-D/A	3340					5000	8000	3800			5600
EFFLUENT COLL.-516											
120-SAL. OPER		21839	23200	23400	19500	18300	33300	34300	14500	31820	25017
130-SAL. R&M	38890	18375	21300	25800	16000	10400	11800	21200	14000	27760	18138
200-SUPPLIES	11957	13741	23600	25600	21400	9600	8900	5900	2900	5070	11342
224-PUMPS,VALV,PIPING	5609	1502	16600	15200	8800		2400	8100	6100	7450	8012
400-SERV. PURCHASED	4223		3900	1700	6100			200		200	2053
500-EQUIP.-D/A	3308	8843	19200	29800	16000	200	2600				12161
510-POWER D/A	30668	29936	29100	30500	38800	35100	51000	99200	34000	47880	48064
EFFLUENT TREATMENT-517											
120-SAL. OPER	15320	21723	19100	60700	22400	15700	27600	21100	12400	27080	26710
130-SAL. R&M	21376	37294	19300	30300	32600	22600	16500	19200	14300	24070	22795
200-SUPPLIES	37584	14986	22700	31300	29300	20200	19900	17100	2400	6570	18111
214-REAGENT-LIME $/M3	497614	641163	673500	959000	860900	749000	861900	807000	424700	549930	744615
400-SERV. PURCHASED	153	10000	2000						6300	6460	6326
510-POWER D/A									19600	32130	25865
WATER MONITORING-518											
120-SAL. OPER	50459	40006	29400	33000	44500	33700	23800	25100	12900	26610	28516
200-SUPPLIES	2868	1131	1900	3400	700	300	300	800	100	950	936
400-SERV. PURCHASED	39108	38344	40900	42200	44400	32300	32200	36800	13800	31750	33352
530-ASSAYS-D/A											
A.M.D. SLUDGE REM-519											
120-SAL. OPER	22581	7730	1600	5700	4800	7900	7700	6400	3600	6110	6029
130-SAL. R&M	17456	3198	6300	17800	26500	8000	2800	1500	2900	5930	9346
200-SUPPLIES	27974	13250	13300	29700	12000	10800	5700	800	100	1170	8611
224-PUMPS,VALV,PIPING	5291	2821	9600	8900	13200	4700	2500	700		760	5129
500-EQUIP.-D/A		89		8200	29800	5600	6500				12525
510-POWER D/A									3200	9280	6240
OVERHEAD ACCTS - 520											
100-SUPERVISION									15000	15000	
120- SAL.OP.(ROAD MAINT.)							3400	8000	5800	8930	8734
200-SUPPLIES								1100	1400	1760	1760
380-FREIGHT								200	2900	3880	3880
400-SERVICES PURCHASED								4700	6300	8700	8700
411-EMPL.WELFARE/SAFETY									5800	8210	
413-SALARY OVERHEAD							52500	49100	15900	29390	28547
415-COMMUNICATIONS								100	3600	4970	4970
418-ALL MOB. EQUIP.									31200	61280	
419-DOMESTIC WATER									100	130	
420-DEISEL/PROPANE/GAS									7100	15190	
421-LUBRICANTS/FILTERS									3100	5440	
SHOP/OFFICE CMPLX - 521											
130-SAL. R&M									1000	2860	
200-SUPPLIES									800	2930	
400-SERV. PURCH.									400	1170	
510-POWER									1500	3040	
520-NATURAL GAS									400	1830	
TOTAL:	922937	992673	1016100	1442100	1327700	1052600	1210500	1206100	704000	1057325	1187029.739

SUMMARY	1987	1988	1989	1990	1991	1992	1993	1994	1995(June)	1995	AVG	Normalized
100-SUPERVISION (F)									15000	15000		12000
120-SAL. OPER (F)	153955	133072	104200	151000	139900	105200	118200	111000	56700	118400	127065.875	104500
130-SAL. R&M (F)	80321	60294	47900	76100	76600	42900	31800	41900	32300	60820	57226.875	69700
200-SUPPLIES (V)	94561	61876	68700	98900	77900	61900	35600	33800	7900	21510	67617	31000
214-LIME (L)	497614	641163	673500	959000	860900	749000	861900	807000	424700	549930	756259.625	625900
224-PUMPS&PIPE (V)	10900	4323	26200	24100	22000	4700	4900	8800	6100	8210	13240.375	11600
400-SERVICES PUR. (F)	48270	53077	47300	64500	65800	43000	34100	43200	27100	51875	54018	55800
413-SALARY OVERHEAD (F)							52500	49100	15900	29390	50800	29000
415-ROAD MAINT (F)							3400	8000	5800	8930	5700	6000
416-BUILDING HEAT (F)									400	1830		5000
500-EQUIP.D/A (F)	6648	8932	19200	38000	45800	10800	17100	3800	31200	61280	18785	49000
510-POWER (V)	30668	29936	29100	30500	38800	35100	51000	99200	58300	92330	43038	100000
Misc. Overhead (F)							0	300	22600	37820	8850	30000
TOTAL:	922937	992673	1016100	1442100	1327700	1052600	1210500	1206100	704000	1057325	1202600.75	1129500
FIXED COSTS:	289194	255375	218600	329600	328100	201900	204600	208200	191100	385345	322445.75	361000
VARIABLE COSTS:	136129	96135	124000	153500	138700	101700	91500	141800	72300	122050	123895.375	142600
LIME COSTS:	497614	641163	673500	959000	860900	749000	861900	807000	424700	549930	756259.625	625900

Mine Reclamation Funds

Ron Giammarino Alan Kraus Josef Zechner
Faculty of Commerce
UBC

Reclamation Cost Characteristics

- Costs may extend indefinitely into the future.
- Costs extend beyond the life of the mine.
- Costs are affected by management decisions.
- Recourse restricted by limited liability
- Public nature of the costs
  - Effects of damage are borne by the public.
  - Residual costs are borne by the taxpayer.

