

HISTORY AND FUTURE OF MINE RECLAMATION IN BRITISH COLUMBIA

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INTRODUCTION

In British Columbia, environmental protection and reclamation is a major component of all mineral exploration and mine development activity. Since 1969 mining companies have been required by law to reclaim all lands disturbed by mining. B.C. was one of the first jurisdictions in Canada to enact mine reclamation legislation, and the first to extend this policy to exploration sites. Mining companies are also required to obtain a reclamation permit and place a security deposit with the Province. These deposits are held until reclamation is completed.

The duties of the Reclamation Section include:

- o review and issue mine reclamation permits;
- o inspection of reclamation at mines;
- o administration of reclamation security deposits on behalf of the provincial government; and
- o participation in selected committees and activities to enhance mine reclamation in the province, including the Technical and Research Committee on Reclamation, the British Columbia Acid Mine Drainage Task Force, and the national Mine Environment Neutral Drainage committee.

STRUCTURE AND ORGANIZATION

The Reclamation Section is comprised of five permanent staff: the Manager, Reclamation Engineer and Senior Reclamation Agrologist, based in Victoria; and two Reclamation Inspectors, one based in Nelson and one in Smithers.

The Section works closely with industry and other members of government to ensure that all concerns are addressed. For reclamation permits involving more than minimal surface disturbance, applications are referred to other government agencies for their input.

To provide an opportunity for information exchange, and for the dissemination of new technology, the Reclamation Section

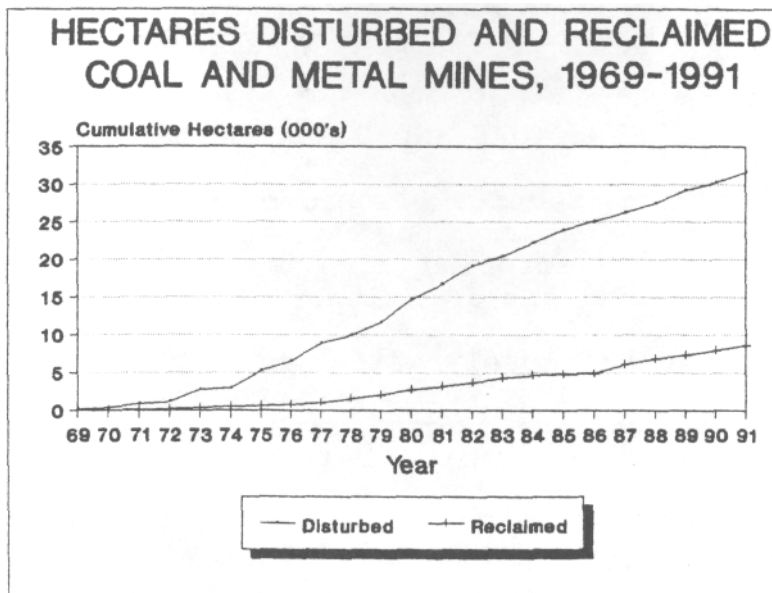
participates in and coordinates a number of research committees comprised of members of industry, government, and the academic community.

