

BRITISH COLUMBIA MINE RECLAMATION, AN OVERVIEW

by

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INTRODUCTION

The Province of British Columbia encompasses 948,569 square kilometers and contains a great diversity of physiographic regions (Figure 1).

The climate varies from the Mediterranean-like Juan de Fuca Strait on the southwest coast where temperatures seldom go below freezing and rainfall is less than 75 cm per year, to the extreme cold of the northeast where winter temperatures drop to minus 50°C. Figure 1 illustrates the different physiographic and climatic characteristics of the province.

There are areas of rain forest on the Pacific Coast where the annual precipitation can exceed 350 cm. In contrast, the southern interior plateau east of the coastal mountains receives less than 30 cm (Figure 2). The province's vegetation reflects these extremes of climate, from the coastal rainforests to the northern alpine tundra with sporadic permafrost, and the southern interior dry bunchgrass areas which in summer resemble deserts.

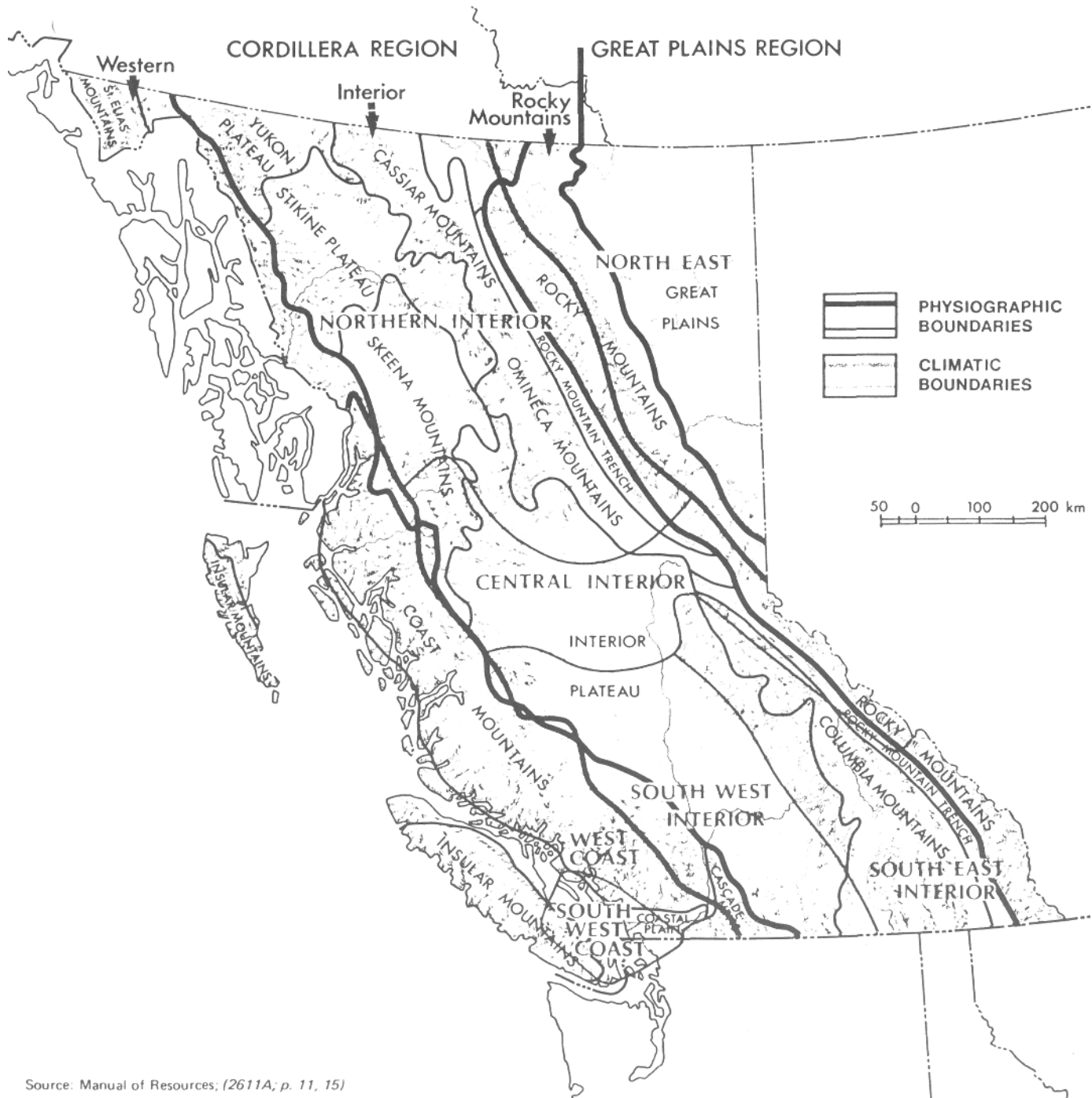
The population of British Columbia is as diverse as its terrain. The population is heavily concentrated in the southern coastal plain: of the 2.5 million inhabitants in the province, nearly three quarters live in the southwest corner. The largest city of the province, Vancouver, contains an ethnically diverse population, in which most minority groups are represented. In addition, there are large clusters of settlement along valley-oriented lines in the southern and central interior. The Kelowna region and the Okanagan, in general, are primarily fruit-growing districts, and resort and retirement areas. The major metal smelting industry is located in the southeast corner of the province: here the population is familiar with heavy industry and its activities. Figure 3 shows the distribution of the population in the province.