Possible Solutions

- Once-and-for-all fund contribution.
  - uncertainty of long-run investment returns
  - uncertainty of future technological/environmental developments
  - Does not provide proper incentives
- Dynamic Fund

Dynamic Fund Setup

- Calculate PV of expected reclamation costs (“mitigation cost value” or MCV).
  - MCV revised periodically
- Initial required Fund size equals MCV plus specified percentage margin.
  - company receives “Fund ownership share” or FOS
- Determine revision schedule and sharing rule for Fund surpluses.

Responsibilities

- Company provides initial Fund and covers future Fund deficits.
- Government guarantees reclamation cost shortfalls if company defaults.

Periodic Fund Reset

- Add investment earnings earnings to Fund.
- Subtract current reclamation costs from Fund.
- Re-estimate MCV.
- Compare current fund balance with MCV plus required margin
  - If excess, distribute to owner of FOS and government according to sharing rule.
  - If deficit, owner of FOS contributes to cover deficit or loses ownership of FOS.

Fund Termination

- When reclamation costs end, terminal Fund balance is distributed to owner of FOS and government according to same sharing rule.

Advantages of Fund

- As long as Fund size is greater than MCV, it is in the company's interest to cover current deficit.
- On average, the company earns fair market return on Fund contributions in excess of MCV.
- FOS is a transferrable asset, which can exist beyond the life of the company.
- The sharing rule and FOS ensures that the company gains from reclamation cost mitigation.

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- Once-and-for-all fund contribution.
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Responsibilities

- Company provides initial Fund and covers future Fund deficits.
- Government guarantees reclamation cost shortfalls if company defaults.

Periodic Fund Reset

- Add investment earnings earnings to Fund.
- Subtract current reclamation costs from Fund.
- Re-estimate MCV.
- Compare current fund balance with MCV plus required margin
  - If excess, distribute to owner of FOS and government according to sharing rule.
  - If deficit, owner of FOS contributes to cover deficit or loses ownership of FOS.

Fund Termination

- When reclamation costs end, terminal Fund balance is distributed to owner of FOS and government according to same sharing rule.

Advantages of Fund

- As long as Fund size is greater than MCV, it is in the company's interest to cover current deficit.
- On average, the company earns fair market return on Fund contributions in excess of MCV.
- FOS is a transferrable asset, which can exist beyond the life of the company.
- The sharing rule and FOS ensures that the company gains from reclamation cost mitigation.

MINE RECLAMATION FUNDS

Final Report

Submitted to

The Mineral Policy Branch

Ministry of Energy, Mines

and Petroleum Resources

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November 19, 1990

Contents

Chapter 1

Executive Summary

Although mining activity can affect the environment in various ways these impacts can usually be mitigated through environmental controls and reclamation technologies. Reclaiming a mine site involves a series of costs over time and responsibility for those costs is a liability of the mining company. In the event that the company defaults on its obligation, the cost of the required reclamation is born by the public through the Provincial Government.

This particular liability can differ from most others, however, in that cash outflows can be incurred over a number of years (possibly in perpetuity in the case of acid mine drainage (AMD)) after the operations of the mine have ceased. This feature of mitigation costs raises three related problems.

i) The ability of the mine to support mitigation expenses is drastically reduced once the economic life of the mine has ended. Since the life of certain mitigation costs can be expected to exceed the life of the mine, the possibility that the company will be unable to make the required payments arises.

ii) The fact that the company may not be able to fund future mitigation costs lowers the incentive for the firm to try to minimize such costs.

iii) Any mitigation costs that are not met by the company must be met by the people of British Columbia, either through government funding of the mitigation costs or through the negative externalities generated by environmental damage.

The Province of British Columbia has provided for the establishment of mine–specific reclamation funds (referred to as the "Fund"), which will serve as security for mine reclamation obligations, in Section 12 of the Mines Act (S.B.C. 1989 C.56). The objective of the Fund is to overcome the problems set out above, and thereby facilitate satisfactory reclamation. It is expected that single–mine companies with long lived reclamation obligations will be interested in establishing such Funds.

Fund contributions will be made either before or during the operation of the mine. The Fund will have a life that matches the life of the mitigation costs and hence is not bounded by the economic life of the mine. At the same time, the Fund structure will be such that if the current value of the Fund is deemed to be more than sufficient to meet the mitigation costs, then some portion of the surpluses will be distributed to the company. In this way the company has the ability to share in any mitigation cost savings that it produces. Finally, it is a requirement of the Fund that the Province be appropriately compensated for the risk that it is required to bear.

Having considered a number of alternative Fund structures, we recommend the following.