SUMMARY OF ACTIVITIES

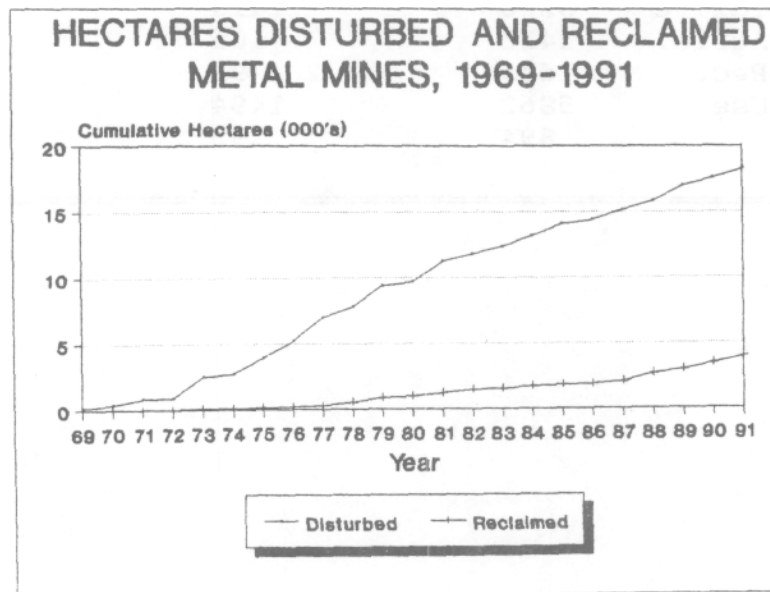
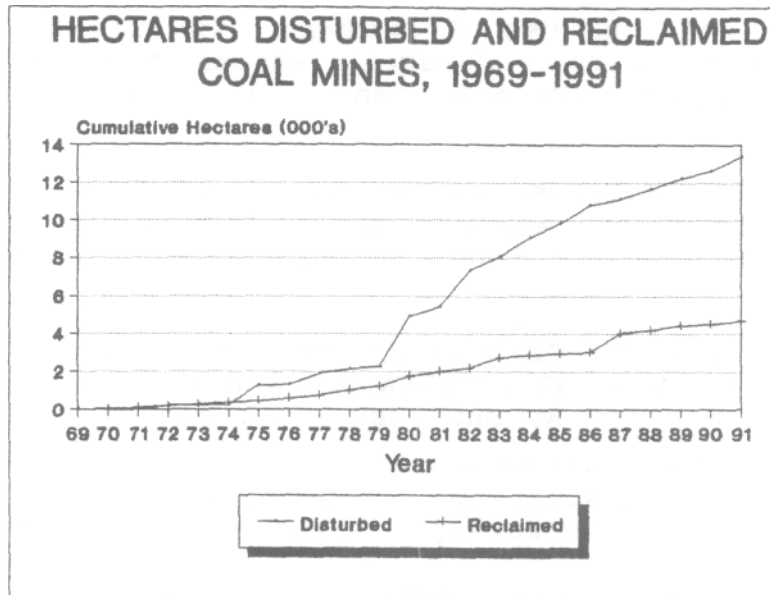
The mining industry in British Columbia primarily consists of large-scale open pit mines which, since the late 1960's, have replaced small underground operations. This evolution has meant a corresponding increase in surface disturbance. Major coal and metal mines now cover a total of 31,650 hectares, compared to less than 200 hectares in the late 1960's. Of the 31,650 hectares, 27 per cent (8,633 hectares) has been reclaimed, leaving a balance of 23,017 hectares of disturbed land.

MINING LAND DISTURBANCE AND RECLAMATION AS OF DECEMBER 31, 1991 (CUMULATIVE HECTARES)

Type of Mine	Area Disturbed	Area Reclaimed
Coal Mines	13,390	4,696
Metal Mines	18,260	3,937
Total	31,650	8,633



The following two graphs show the breakdown of disturbed and reclaimed land at coal and metal mines. Coal mines have disturbed 13,390 hectares, 35 per cent of which (4,696 hectares) has been reclaimed. Metal mines have disturbed 18,260 hectares, of which 3,937 hectares (22%) have been reclaimed.



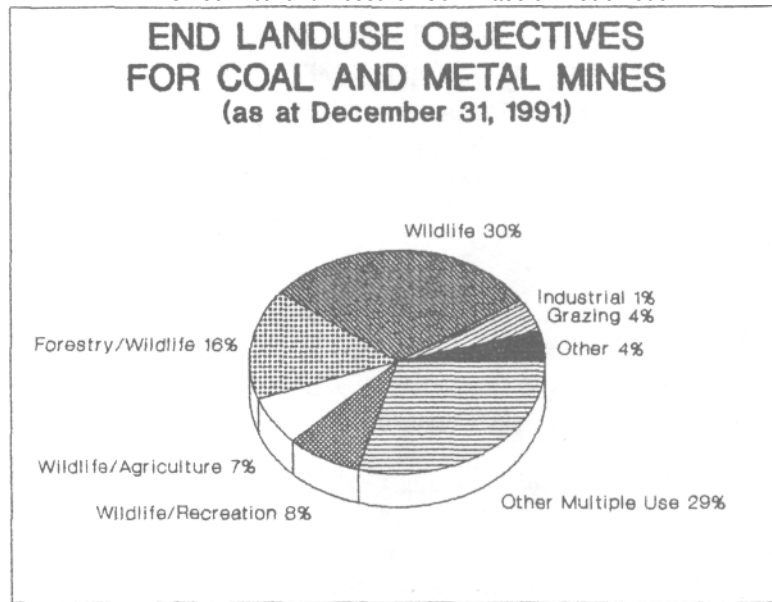
The higher percentage of land reclaimed at coal mines partly reflects the different mining conditions. Most metal mine ore deposits are contained in single pits which continually expand as mining proceeds. Coal seams, on the other hand, are frequently shallow stratabound deposits which can be mined and immediately backfilled and reclaimed, allowing more rapid reclamation success.