LAND-USE

Land-use in the province is reflected in population distribution and the producing capability of the various biogeoclimatic zones. The following is a brief discussion of the important land-use aspects of British Columbia's industrial base.

Figure 1

BRITISH COLUMBIA PHYSIOGRAPHIC AND CLIMATIC REGIONS



Source: Manual of Resources; (2611A; p. 11, 15)

Figure 2

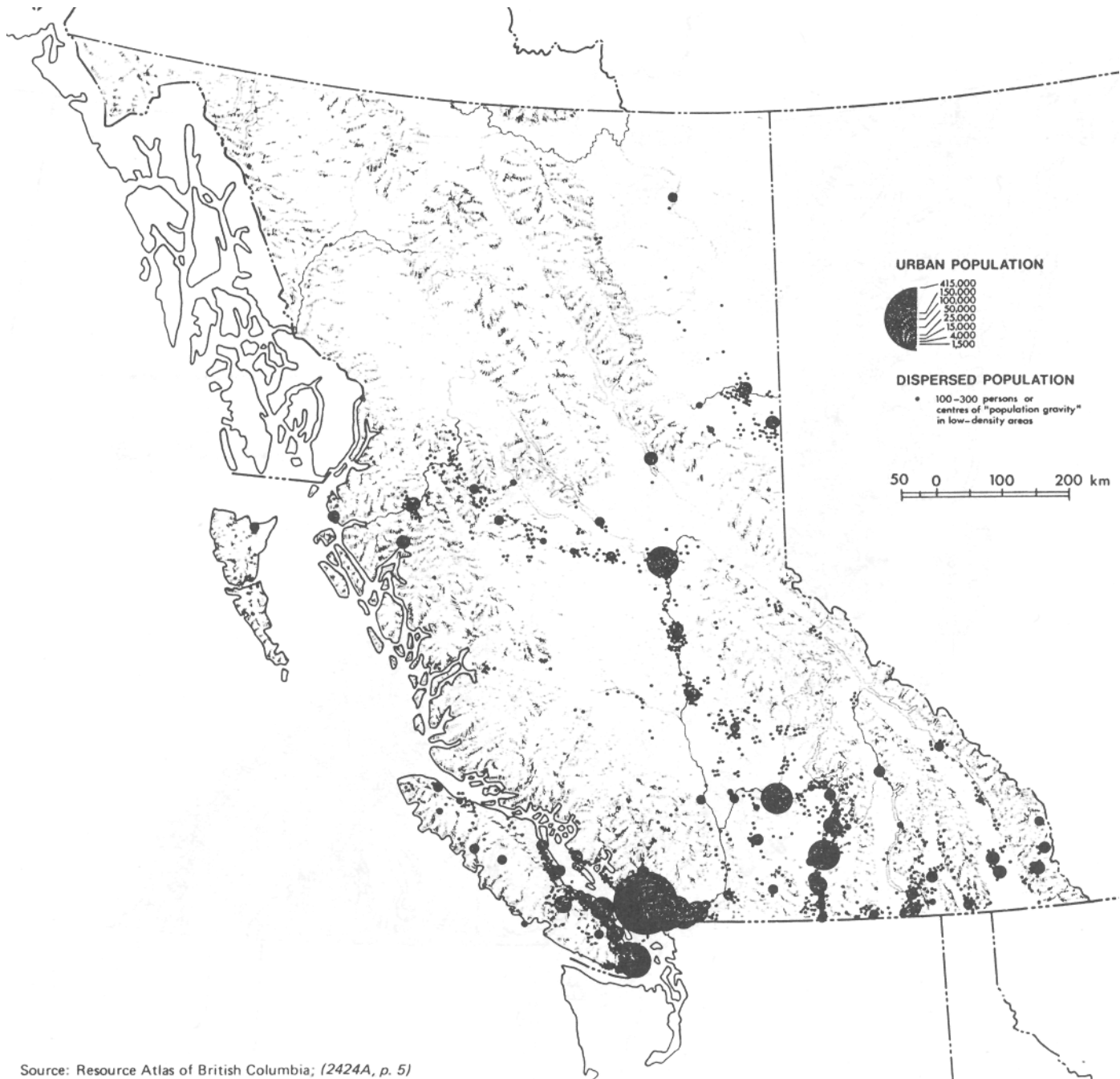
MEAN ANNUAL PRECIPITATION



Source: Resource Atlas of British Columbia; I2424A;p. 431

Figure 3

POPULATION DISTRIBUTION (1976)



Source: Resource Atlas of British Columbia; (2424A, p. 5)

FORESTRY

British Columbia's vast forests provide the natural resources for the province's largest industry. Fifty-five per cent of the provincial land area is forested, mostly with stands of coniferous trees. The coastal forests from Prince Rupert south to the Washington border, because of their large stands of timber, milder climate and plentiful rainfall are the most productive. However, the interior forests are becoming more important, to the point that in 1976 the provincial harvest was nearly evenly distributed between the coast and the interior (Figure 4).