- Fund contributions and disbursements should be based on a benchmark figure which we refer to as the mitigation cost value or **MCV**. This figure is the present value of the expected mitigation costs. The risk of technological change as well as the investment risk generated by the Fund's portfolio of financial assets is accounted for in computing this value.

- The company will contribute an initial amount to the Fund which will be set at a fixed percent margin above MCV. In return the company receives a claim to the Fund which we will refer to as a Fund ownership share (**FOS**). The FOS is a financial asset and ownership is transferable once the mine has ceased operations.[1]

- Each year, an end of year Fund size is computed as the previous year's balance plus the realized investment income, minus actual mitigation costs. In addition, the MCV is recomputed each year taking into account changes in market conditions and technological changes.

[1] One of the objectives of the Fund is to provide an incentive for companies to reduce the ultimate mitigation costs whenever possible by providing it with a share in any savings. This incentive would be eliminated if ownership of the FOS were transferred prior to the mine ceasing operations and it is for this reason that such a transfer would be prohibited.

- If the realized Fund size exceeds the MCV plus margin at the end of the year, then the surplus is shared by the owner of the FOS and the Province according to a predefined sharing rule.

- If the realized Fund is less than the MCV plus margin, then the owner of the FOS is required to contribute sufficient funds to bring the Fund up to the MCV plus margin. Failure to do so results in the extinction of the FOS and the Province becomes the sole claimant to the Fund.

- The Fund is terminated when the MCV reaches zero and at that point a liquidating dividend is paid to the owner of the FOS and the Province.

This structure accomplishes the objectives set out above. The margin requirement provides a reasonable level of assurance that the mitigation costs will be met at a significantly lower Fund size than would be necessary if the FOS procedure were not adopted. This is due to the fact that the FOS is a valuable asset and its value is independent of the economic viability of the mine involved. As a result, the Province has greater assurance that the owner of the FOS will contribute to future mitigation costs if necessary. Moreover, the remaining possibility that the Province will be required to contribute funds in the future is exactly offset (on an expected value basis) by the possibility that it will share in future surplus disbursements. Because the value of the FOS is increased with decreases in the mitigation costs, the company benefits from actions which reduce future mitigation costs *even if* *the company is no longer in existence when the cost savings are realized.*

At the same time the structure of the Fund provides the company with considerable flexibility. To some extent, the initial contribution to the Fund and the sharing rule are substitutes so that the company can lower the initial cash requirements at the expense of having a smaller claim on future surpluses. In addition, the FOS can be sold to a third party once the mine has ceased operations and the proceeds used to pay a liquidating dividend to the company.

Another feature of the proposed framework is that the terms of the Fund can be computed for any particular asset mix. This allows the company and the Province to adjust the investment portfolio of the Fund while ensuring that the objectives of the Fund will continue to be met.

Chapter 2

Objectives and Fund Structure

Although mining activity can impact the environment in various ways these impacts can usually be mitigated through environmental controls and reclamation technologies. Reclaiming a mine site involves a series of costs over time and responsibility for those costs is a liability of the mining company. In the event that the company defaults on its obligation, the cost of the required reclamation is born by the public through the Provincial Government.

This particular liability can differ from most others, however, in that cash outflows can be incurred over a long number of years (possibly in perpetuity in the case of acid mine drainage (AMD)) after the operations of the mine have ceased. This feature of mitigation costs raises three related problems.

i) The ability of the mine to support mitigation expenses is drastically reduced once the economic life of the mine has ended. Since the life of certain mitigation costs can be expected to exceed the life of the mine, it is possible that those mitigation payments may not be made by the company, particularly if the depleted mine was the company's main source of income.

ii) The fact that the company may not be able to fund future mitigation costs lowers the incentive for the firm to try to minimize such costs.

iii) Any mitigation costs that are not met by the company must be met by the people of British Columbia, either through government funding of the mitigation costs or through the negative externalities generated by environmental damage.

The Province of British Columbia has provided for the establishment of mine–specific reclamation funds (referred to as the "Fund"), which will serve as security for mine reclamation obligations, in Section 12 of the Mines Act (S.B.C. 1989 C.56). The objective of the Fund is to overcome the problems set out above and thereby to facilitate satisfactory reclamation. It is expected that single–mine companies with long lived reclamation obligations will be interested in establishing such Funds.

Fund contributions will be made either before or during the operation of the mine. The Fund will have a life that matches the life of the mitigation costs and hence is not bounded by the economic life of the mine. At the same time, the Fund structure will be such that if the current value of the Fund is deemed to be more than sufficient to meet the mitigation costs, then some portion of the surpluses will be distributed to the company. In this way the company has the ability to share in any mitigation cost savings that it produces. Finally, it is necessary that the structure of the Fund reflect the risk that the Province faces as the ultimate guarantor of reclamation performance. Elimination of all risk faced by the Province is not practical since it would require an extremely large Fund to cover the most extreme conceivable contingency. As a result, the structure of the Fund must recognize the risk that remains and compensate the Province accordingly.

2.1 Fund Structure

The principal requirement of the Fund is that it be a vehicle through which contributions are made on the basis of expected mitigation costs; however the magnitudes of these costs are often difficult to predict. Furthermore, since the Fund is likely to be invested for a long period of time, there will be investment risk. Consequently, the ability of the Fund to meet the actual mitigation costs that arise will depend on those two sources of risk.

