MINE RECLAMATION IN BRITISH COLUMBIA - TWENTY-FIVE YEARS OF PROGRESS

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1.0 INTRODUCTION

Mining is British Columbia's second largest industry and a major contributor to the Province's economic development and its resultant prosperity. Mining has always been a highly valued use of the Province's land base. However, as we enter the 21st century, the public is increasingly opposing mining developments. If mining is to continue to play a strong role in British Columbia's economy, we must all work to ensure that mining is carried out in an environmentally sound fashion and in particular, on closure, reclaimed to a useful and productive state which does not pose an ongoing legacy and cost to public funds.

Although current Provincial legislation regards mining as a temporary land use and requires all mining companies to carry out a program of environmental protection and reclamation, it is now quite clear that many of our mines are not temporary and will require some form of ongoing monitoring and maintenance. It is up to industry and Government regulators to ensure that any ongoing legacy is manageable and that the mechanisms will be in effect to ensure that upon termination of mining, the land and watercourses will be returned to a safe and environmentally sound state and to an acceptable, productive end use.

The Ministry of Energy and Mines is committed to achieving reclamation by establishing a clear framework within which both the mining industry and Government can work. Legislation seeks to establish broad standards and encourages industry to be innovative and cost-effective in meeting these standards. The Ministry is committed to base all decisions on the best available information and on reasoned judgement. As well, the Ministry is committed to be accountable to the public and industry.

Government has regulated mine reclamation since 1969, and during this time has seen the mining industry evolve from one composed almost exclusively of underground operations, to an industry consisting mainly of large-scale, open pits. Coal and copper mining has expanded greatly, and more recently, gold mining is again becoming important.

One of the most important factors in developing and fostering mine reclamation expertise in British Columbia has been through the annual mine reclamation symposia organized by the Technical and Research Committee on Reclamation (TRCR). The first symposium, of course, was held 25 years ago in 1977. During the second symposium, held a year later, the first reclamation awards were presented.
2.0 MINING LAND BASE AND RECLAMATION

Since the late 1960s, land occupied by the mining industry has steadily grown. Major coal and metal mines, which occupied less than 1,000 hectares in 1969 had, by the end of 2000, expanded to cover 40,043 hectares. Revegetation activities have reclaimed over 31 percent or 12,563 hectares (Figure 1).

![Figure 1 - Area Disturbed and Reclaimed for All Mines in British Columbia, 1969 to 2000](image)

Major metal mines, which occupied less than 1,000 hectares in 1969 had, by the end of 2000, expanded to cover 23,508 hectares, and 7,311 hectares (or 31 percent) have been reclaimed (Figure 2).
Coal mines have disturbed 16,535 hectares, and 5,252 hectares (or 32 percent) have been reclaimed (Figure 3).
The data presented in Figures 1, 2 and 3 represent the cumulative disturbance, which continually increases as new mines are developed. When mines close either permanently or temporarily, they remain in the database until they are finally reclaimed. Many of our closed mines have not been fully reclaimed and several remain on a care and maintenance status until economics improve. The reclamation performance of both the coal and metal mine sectors has been steady.

3.0 RECLAMATION AND MINE EFFLUENT DRAINAGE

Mine reclamation legislation and policy includes requirements for the prevention or treatment of effluent escaping from a mining property. The environmental and social consequences of uncontrolled acid effluent can have major impacts on the water quality of the receiving environment.

Of the 10 metal mines currently operating in British Columbia, 2 are producing acid mine drainage and 6 more have the potential to produce acid or alkaline effluent. None of these mines are releasing toxic effluent into the receiving environment.

Of the seven operating coal mines, none are presently generating acid mine drainage. Although one coal mine has the potential to do so, it has been designed to prevent acid mine drainage. For proposed new mines, Government policy is to approve only those mines which develop mine plans that prevent or control acid mine drainage.

Alkaline mine drainage is also an environmental concern. Metals such as molybdenum are soluble at high pH and are present in elevated levels at several mines in British Columbia.