MINING

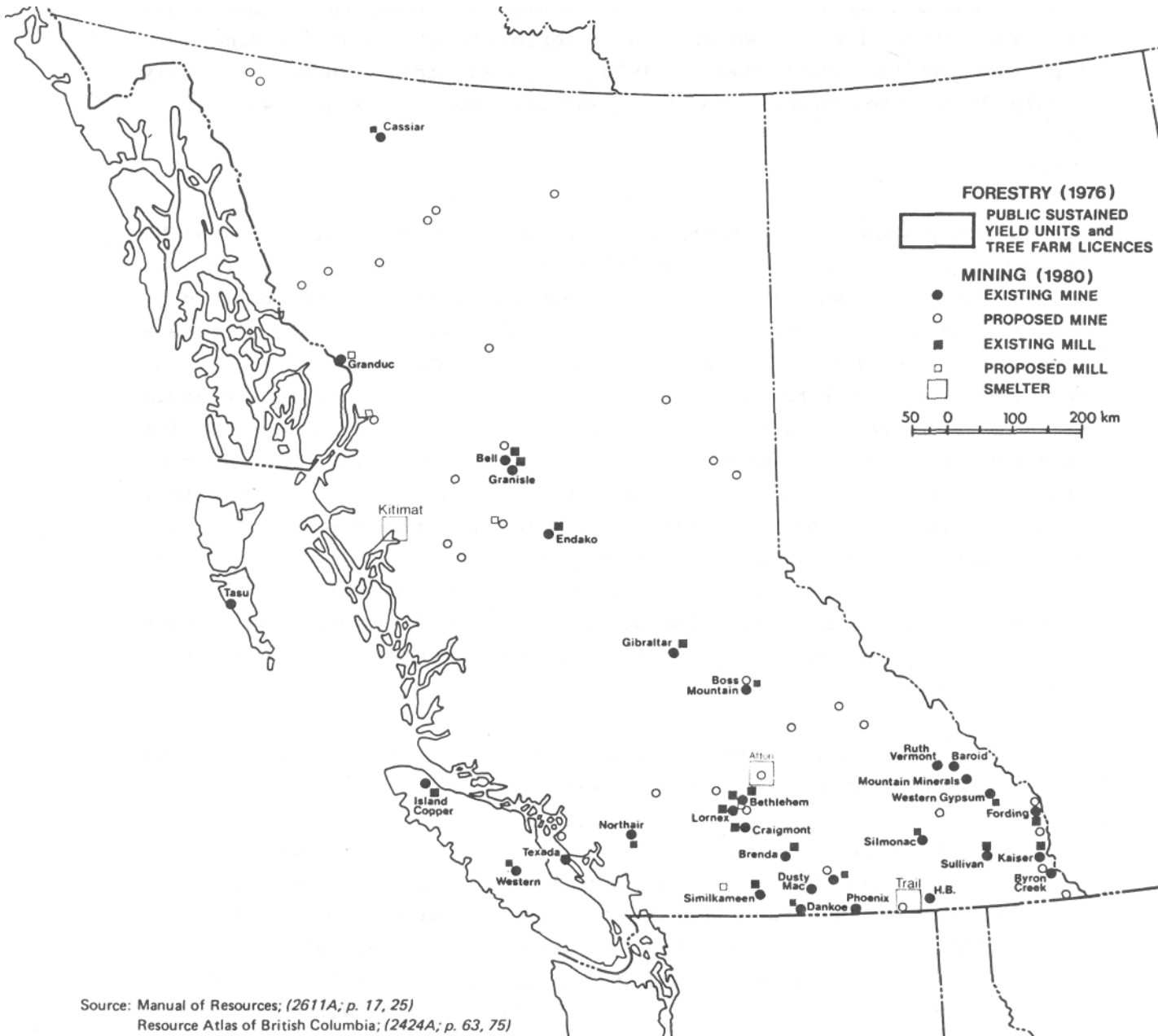
Mining ranks second after forestry as a generator of provincial wealth. It has grown in annual value from \$30 million in 1910 to a value of \$1.4 billion in 1979. Because it is a non-renewable resource, the pattern of mining land-use has tended to vary over the decades as deposits are brought into production, mined and abandoned. Open-pit production of base metals and coal has characterized the industry in British Columbia over the past two decades. During this period iron and copper deposits have been developed on the south coast. In the Kootenays, lead and zinc production has declined while coal has increased, and the vast Liard Mining Division in the northeast section of the province has come into prominence. In addition, there is asbestos at Cassiar, accounting for eight per cent of Canadian production and precious and base metal mines in the Portland Canal area. The oil and gas fields in the Peace River region of northeastern British Columbia are of enormous importance to the province.