There are two approaches that can be used to deal with this risky situation. One is simply to value the mitigation cost liability, recognizing the risks involved, and transfer the liability from the company to the Province in exchange for a fee which would be the size of the Fund. Subsequent deficiencies in the Fund are offset by Provincial government contributions and surpluses would be distributed to the Province. The second is to adopt a dynamic approach in which company involvement in reclamation continues for some time.

There are, however, two problems with the first approach. First, it is very difficult to fully characterize the nature of the financial and technical risks faced by the Fund. On the one hand, although the investment risk is something that can be dealt with since the instruments and institutions have a long history which can be used to form the basis of a projection into the future, forecasts for long periods of time are difficult to make. On the other hand, however, the nature of the costs generated by environmental damage are, in many cases, not well known. Hence, any assessment of the risk involved is at best tentative and must be reassessed regularly. The second problem is that the mitigation costs can be affected by the actions of the mine operator. If the mitigation cost liability is completely removed, then the operator has no incentive to minimize costs.

Both of these concerns argue for the second approach, which is a dynamic Fund structure. Our recommendation is that the following general structure be adopted.

- The Fund will be established by the company. In establishing the Fund, the company will receive a Fund Ownership Share (**FOS**). The owner of the FOS will receive part of any surpluses generated by the Fund but may also be required to make future contributions to the Fund.

- Contributions to and disbursements from the Fund are made at the end of each 'period'. The length of each period (i.e., whether a year, a quarter, a month, etc.) is established separately for each mine. The factors that enter into the determination of the length of the review period are discussed below.

- The Fund contributions and disbursements will be based on a benchmark figure which we refer to as the mitigation cost value or MCV. This figure is essentially the present value of the expected mitigation costs. The risk of technological change as well as the investment risk generated by the Fund's portfolio of financial assets is accounted for in computing this value.

- The initial amount of the Fund, contributed by the company, will be equal to the MCV plus a specified amount (the margin) of the MCV (e.g. if 10% were specified, then the Fund would be set at 110% of the MCV). The company will receive a FOS in return for establishing the Fund. The FOS is a financial asset and ownership is transferable once the mine has ceased operations.

- Each period an end of period Fund size is computed as the previous period's balance plus the realized investment income, minus the actual mitigation costs. In addition the MCV is recomputed each period taking into account changes in market conditions, site conditions and technology changes.

- If the realized Fund size exceeds the MCV plus margin at the end of the period then the surplus is shared by the owner of the FOS and the Province according to a predefined sharing rule.

- If the realized Fund is less than the MCV plus margin, then the owner of the FOS is required to contribute sufficient funds to bring the Fund up to the MCV plus margin. Failure to do so results in the extinction of the FOS and the Province becomes the sole claimant to the Fund.

- The Fund is terminated when the MCV reaches zero and at that point a liquidating dividend is paid to the owner of the FOS and the Province.

- The length of the period after which the required fund size is to be recalculated should reflect an optimal balancing of the costs and benefits involved. The cost of a shorter period is that it implies more reviews and therefore greater review costs. The benefit of a more frequent review is that the expected required payments by the Province are decreased. These costs and benefits will in turn be influenced by the volatility of rates of return and mitigation costs. In our simulations we assume that the Fund size is recalculated at the beginning of each year.[1]

This structure meets the objectives of the Fund. We wish to point out that the dynamic nature of the proposed Fund structure lowers the risks to the mining company as well as to the Province significantly. To see this, we

[1] Annual recalculation corresponds to current reclamation reporting requirements.

emphasize that forecasts of rates of return as well as mitigation costs over very long horizons such as 100 years cannot be made with high accuracy. However, because of the dynamic adjustments implicit in the proposed Fund structure, the adverse impact of errors in the forecasts in rates of return and mitigation costs is greatly reduced. If, say, future realized rates of return turn out to be higher than the forecasted rates of return, then, at the end of each period, the company receives the predefined share of the implied surpleses. The same is true if mitigation costs turn out to be lower than expected. This point is illustrated in Section 8 in Chapter 3 of this report (Tables 8 and 9).

In addition, the margin requirement provides a reasonable level of assurance that the mitigation costs will be met at a significantly lower Fund size than would be necessary if the FOS procedure were not adopted.[2] This is due to the fact that the FOS is a valuable asset whose value is independent of the economic viability of the mine involved. Hence, the owner of the FOS has a financial incentive to avoid the loss of this valuable asset by making further contributions as required. As a result, the Province has greater assurance that the owner of the FOS will contribute to future mitigation costs if necessary so that the expected contributions by the Province are reduced. Moreover, the remaining possibility that the Province will be required to contribute funds in some cases is exactly balanced by the possibility that it will share in future surplus disbursements in other cases.

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[2]This point is illustrated in Chapter 3 below.

Because the value of the FOS is increased with decreases in the mitigation costs, the company benefits from actions which reduce future mitigation costs *even if the company is no longer in existence when the cost savings are realized.* To illustrate, suppose that, just prior to the mine closing, the company can take an action which will reduce mitigation costs several years later. Suppose that when the mine closes the company wishes to wind up and pay a liquidating dividend. One of the assets of the mine will be the FOS which will have a value roughly equal to the size of the Fund minus the discounted expected future reclamation costs. Since these reclamation costs have been reduced by the action, the price that will be received for the FOS will be increased by the cost saving involved. Therefore, the owners of the FOS when the decision is made benefit in that their liquidating dividend is increased by the cost saving.