The Reclamation Section has also initiated two new information systems. The first stores data on the nature and quantity of waste rock and tailings and the second stores information on end land use objectives. The first database will eventually allow us to accurately assess the amount of acid generating or potentially acid generating waste material in the province.

The land use database system is a compilation of end land use objectives for all major mines. The following tables and charts depict reclamation land use objectives for major mines:

**LAND USE OBJECTIVES FOR MAJOR MINES
PERCENT RECLAMATION ACHIEVED
AS AT DECEMBER 31, 1991**

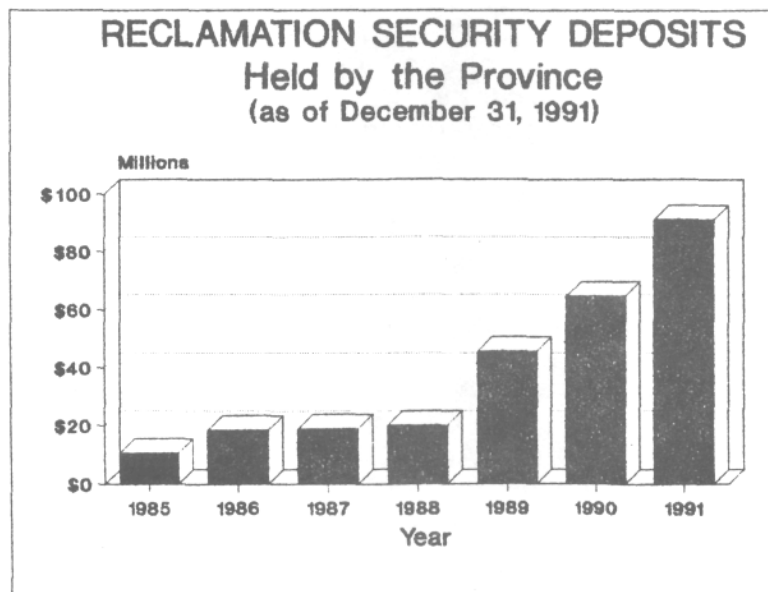
Land use Objective	Disturbance (Hectares)	Reclamation (Hectares)	Percent Reclaimed
Wildlife	6016	1953	32
Recreation	24	5	21
Industrial	118	41	35
Grazing	849	285	34
Forestry	58	22	38
Forest/Wildlife	3226	1415	44
Wildlife/Agric.	1415	105	7
Wildlife/Rec.	1655	94	6
Multiple Use	5862	1494	26
Other	894	192	22