The Mining Association described the present status of the mining industry in British Columbia as follows:

"Mining in British Columbia received its initial impetus from coal deposits on Vancouver Island and alluvial gold discoveries on the Fraser River and its tributaries, in the mid 1800's. The mining industry has grown from these beginnings to the second largest industry in British Columbia with a gross value of production of \$1.34 billion in 1978 with direct employment of 15,587 people and estimated additional indirect employment of 40,000 people in associated businesses in the province, and in Canada as a whole another 110,000 people."

Figure 4

FORESTRY AND MINING



AGRICULTURE

Arable land inside the boundaries of British Columbia's agricultural land reserves is only 4.6 million hectares of the total 95 million hectare provincial total. Most of this productive land is located in river deltas/ inter-mountain valleys, the interior plateau and the northeastern plain. A further 10 million hectares are rangelands used for domestic and wild animal grazing, much of which is forested (Figure 5).

GEOLOGY

The plate tectonics model for the western Cordillera is of considerable importance in understanding the evolution of this region. This model essentially proposes that the different belts or terrains of this region were not derived in situ, but were rafted into their present position by plate tectonics and eventually docked and fused together to form a part of the province. Thus all or part of the different belts may have originated hundreds of kilometers away and brought very diverse geology and mineral deposits into contact with each other.

The eastern marginal belt consists of a continuation of the westward thickening sedimentary wedge which underlies the great plains of western Canada but with increasingly greater amounts of shales to the west. Volcanic rocks are rare, the area is strongly deformed but not metamorphosed.

The Omineca belt is composed of very strongly deformed and commonly highly metamorphosed volcanic and sedimentary rocks of Precambrian to early Mesozoic age. Granite intrusions are very common in this belt. Major regional uplift and erosion affected this terrain during the late Mesozoic period. In the tertiary, continental sedimentation and volcanoes were widespread in the western part of this region.

The Intermontane belt contains a series of late Paleozoic to mid-Mesozoic marine volcanic and sedimentary rocks. Many geologists consider the sequence to be an ancient volcanic island terrain which is overlain by continental sedimentary and volcanic rocks of mid-Mesozoic to mid-Tertiary age. These later continental rocks were deposited in what is known as "successor basins".