At the same time the structure of the Fund provides the company with considerable flexibility. To some extent, the initial contribution to the Fund and the sharing rule are substitutes so that the company can lower the initial cash requirements at the expense of having a smaller claim on future surpluses.[3] In addition, the FOS can be sold to a third party once the mine has ceased operations and the proceeds used to pay a liquidating dividend

[3]The extent to which the initial contribution can be lowered is, however, limited by the fact that, as the share of surpluses paid to the company is diminished, the incentive to efficiently reduce expected mitigation costs is also reduced. It is also true that, for a given review period, the risk to the province increases. For both of these reasons a minimum sharing rule should be set.

to the company.

Another feature of the proposed framework is that its terms can be computed for any particular asset mix. This allows the company and the Province to adjust the investment portfolio of the Fund while ensuring that the objectives of the Fund will continue to be met.

We apply the recommended Fund structure in detail to the hypothetical case outlined below.

Chapter 3

Fund Size Determination

3.1 Overview

In this chapter we calculate the initial Fund size for the hypothetical case in which the annual costs of the site reclamation are expected to be $1 million. Underlying the following approach is the assumption that the required Fund size will be estimated annually. Thus, at the beginning of each year, the present value of the expected cost of reclaiming the site is estimated. The details of estimating future discount rates are given in Section 3.3. The required Fund size is then equal to the MCV (present value of the expected costs) plus the margin. That is, if the present value of the costs is $30 million and the margin is set at 10%, then the required size of the Fund is $33 million.

If the Fund's size exceeds the required level, a percentage of the difference is paid out to the company. If the Fund's size is below the required level, the company is asked to make an additional payment to bring the Fund's size to the required level. If the Fund's size before this payment exceeds the present value of the expected costs, we assume the company will always make the required additional payment. In this case it is in the company's interest to retain its FOS claim. If the Fund's size before the payment falls significantly below the present value of the expected costs, the company may choose to default on the required payment and thereby give up its FOS and any future claim on Fund surpluses. In the latter case, the Province takes over the Fund along with all future deficiencies and surpluses.

3.2 Asset Mix

We base the numerical analysis of our recommended method on the assumption that the assets of the Fund would be invested equally in Canadian Treasury Bills, Canadian Government Bonds and Canadian equities. This represents diversification across the major Canadian asset groups which will tend to reduce Fund risk.

In addition to these traditional investments, we note the recent introduction of Index-Linked Mortgages (ILMs), guaranteed by the Central Mortgage and Housing Corporation (CMHC). These ILMs have a maturity of 30 years and currently offer real rates of return of 4.5% to 5% (net) over their term. Although the principal amount invested in ILMs is effectively insured against default, there are significant possibilities that the promised real rate of return will not be earned for the full term to maturity. To see this, it is necessary to note some specific details about these instruments. The ILMs are issued to finance co-operative housing under the Federal Co-operative Housing Program. Under this program, non-profit housing co-operatives may obtain 100% debt financing. Thus, the co-operative may begin with zero equity. In the event of an economic downturn, a significant drop in incomes and real estate values will then render the co-operative's equity negative and the members will default on the mortgage. In such a case, the CMHC will pay off the principal of the mortgage. In fact then, the ILM is likely to be prepaid in exactly the circumstances when available real rates of return are depressed. Thus, the ILMs have an indirect prepayment option to the borrower which we feel greatly reduces their suitability as a means of guaranteeing high real rates of return. In addition, the lack of a secondary market for the ILMs limits the flexibility for paying out Fund surpluses to the company.

3.3 Forecasts of Future Discount Rates

We estimated future rates of return in the following manner. We estimated the long-run mean real return[1] and the historical speed of convergence to this long-run mean using realized real rates of return since 1954 on an equally weighted mix of Canadian Treasury Bills, Canadian Government Bonds and Canadian equities. Movement toward the long-run mean for this particular asset mix depends on the current real rate level through the following

[1]The real rate is the realized nominal rate less the realized inflation rate, as measured by changes in the CPI.

relationship

$$R_t = 0.0245 + 0.105R_{t-1}$$

where R_t denotes the continuously compounded real rate of return on an equally weighted portfolio in year t. The parameters of this equation are those which best fit the history of real rates of return since 1954. The long-run real rate of return in our rate of return forecast (compounded annually) matches the historical average of 3.02%.

To forecast future real rates of return from a given current level, the current rate is substituted for R_{t-1} in the above equation and the calculated value of R_t is the forecast for the following year. Then this forecast is substituted in the right-hand side of the equation and a forecast for a further year is produced. Repeating this procedure produces a series of forecasts for all future years.

3.4 Probability Distribution of Future Costs

Our data on future annual mitigation costs are based on a hypothetical probability distribution which has an expected cost per year of $1 million. The cumulative distribution is depicted in figure 3.1.