4.0 HISTORY OF LEGISLATION

Reclamation legislation was first enacted in 1969, when existing mining legislation was amended, requiring reclamation for major coal mines and hardrock mineral mines. In 1973, legislation was amended to include coal exploration, mineral exploration, sand and gravel pits, and quarries. In 1984, the Minister of Energy, Mines and Petroleum Resources published reclamation guidelines. The Mines Act remained relatively unchanged until it was amended in 1990. Tin's amended Act and its accompanying "Health, Safety and Reclamation Code for Mines in British Columbia" (HSR Code) continues to provide the framework for reclamation policy.

Although the Mines Act has remained constant during the 1990s, there have been a number of significant guideline and policy initiatives that have been developed and are complimentary to the legislation. Some of these include:


5.0 CURRENT RECLAMATION LEGISLATION

Mining, especially open pit metal mining, has an intense impact. For example, for every kilogram of copper produced in British Columbia, there may be 200 kilograms of waste rock excavated and stored in waste dumps and another 200 kilograms of tailings. The environmental acceptability of mining hinges on being able to confine these impacts to a limited area and, following closure, to achieve an acceptable reclamation standard.

For major mines, the Province reviews each project on its own merits under the Environmental Assessment Process, which is then followed by a number of permits and licences, including a permit issued under the Mines Act. The Ministry of Energy and Mines' philosophy has been to set broad reclamation standards which allow each company to develop their own program on a site-by-site basis. The standards set out in the Mines Act and accompanying HSR Code maintain this philosophy. They were produced following considerable discussion with industry and other Government agencies.

Since reclamation legislation was first introduced, companies have now largely integrated their reclamation planning into the overall mine planning process.

5.1 Environmental Assessment Process

The Environmental Assessment Act (EA Act) was proclaimed on June 30, 1995. It replaced the Mine Development Review Process and applies to new mine developments (or modifications to existing mines) meeting the following threshold criteria established under the EA Act:

• Coal Mines - Any new mine with 250,000 tonnes of clean and/or raw coal production per year or an existing reviewable-scale mine entailing either 50 percent increase in area of mining disturbance or 750 hectares new disturbance.

• Mineral Mines - Any new mine with 75,000 tonnes of mineral ore production per year or an existing reviewable-scale mine entailing either 50 percent increase in area of mining disturbance or 750 hectares new disturbance.
• Sand and Gravel Pits - Any new pit with 500,000 tonnes of sand and/or gravel production per year or 1,000,000 tonnes over 4 years or an existing reviewable-scale pit entailing 35 percent increase in area of mining disturbance.

• Placer Gold Mines - Any new placer operation with production of 100,000 tonnes of pay-dirt per year or an existing reviewable-scale operation entailing 35 percent increase in area of mining disturbance.

• Construction Stone and Industrial Mineral Quarries - Any new quarry with production of 250,000 tonnes of quarried product per year or an existing reviewable-scale operation entailing either 50 percent increase in area of mining disturbance or 750 hectares new disturbance.

Proposed mines that meet or exceed the threshold criteria of the EA Act require a Project Approval Certificate under the Act prior to issuance of a Mines Act permit.

The EA Act establishes a single, comprehensive, Provincial review and approval process and provides a means of identifying potential effects of major projects and an evaluation of opportunities to prevent or mitigate impacts. If the project is acceptable, the proponent receives a Project Approval Certificate signed by the Minister of Energy and Mines and the Minister of Sustainable Resource Management.

5.2 Mines Act Permitting Process

Standards for mine reclamation are described in Part 10 of the HSR Code and pertain largely to major coal and metal mines. These standards define mine reclamation and include provision for returning the land and watercourses to a productive land use, ensuring that impoundment structures and waste rock dumps are stable over the long-term, and ensuring that water quality released from a minesite is of an acceptable standard. In addition, mineral exploration standards are outlined in the Mineral Exploration Code, which is the new Part 11 of the HSR Code.