Figure 5

FISHING, AGRICULTURE AND MAJOR PARKS

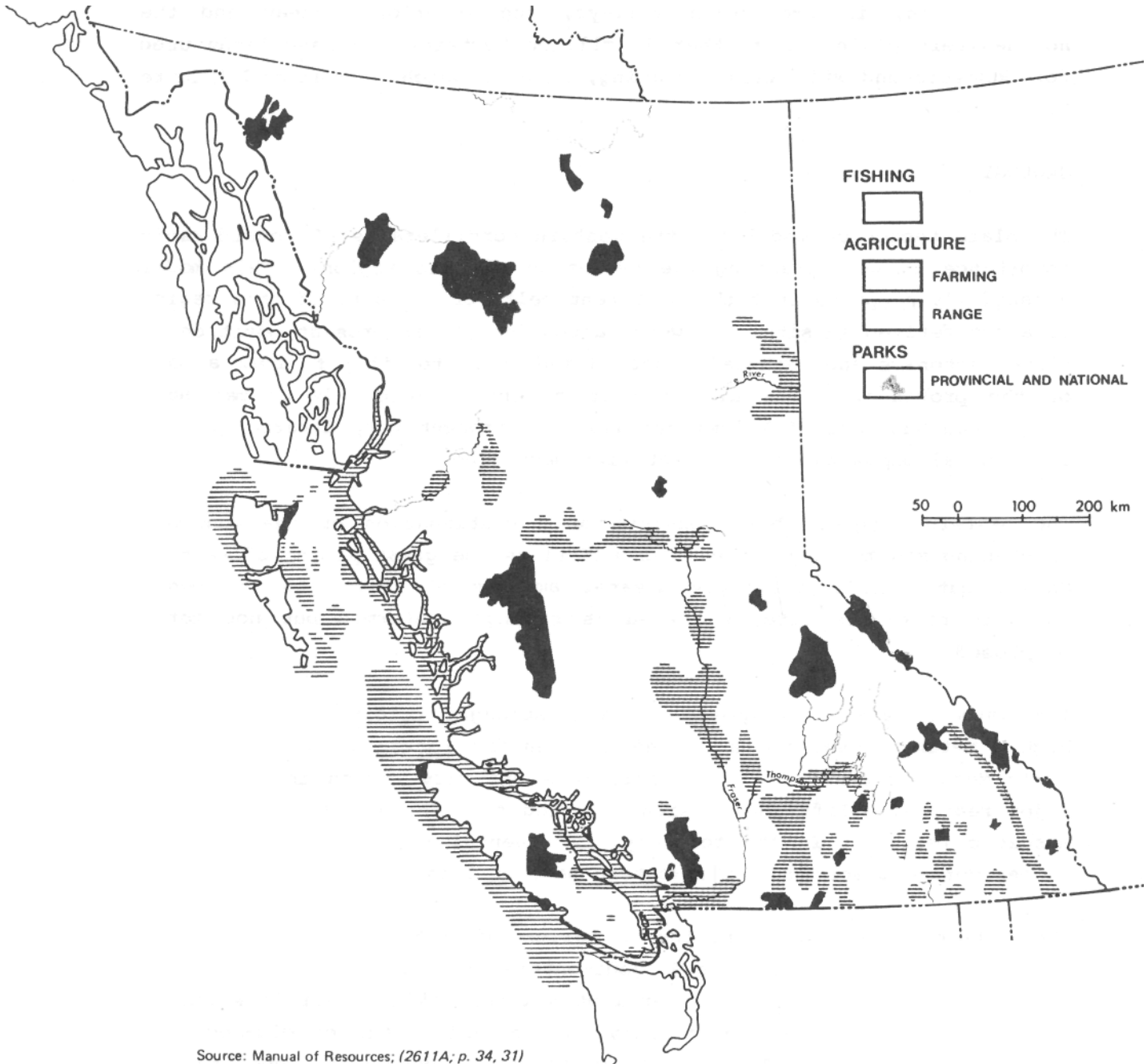
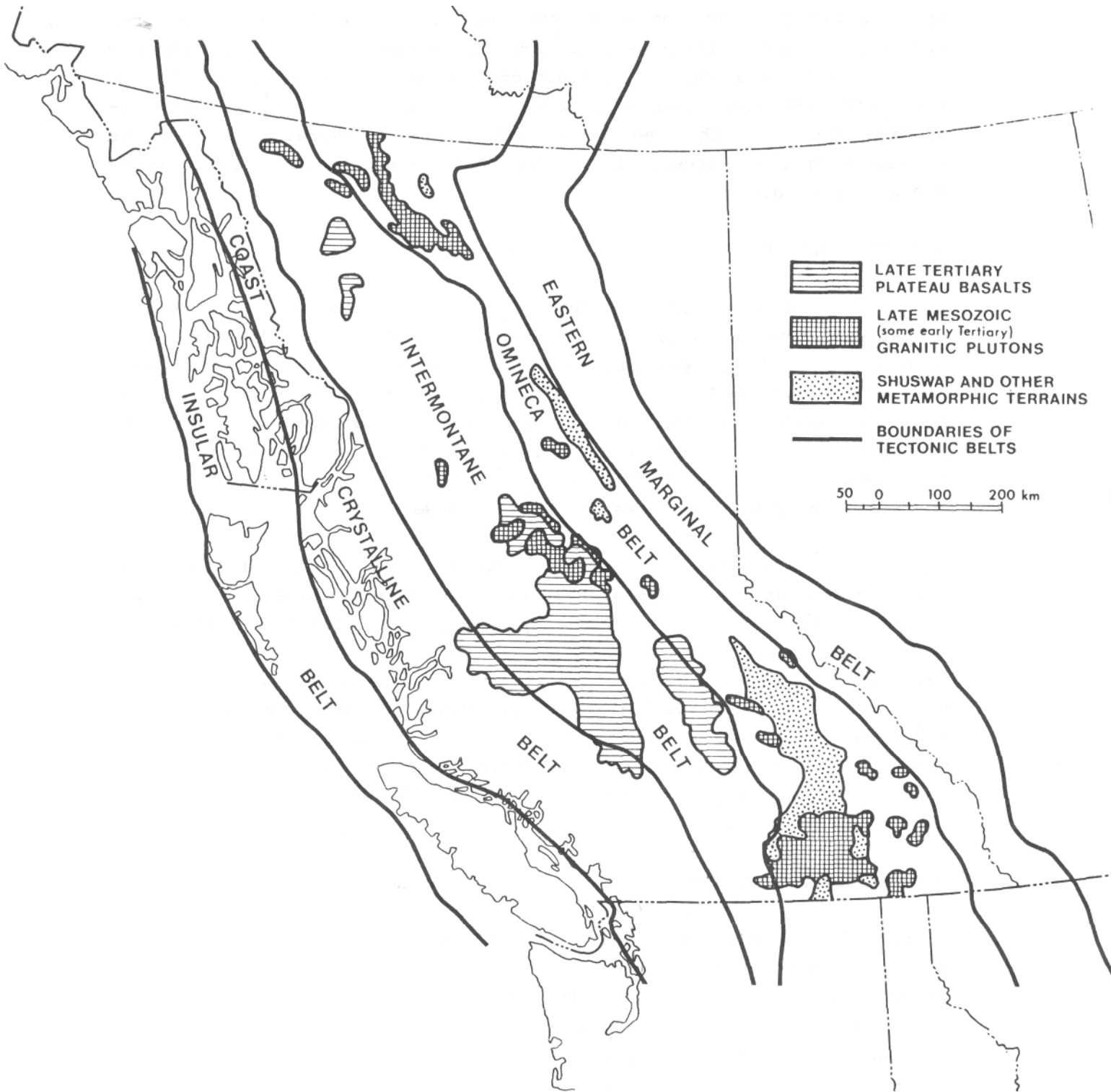