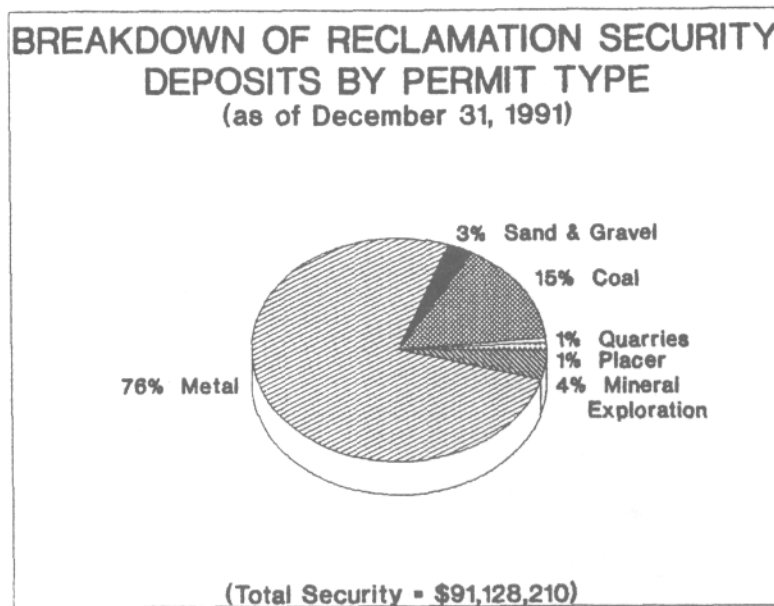


The multiple use category includes a combination of two or more land uses.

RECLAMATION SECURITIES AND FUNDS

In accordance with the Mines Act (1989), reclamation security bonds should be sufficient to provide for the costs required to perform all outstanding reclamation. The Reclamation Section is working towards meeting this goal, and the recent increase in the amount of security held by the Province is an indication of the success achieved to date.





At the end of 1991, a total of \$91,128,210. was held in reclamation security. Metal mines had posted the largest amount (76% of the total), primarily because of the costs associated with the long-term treatment and control of acid mine drainage.

Both government and industry recognize the large financial implications of long-term treatment of acid mine drainage. The Mines Act provides for the establishment of mine specific Reclamation Funds which can be established during mine operations to finance the long-term treatment costs associated with acid mine drainage.

RECLAMATION SECTION HIGHLIGHTS

The Ministry believes there is a need for improved public access to information, greater public involvement in decision making processes, and improved regulations. A number of these initiatives were completed during 1991:

- o Publication of Reclamation Policy overview.
- o Protocol agreements with Ministry of Environment, Lands and Parks on bonding and rock drains.
- o Successful agreement with Equity Silver Mines Limited for placement of \$37.5 million security; thirty-two million for long-term treatment of acid mine drainage, and \$5.5 million for till cover and decommissioning costs.
- o Formation of a Public Liaison Committee in Kimberley to oversee the decommissioning and reclamation of the Sullivan Mine.

- o Continuing to work with the Public Surveillance Committees established to review the Brenda Mines and Equity Silver Mines closure plans.

- o Continued reclamation work on the Mount Washington site achieving cleanup and improved water quality of approximately fifty percent of the pit area.

ACID MINE DRAINAGE INITIATIVES IN BRITISH COLUMBIA

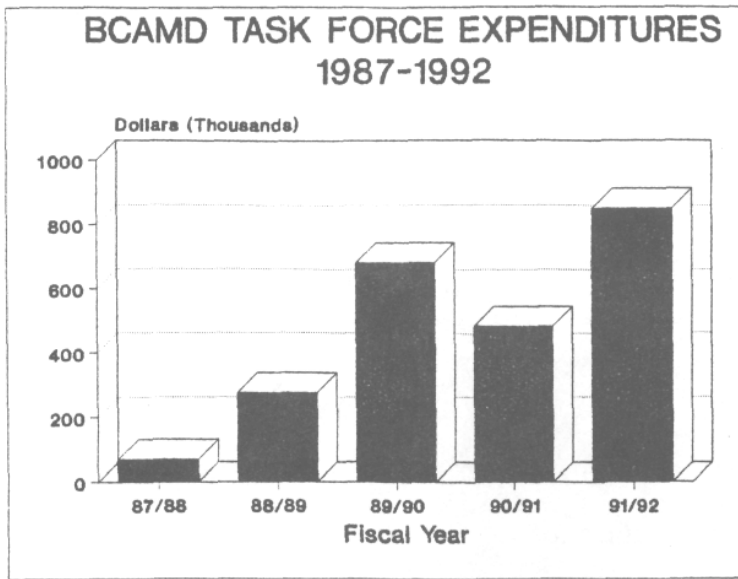
Acid mine drainage (AMD) is the largest single environmental problem facing the Canadian mining industry today and British Columbia is no exception.