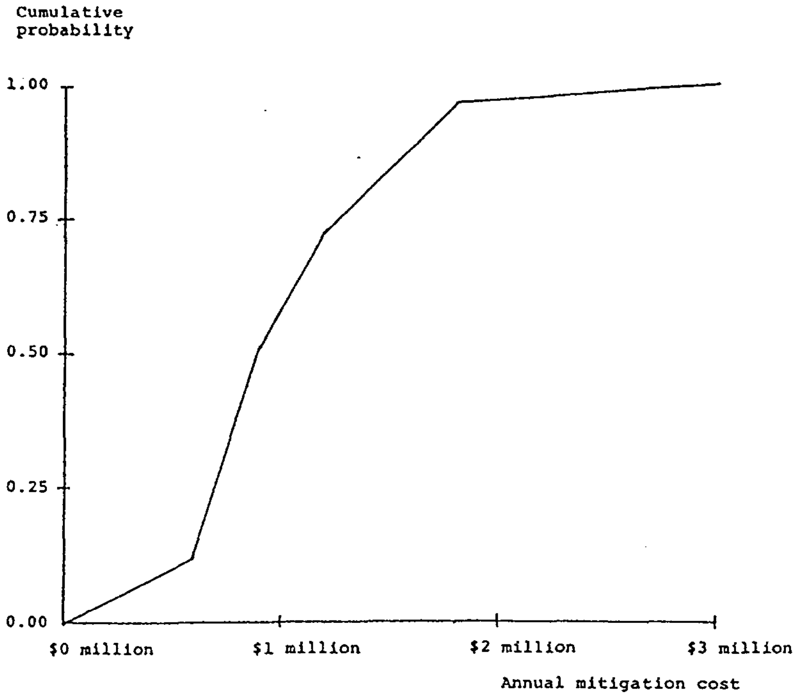

Figure 3.1: Cumulative Distribution of Mitigation Costs

3.5 Calculation of the Initial MCV

To obtain a series of real rates of return, we take a starting value of 6.19% which corresponds to the realized real rate of return on the equally weighted asset mix in 1988.[2] The future rates of return are then calculated on the basis of the historical rate of return process estimated according to the equation in Section 3.4. For example, for the years 1988 to 1993 the following rates of return were used

Year	*Rate*
1988	6.19%
1989	3.37%
1990	3.05%
1991	3.02%
1992	3.02%
1993	3.02%

The expected annual mitigation cost from the probability distribution described above is $1.00 million (in constant 1988 dollars). Using the forecasted discount factors given above, the present value of expected costs is $33.50 million. This number is the initial MCV and is used in the numerical simulations described below.

3.6 Simulation of Fund Performance

To analyze the effects of our proposed method to the company and the Province, we performed an extensive numerical simulation of Fund results for different interest rate paths and mitigation costs. We consider margin percentages ranging from 0% to 30%. For each future year of the Fund's

[2]This corresponds to the realized market rate for 1988 on the equally weighted asset mix. The original statement of the problem to be addressed specified the use of 1988 as a starting value for our forecasts.

operation, the results depend on the realized rate of return and the realized mitigation cost for that year. We describe below how we generate the realizations of rates of return and mitigation costs and the resulting payments into and out of the Fund each year.

We assume that the mitigation cost in the first year equals the mean of the distribution described in Section 3.4. To generate the costs for succeeding years, we drew a value from the probability distribution and assumed that the costs moved linearly to that value over six years. For example, if a long-run value of $1.5 million was drawn from the distribution, then the annual costs would be as follows

Year	*Cost*
1993	$1.00 m
1994	$1.10 m
1995	$1.20 m
1996	$1.30 m
1997	$1.40 m
1998 & on	$1.50 m

The path of real rates of return was drawn from the historical frequency distribution of real rates since 1954. The realized rate of return for year t equals the forecast given by the equation in Section 3.3 plus a random deviation based on the historical variance of realized rates.

Each year the Fund is credited with earnings based on the realized rate of return and pays out the realized cost for that year. Then the required Fund size to begin the next year is calculated. This is done by using the current realized cost as the estimated annual cost from then on and forecasting a series of expected future real rates using the method described earlier with that year's realized rate of return as a starting value. The resulting MCV times one plus the margin percentage gives the required Fund size for the beginning of the next year.

If the actual Fund size exceeds this required size a percentage of the difference is paid out to the company. The remainder of the excess is paid to the Province. If the required Fund size exceeds the actual Fund size, the company must make a new contribution to the Fund equal to the deficiency. If the deficiency is smaller than a critical level (generally 10% of the required Fund size), then we assume that the company makes the payment but if the deficiency exceeds this critical value, the company is assumed to default on its obligation and give up its FOS. In the event of default, no further payments into the Fund are made by the company, nor are any future surpluses paid to the company and so all future deficiencies and surpluses are paid or received by the Province. Following the steps described above, we generate a series of cash flows to the company and the Province, corresponding to each cost path and rate of return path drawn from the distributions.

3.7 Simulation Results

We have simulated Fund results under four alternative assumptions about the percentage shares of surpluses going to the company and the Province:

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100% to the company and 0% to the Province, 90% to the company and 10% to the Province, 80% to the company and 20% to the Province and 70% to the company and 30% to the Province. For each sharing rule we considered four alternative margin percentages: 0%, 10%, 20% and 30%. For each of the sixteen combinations of sharing rule and margin percentage we simulated 500 histories of Fund performance, each consisting of 100 years of mitigation costs and rates of return.[3] We recorded the average payments by year for the company and the Province and the present value of these average payments. The tables below show the results of the simulations along with the initial Fund size for each case.