The Mines Act permit system itself has remained relatively unchanged since 1969 and provides for:

• A Mine Plan and Reclamation Report - to be submitted prior to commencement of operations, outlining a program for the protection and reclamation of the land and watercourses affected by the mine. In recent years, the report has focussed on the prediction and prevention of metal leaching and acid rock drainage.

• Publication of a Notice of Filing in the British Columbia Gazette and Local Newspapers - this is a requirement for major mines and, depending on the level of public concern, can be required for exploration activities or placer mines.

• Report Review - by an inter-agency committee of Government. The Regional Mine Development Review Committees provide the detailed technical review, and the Victoria-based Reclamation Advisory Committee is the coordinating body.
Reclamation Security - reclamation securities are required as a condition of all reclamation permits. Over the last several years, reclamation security bonds have been increased on many properties, as permits have been revised or renewed. This policy reflects Government's desire to reduce the possibility that public funds might be required to reclaim a mine in the case of default, by more accurately reflecting the outstanding reclamation obligations of each mine property.

Reclamation security deposits increased from $18 million in 1984 to over $191 million by December 31, 2001 (Figure 4). At present, the only securities acceptable include term deposits, GICs, bonds of not longer than three year's duration guaranteed by the Government of Canada or any province of Canada (all of which are held by a bank using a Safekeeping Agreement), cash, or an irrevocable letter of credit.

Figure 4 - Reclamation Security Deposits Held by the Ministry of Energy and Mines, 1984 to 2000.

The Mines Act also makes provision for a mine-specific reclamation fund which enables companies to set aside money today for obligations which are being incurred (such as acid mine drainage) that will require funds to be expended at some future date.

• Permit - a permit is issued! with special terms and conditions based upon recommendations from the Reclamation Advisory Committee as well as public response.
• Continual , and Progressive Reclamation - is required over the life of the mine including an annual submission of a report describing the progress of the mine plan, the metal leaching and acid rock drainage work and the reclamation program.

• Confiscation - where there is non-compliance with conditions of the Reclamation Permit the Chief Inspector of Mines may order closure of the mine and forfeiture of the security.

• Permit Amendment - like many other approvals, permits require continual updating. The company's proposed mine plan, and hence its reclamation plan, may change due to economic, geological or environmental factors. Thus, the Reclamation Advisory Committee regularly reviews reclamation programs and modifies permit conditions and security levels.

More information about the Mines Act, the HSR Code, the Environmental Assessment Process, and the permitting process can be found on the Ministry of Energy and Mines' web site at http://www.gov.bc.ca/em.

6.0 HISTORIC MINESITES

Mining has taken place in British Columbia since the mid-180Os, but reclamation requirements were first legislated in 1969. There are, therefore, a number of old mining sites that were not reclaimed when operations ceased. In many cases, nature has successfully undertaken this function and many sites are no longer visible. In other cases, the mines are of historic significance and the remnants of mining are protected and preserved.

However, there are instances where old sites create a safety hazard, for example, unsealed underground workings and shafts or collapsed tunnels, which create surface slumps. In these cases, the Mines Branch, Ministry of Energy and Mines, is responsible for taking action to ensure public safety.

There are also minesites that are, or have the potential to be, generators of acid mine drainage. Britannia, Mt Washington and Anyox are well known historic mines that continue to be a problem. It is important to note, however, that these mines operated and closed under a vastly different regulatory regime than exists today. If these same mines were to have operated and closed under today's regulatory regime, the environmental problems associated with them would not exist.

Many of our older pre-legislation sites tend to be small, underground operations and the impacts are manageable. It is also fortunate that some of these sites once again represent attractive exploration targets. Wherever possible, the Ministry of Energy and Mines seeks to encourage such exploration in the hope that a viable mine can be established since, in the course of developing a new mine, the old problems can often be cleaned up quite readily.
If the original mine owner or operator responsible for the damage can be identified, it is the policy of Government to hold the company liable, even if the damage occurred prior to 1969. Frequently, however, the owner cannot be identified, does not have the financial capacity to pay for the damage, or challenges the liability. Government may then have to assume responsibility for these so-called "orphan" sites.