The British Columbia Acid Mine Drainage (BCAMD) Task Force was founded in 1987 in response to the growing environmental concern over acid mine drainage. Although a national committee, Mine Environment Neutral Drainage (MEND), already existed, British Columbia was the first province to set up its own task force. Since that time, several other provinces have launched their own initiatives. All provincial committees coordinate research with MEND to avoid duplication of effort.

The BCAMD Task Force draws its members from universities, provincial and federal government agencies, the Mining Association of B.C., the B.C. and Yukon Chamber of Mines, and the mining industry.

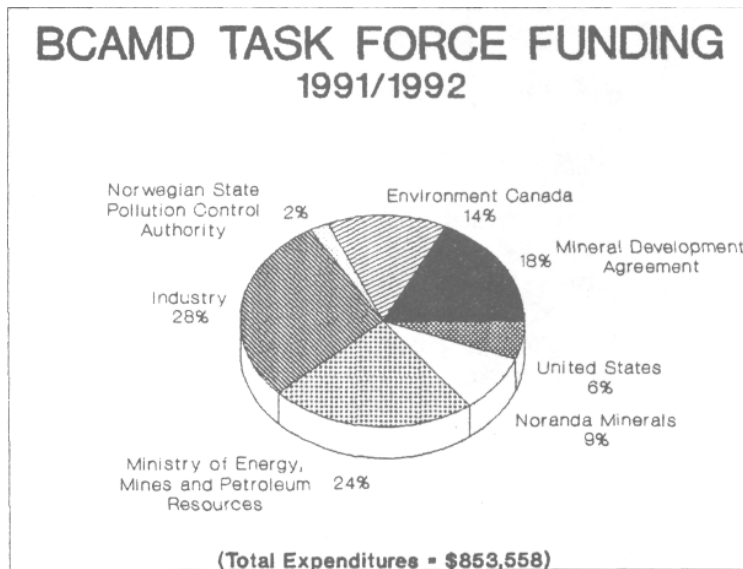
The purpose of the BCAMD Task Force is to coordinate research activities directed at solving acid mine drainage (AMD) problems. This involves administering funding, managing research projects, reviewing project findings, proposing new avenues of research, and assessing independent proposals.

Since 1987, the Task Force has undertaken thirty-one projects, twenty-one of which are still ongoing. A total of \$2,370,061. has been spent on projects covering all aspects of acid mine drainage research.



Task Force expenditures have increased fairly steadily since 1987, totalling \$853,558. last year.

Funding was supplied by the provincial and federal governments through the Mineral Development Agreement, Environment Canada, Ministry of Energy, Mines and Petroleum Resources, the mining industry, the Norwegian government, and by a private contribution from Noranda Minerals Inc.



One of the first projects that the BCAMD Task Force commissioned in 1987 was the production of a technical guide for acid mine drainage. The Acid Rock Drainage Technical Guide contained the most up-to-date information on the prediction, prevention, treatment, control and monitoring of acid mine drainage. The contents of this guide have provided the basis for courses offered throughout Canada and internationally.

Prediction projects have included a compilation prediction data and interpretative rules, monitoring of on-site waste rock pads to assess AMD potential, and the creation of mathematical computer models which will predict AMD potential.

Research into preventative techniques has concentrated on two options: underwater disposal of waste rock and tailings, and ending of acid generating and acid consuming materials in waste rock dumps. Results from underwater disposal projects are the most promising.

Treatment options for existing acid producing sites are also being evaluated. The use of wetlands as a passive treatment system, and the placement of cover materials on acid producing waste rock dumps are the subject of ongoing research. Preliminary studies have also been conducted recently into two other methods of treatment: in-situ treatment of waste rock dumps with lime, and the use of ion exchange technologies to remove metals from acidic drainage.

Monitoring projects have studied changes in biological communities and sediments, and a computer model has been created which assesses the uptake of metals by organic material. Emphasis has been placed on optimizing monitoring programs on a site specific basis and on collecting reliable and defensible data.

Through the quantity and quality of work conducted, the Task Force has gained an international reputation and has placed British Columbia on the leading edge of AMD technology.

In 1991, along with the publication of its 1990/91 annual report, the BCAMD Task Force published four additional project reports. The reports have been distributed widely to mining companies, consultants, regulatory agencies, universities, and public interest groups. All BCAMD Task Force reports are available from BiTech Publishers Ltd. (#903 - 580 Hornby Street, Vancouver, B.C. V6C 3B6).