[3]The number of 500 simulations reflects a tradeoff between the accuracy of the results and computing costs. For some scenarios we have performed 10,000 simulations and found that the results - although more accurate - were not significantly different from the results based on the smaller number of 500 simulations. The 100 year horizon is used for computational ease. Extension of the horizon would not significantly alter the present values.

Table 1.

Sharing rule: Company 100%, Province 0%

Margin	*Initial Fund Size*	*PV to Company*	*PV to Province*
0%	$33.5 million	$5.7 million	-$6.2 million
10%	$36.9 million	$7.3 million	-$2.9 million
20%	$40.2 million	$9.6 million	-$2.1 million
30%	$43.6 million	$11.0 million	-$0.8 million

Table 2.

Sharing rule: Company 90%, Province 10%

Margin	*Initial Fund Size*	*PV to Company*	*PV to Province*
0%	$33.5 million	$5.2 million	-$4.2 million
10%	$36.9 million	$6.4 million	-$2.0 million
20%	$40.2 million	$6.5 million	-$0.7 million
30%	$43.6 million	$8.4 million	$1.2 million

Table 3.

Sharing rule: Company 80%, Province 20%

Margin	*Initial Fund Size*	*PV to Company*	*PV to Province*
0%	$33.5 million	$4.8 million	-$3.8 million
10%	$36.9 million	$4.1 million	-$0.6 million
20%	$40.2 million	$5.1 million	$1.9 million
30%	$43.6 million	$6.1 million	$5.5 million

Table 4.

Sharing rule: Company 70%, Province 30%

Margin	*Initial Fund Size*	*PV to Company*	*PV to Province*
0%	$33.5 million	$3.6 million	-$3.2 million
10%	$36.9 million	$3.8 million	-$1.4 million
20%	$40.2 million	$4.6 million	$2.6 million
30%	$43.6 million	$2.7 million	$7.8 million

The most important results demonstrated by these simulations are:

- In terms of the effect on the Province there is a distinct tradeoff between the margin percentage and the share of surpluses going to the Province.

- To limit the Province's position to approximately zero requires either a 30% margin (i.e. $43.6 million initial Fund size) if 100% of surpluses are paid to the company or a margin between 10% and 20% (i.e. $ initial Fund size between $36.9 and $40.2 million) if the Province receives 20% or 30% of the surpleses.

We note that, while the Fund accounts for the risk that must be born, it does not eliminate risk. Table 5 illustrates this by presenting the 90% confidence interval for the Government and the Company.

Table 5.

Margin	*Percent of Surplusses Paid to Government*	*90% Confidence Interval for the Present Values to the Government*	*to the Company*
10%	20%	-$33 m - $18 m	-$2 m - $18 m
10%	30%	-$40 m - $19 m	-$3 m - $15 m
20%	20%	-$29 m - $24 m	-$2 m - $21 m
20%	30%	-$27 m - $23 m	-$1 m - $18 m

3.8 Example of Two Cost Scenarios

In order to illustrate how the Fund would operate and to demonstrate the role of the required margin above MCV, we examined two particular mitigation cost scenarios. In the first scenario mitigation costs are significantly higher than expected: during the first five years the annual cost rises steadily from $1.00 million to $1.50 million and then remains at $1.50 million thereafter. Mitigation costs in the second scenario are significantly below expectations: the annual cost falls steadily from $1.00 million to $0.50 million and then remains constant. In order to focus on the effects of mitigation cost realizations, we assumed for both scenarios that realized rates of return exactly followed the forecasts on which the MCV is based. In other words, the only surprises that occur in the scenarios are the realized mitigation costs.

Table 6 shows results for 1993 through 1999 in the high cost scenario for the case of a Fund with zero margin. Beyond 1999 the annual mitigation cost remains $1.50 million. The column labelled "MCV+0% margin" shows the required Fund size at the end of each year after that year's mitigation cost is paid. The MCV for that year is calculated on the assumption that future mitigation costs will remain at the level of the cost realized that year, In other words, in each of the years 1994 through 1998 expected future costs are re-evaluated upward as the cost realized that year exceeds the previous year's expectation. From 1999 onwards realized costs match the previous expectations.

The column labelled "Fund" shows the Fund balance each year after realized investment income is received and realized mitigation costs are paid. The excess or deficiency of the realized Fund balance relative to the required Fund size (MCV plus margin) is shown in the column labelled "Surplus". A positive entry in this column indicates a surplus to be shared by the owner of the FOS and the Province; a negative entry indicates a deficiency that must be made up by a contribution of additional Funds by the company. From 1999 onward the annual surplus is constant. In order to examine the incentives of the owner of the FOS to contribute additional Funds where required, the column labelled "FOS" shows the value of the entire FOS (i.e. ignoring any sharing rule) assuming all previous years' surpluses have been paid out and deficiencies paid in but before action has been taken on that year's surplus or deficiency.

The effect of zero margin when realized mitigation costs exceed expectations is clearly seen in Table 6. At the end of 1994 there is a deficiency of $3.79 million in the Fund. With zero margin the FOS (ignoring sharing rules) is always equal to the surplus/deficiency, so in 1994 it is also a negative

$3.79 million. This means that the financial incentive for the company is to give up ownership of the FOS rather than contribute additional Funds. If this occurs, the Province takes over the FOS, pays that year's deficiency and pays or receives all future deficiencies or surpleses. For the cost scenario in Table 6, if the company were to give up the FOS at the first date when there is a financial incentive to do so (i.e. 1994), the additional payments made by the Province to cover deficiences in the Fund have a total present value as of the inception of the Fund (i.e., the end of 1988) of $15.48 million.