Public funds have been used for reclamation at several minesites, including the Mt. Washington mine on Vancouver Island and the Union mine near Greenwood.

Although the Ministry of Energy and Mines has extensive records on exploration and mining activity dating back to the previous century, much of this information is not readily accessible. At present there are only a few known historic sites considered likely to require significant remedial action to mitigate environmental damage, however, the Ministry has commenced a program to review historic minesites and to develop an historic mine database.

7.0 RECLAMATION RESEARCH

Companies are responsible for developing and instituting their own reclamation programs and have generally carried out research to solve their particular problems and issues. The Ministry of Energy and Mines' role has been one of encouragement and support, although limited funds have been made available over the past 25 years through several initiatives, including the Canada/British Columbia Mineral Development Agreement and, more recently, the Sustainable Environment Fund.

7.1 Technical and Research Committee on Reclamation

The TRCR has been active in promoting and fostering reclamation research for over 25 years. The TRCR is made up of members from the Ministry of Energy and Mines; the Ministry of Sustainable Resource Management; the University of British Columbia (UBC); the University of Northern British Columbia; Camosun College; the Mining Association of British Columbia; and the Coal Association of Canada; as well as individual mining company representatives. The TRCR has organised the annual B.C. Mine Reclamation Symposium for the past 24 years, and has successfully held joint annual meetings with the Canadian Land Reclamation Association on a number of occasions.

The TRCR has helped coordinate research in a number of specific areas. In 1976, Dr. Les Lavkulich from UBC's Department of Soil Science was asked to evaluate the characteristics of mine tailings as a possible plant growth medium, and two reports were produced describing the physical and chemical characteristics of metal and coal mine tailings materials throughout the Province.

The TRCR has addressed the issue of resloping waste rock dumps, the management of cyanide in mining, and the management of molybdenum and its affect on ruminants.
When there has been no funding available, the TRCR has been able to encourage work by focusing on specific topics at the annual mine reclamation symposium. Last year, for example, the symposium devoted half of its time to selenium and was able to attract a number of experts in the field. The resulting symposium proceedings now contain an excellent review of selenium and its possible effects on the environment.

7.2 Acid Rock Drainage Programs

For the past 16 years, considerable effort has been directed towards the issue of acid rock drainage. In British Columbia, industry and Government carried out much research under the umbrella of the British Columbia Acid Mine Drainage Task Force and the national Mine Environment Neutral Drainage (MEND) program. As a result of this work, both Government and industry have greatly improved their ability to predict, prevent, treat and control acid rock drainage. Work of the Task Force was largely completed with the hosting of the 4th International Conference on Acid Rock Drainage in Vancouver, May and June 1997, although Task Force members still hold and sponsor an annual metal leaching/acid rock drainage workshop in Vancouver and continue to participate in the national MEND 2000 program.

8.0 MINE RECLAMATION ACHIEVEMENTS

British Columbia mining companies have successfully reclaimed disturbed land to achieve a number of proposed end land use objectives, over 50 percent of which are directed at providing wildlife habitat, although forestry and grazing opportunities are also important (Table 1). For example, land has been reclaimed to support deer, moose, elk, and Rocky Mountain Bighorn sheep. Watercourses have been restored and enhanced to support Kamloops trout, cutthroat trout, and Bull trout.

**Table 1 - Proposed Reclaimed End Land Use Objectives**

<table>
<thead>
<tr>
<th>Proposed End Land Use</th>
<th>Percentage to be Reclaimed</th>
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<tbody>
<tr>
<td>Wildlife</td>
<td>53</td>
</tr>
<tr>
<td>Forest</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
</tr>
<tr>
<td>Grazing</td>
<td>9</td>
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One of the most important elements of the TRCR and the annual reclamation symposium has been the presentation of the B.C. Mine Reclamation Award to recognise outstanding achievement in mine reclamation. The award has been presented annually since 1977 to the following companies, as outlined in Table 2.
The sequence of reclamation award winners over the last 24 years provides an excellent historic summary of reclamation issues. The initial focus and early results were largely a result of work in the Kootenay Coal Block. During the first seven years, coal companies won the award five times. Only the revegetation research work of Bob Gardiner at Cominco and reclamation achievement at Island Copper prevented the coal industry from winning all the awards. Virtually all this initial work was centred on revegetation of mine wastes.