Reports currently available from BiTech include the following:

- o Acid Mine Drainage From Mine Walls:: The Main Zone Pit at Equity Silver Mines
- o Acid Mine Drainage Project: Review and Assessment Study
- o A Preliminary Biological and Geochemical Assessment of Subaqueous Tailings Disposal in Benson Lake, Columbia
- o Geochemical Assessment of Subaqueous Tailings Disposal in Buttle Lake, British Columbia

- o Hydrogeological Assessment and Development of AMD Control Technology for Myra Falls Waste Rock
- o Kutcho Creek Project Acid Generation Testwork, Phase II
- o Literature Review for Biological Monitoring of Heavy Metals in Aquatic Environments
- o Monitoring Acid Mine Drainage
- o Draft Acid Rock Drainage Technical Guide, Volume I
- o Review of Sediment Monitoring Techniques
- o Shotcrete Application of Cementitious Sealant Materials for Acid Rock Drainage Control
- o The Effect of Treated Acid Mine Drainage on Stream Macroinvertebrates and Periphytic Algae: An In Situ Mesocosm Experiment

In 1991, the Task Force continued to support nine ongoing projects and coordinated the start up of 10 new projects. The nineteen projects included:

- o Compilation of AMD Prediction Data
- o Compilation of AMD Prediction Rules
- o Cinola Gold Project Kinetic Tests
- o Waste Rock Modelling
- o Abandoned Mines Survey
- o Underwater Disposal of Waste Rock & Tailings
- o Submarine Disposal
- o Blending and Segregation (Kutcho Creek Project)
- o Samatosum AMD Project
- o Mount Washington Evaluation
- o In-Situ Treatment of Waste Dumps
- o Constructed Wetlands (Bell Mine)
- o Use of Zeolites to Treat Drainage
- o Norwegian Remediation Study

- o Aquatic Invertebrate Monitoring
- o Paleolimnological Techniques
- o Ion Speciation Model
- o Field Sampling Quality Assurance/Quality Control
- o Monitoring Goals Workshop

THE FUTURE OF MINE RECLAMATION

At the June 1990 reclamation symposium held in Cranbrook, I attempted to predict reclamation policy for the 1990's. I made several predictions which have come true:

- o that the growing public awareness would clearly influence government's regulation of the mining industry, and that the mining industry should not expect their requirements to diminish.
- o that the mining industry must finally realize that reclamation requirements must be met, and in some cases exceeded, if mining is going to continue as a viable resource industry in British Columbia.
- o that there would be a greater requirement for securing outstanding obligations through increased reclamation security deposits.
- o that there would be an acceptance by industry and government that some closed mines can never be completely reclaimed, and there would be a requirement for some degree of monitoring and inspection for many years.
- o that on-going long-term activities would require the establishment of a long-term funding mechanism.

However, I also predicted that there would be increased coordination between government approvals and permits and the Mine Development Review Process. Most of you are aware of the recent Environmental Assessment Legislation Consultation Program which was carried out in British Columbia under the chairmanship of Dale Lovick, MLA for Nanaimo and Parliamentary Secretary to the Minister of Environment, Lands and Parks. The legislation

discussion paper, which forms the basis for this consultation, contains forty-five recommendations and is based upon the seven guiding principles; that the process must be accountable, integrated, balanced, accessible, consistent, equitable and flexible. I see no room for increased coordination between approvals and permits in any process which emerges from this review.

The science of mine reclamation has evolved from simple revegetation activities to a discipline which will ultimately involve the long-term management of the entire mining "ecosystem" over an extended period of time. Metal mines by their very nature are developed in locations where metal levels are elevated. The management of these sites to ensure water quality meets discharge criteria, to ensure plant metal uptake is acceptable, and ensure any future use of these sites does not pose a health or environmental risk is a formidable, yet necessary challenge, if the mining industry expects to remain active in this province.

Acknowledgements

This paper draws heavily on material prepared as part of the Branch annual report and the B.C. Acid Mine Drainage annual report. I would like to acknowledge and thank Sharon Biddle for her assistance in collecting much of the data found in this report.