Table 7 shows results for the same mitigation cost scenario as in Table 6 but for a Fund that includes a 10% margin above MCV. What is apparent from the "FOS" column in Table 7 is that the owner of the FOS has each year in which there is a deficiency a financial incentive to contribute the additional funds required that year rather than relinquish ownership of the FOS. (The 1994 "FOS" value of $0.00 million indicates a breakeven situation with respect to retaining ownership of the FOS.) Since the company has a financial incentive to make the required payments to cover deficiencies in the Fund, the Province does not have to bear the unforeseen extra mitigation costs. This is in contrast to the situation in Table 6 and shows the importance of the margin above MCV in the operation of the Fund.

Tables 8 and 9 show results for 1993 through 1999 for the scenario in which realized mitigation costs fall below expectations. Table 8 is for the zero margin Fund considered in Table 6 and Table 9 is for the 10% margin

Fund considered in Table 7. Tables 8 and 9 show how the revision of cost expectations as realized costs fall below previous expectations leads to surpluses that are paid out to the owner of the FOS and the Province according to some sharing rule.

The significant conclusion that emerges from consideration of Tables 6, 7, 8 and 9 together is that the inclusion of a positive margin above MCV greatly reduces the Province's exposure to bearing the effects of higher than expected mitigation costs because the margin significantly affects the financial incentive of the company to contribute required additional funds rather than give up ownership of the FOS. When mitigation costs turn out to be lower than expected, on the other hand, the inclusion of a positive margin merely increases the positive surpluses that will be paid back to the company.

Table 6

Year	*Cost*	*MCV+0% Margin*	*Fund*	*Surplus*	*FOS*
1993	\$1.00 m	\$37.03 m	\$37.03 m	\$0.00 m	\$0.00 m
1994	\$1.10 m	\$40.63 m	\$36.84 m	-\$3.79 m	-\$3.79 m
1995	\$1.20 m	\$44.21 m	\$40.43 m	-\$3.78 m	-\$3.78 m
1996	\$1.30 m	\$47.77 m	\$44.00 m	-\$3.77 m	-\$3.77 m
1997	\$1.40 m	\$51.55 m	\$47.55 m	-\$3.77 m	-\$3.77 m
1998	\$1.50 m	\$54.83 m	\$51.07 m	-\$3.76 m	-\$3.76 m
1999	\$1.50 m	\$54.67 m	\$54.67 m	\$0.00 m	\$0.00 m

Table 7

Year	*Cost*	*MCV+10% Margin*	*Fund*	*Surplus*	*FOS*
1993	\$1.00 m	\$40.73 m	\$40.83 m	\$0.10 m	\$3.80 m
1994	\$1.10 m	\$44.69 m	\$40.63 m	-\$4.06 m	\$0.00 m
1995	\$1.20 m	\$48.63 m	\$44.59 m	-\$4.04 m	\$0.38 m
1996	\$1.30 m	\$52.55 m	\$48.53 m	-\$4.02 m	\$0.75 m
1997	\$1.40 m	\$56.44 m	\$52.44 m	-\$4.00 m	\$1.13 m
1998	\$1.50 m	\$60.31 m	\$56.33 m	-\$3.98 m	\$1.50 m
1999	\$1.50 m	\$60.14 m	\$60.29 m	\$0.15 m	\$5.62 m

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Table 7

Year	*Cost*	*MCV+0% Margin*	*Fund*	*Surplus*	*FOS*
1993	\$1.00 m	\$37.03 m	\$37.03 m	\$0.00 m	\$0.00 m
1994	\$0.90 m	\$33.24 m	\$37.04 m	\$3.79 m	\$3.79 m
1995	\$0.80 m	\$29.47 m	\$33.26 m	\$3.78 m	\$3.78 m
1996	\$0.70 m	\$25.72 m	\$29.50 m	\$3.77 m	\$3.77 m
1997	\$0.60 m	\$21.99 m	\$25.76 m	\$3.77 m	\$3.77 m
1998	\$0.50 m	\$18.28 m	\$22.03 m	\$3.76 m	\$3.76 m
1999	\$0.50 m	\$18.22 m	\$18.22 m	\$0.00 m	\$0.00 m

Table 9

Year	*Cost*	*MCV+0% Margin*	*Fund*	*Surplus*	*FOS*
1993	\$1.00 m	\$40.73 m	\$40.83 m	\$0.10 m	\$3.80 m
1994	\$0.90 m	\$36.57 m	\$40.83 m	\$4.26 m	\$7.59 m
1995	\$0.80 m	\$32.42 m	\$36.66 m	\$4.24 m	\$7.19 m
1996	\$0.70 m	\$28.30 m	\$32.52 m	\$4.22 m	\$6.79 m
1997	\$0.60 m	\$24.19 m	\$28.39 m	\$4.20 m	\$6.40 m
1998	\$0.50 m	\$20.10 m	\$24.28 m	\$4.18 m	\$6.01 m
1999	\$0.50 m	\$20.05 m	\$20.10 m	\$0.05 m	\$1.87 m