Over the next decade, we saw other issues being rewarded. The 1988 award to Equity Silver Mines recognised their management of the serious problem of acid mine drainage.

Table 2 - British Columbia Mine Reclamation Award Winners

<table>
<thead>
<tr>
<th>YEAR PRESENTED</th>
<th>MINE RECLAMATION AWARD WINNER</th>
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<tbody>
<tr>
<td>2000</td>
<td>Highland Valley Copper Corporation</td>
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<tr>
<td>1999</td>
<td>Afton Operating Corp. - Afton Mine</td>
</tr>
<tr>
<td>1998</td>
<td>BHP Minerals Canada Ltd. - Island Copper Mine</td>
</tr>
<tr>
<td>1997</td>
<td>Cominco Ltd. - Kimberly Operations</td>
</tr>
<tr>
<td>1996</td>
<td>Line Creek Resources</td>
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<tr>
<td>1995</td>
<td>Homestake Canada Inc.</td>
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<tr>
<td>1994</td>
<td>Cheni Gold Mines Inc.</td>
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<tr>
<td>1993</td>
<td>Fording Coal Limited - Fording River Operations</td>
</tr>
<tr>
<td>1992</td>
<td>Highland Valley Copper</td>
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<tr>
<td>1991</td>
<td>Brenda Mines</td>
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<tr>
<td>1990</td>
<td>Westar Mining - Balmer Operation</td>
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<tr>
<td>1989</td>
<td>Noranda Mines - Boss Mountain</td>
</tr>
<tr>
<td>1988</td>
<td>Equity Silver Mines Ltd., Houston, BC</td>
</tr>
<tr>
<td>1987</td>
<td>Byron Creek Collieries</td>
</tr>
<tr>
<td>1986</td>
<td>Highland Valley Copper Mine</td>
</tr>
<tr>
<td>1985</td>
<td>Quintette Coal Ltd.</td>
</tr>
<tr>
<td>1984</td>
<td>Island Copper, Port Hardy</td>
</tr>
<tr>
<td>1983</td>
<td>B.C. Coal - Environmental Services, Sparwood</td>
</tr>
<tr>
<td>1982</td>
<td>Crows Nest Resources - Line Creek Operation</td>
</tr>
<tr>
<td>1981</td>
<td>Island Copper, Port Hardy</td>
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<tr>
<td>1980</td>
<td>Fording Coal Limited - Fording River Operations</td>
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<tr>
<td>1979</td>
<td>Kaiser Resources Ltd., Sparwood</td>
</tr>
<tr>
<td>1978</td>
<td>Cominco Ltd., Trail</td>
</tr>
<tr>
<td>1977</td>
<td>Kaiser Resources Ltd., Sparwood</td>
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</table>
During the 1990s, mines that have received the award have been recognised for much more than revegetation. Where revegetation has been the central element in a reclamation program, the revegetation program is usually much more focused on achieving a particular land use objective. Many of the winners had programs that dealt with watercourse restoration or some form of effluent management or control.

9.0 CONCLUSION

Although the mining industry has achieved considerable progress over the past 25 years, there needs to be continued improvement. In British Columbia, because of our varied climate and varied mining industry, many mines present their own set of unique problems. Although technology and expertise can often be transferred from one property to another, rarely can this technology be adapted completely. All mines will need to continue developing their own techniques to meet their own land use objectives by creating their own topography, re-establishing their own soil materials, planting a variety of tree and shrub species and applying their own seed and fertilizer prescriptions. All mines will also need to continue to pay close attention to their waste materials and their soils, and to develop programs to predict and prevent metal leaching and acid rock drainage. The TRCR has contributed greatly to reclamation success during the last 25 years and will, no doubt, continue this valuable work well into the 21st century.