Figure 6

GEOLOGY OF BRITISH COLUMBIA



Source BCM EMPR, I2018S; p. 16,45!

The Coast Crystalline Belt is an enormous batholith of granitic rock of mid-Mesozoic to early tertiary age. Remnants of Mesozoic volcanic rocks have been found within this batholith.

The Insular Belt is composed principally of late Paleozoic to mid-Mesozoic volcanic island assemblages. Successor basins started to form in the late cretaceous. In addition, early Paleozoic rocks and mid-Paleozoic intrusions and metamorphic rocks are known. The main intrusive rocks of the region are much less widespread than in the neighbouring coast crystalline belt. Acidic and basic volcanic rocks are also present.

MINE RECLAMATION

Prior to 1960 most mines in British Columbia were small underground operations creating very little impact on the land. Following the development of large open pit metal mining in the early 1960"s and open pit coal mining in 1968, the Government of British Columbia introduced mine reclamation legislation in 1969. British Columbia was the first Province in Canada to introduce mine reclamation legislation and is the only Province where mine reclamation remains under the jurisdiction of the Ministry of Energy, Mines and Petroleum Resources.

Because of the extreme variation in topography, climate and elevation, detailed regulations or legislation have not been established in British Columbia. We have mines in level topography in the interior plateau and on the steep slopes of the Rocky Mountains. Mining occurs in the dry belt of the Okanagan (30 cm of rainfall a year) and the rain forest of the coast (350 cm of rainfall a year). Mines operate from sea level up to elevations of 7,000 feet. For this reason the Ministry of Energy/Mines and Petroleum Resources has dealt with each minesite on a site-specific basis. Figure 4 outlines the location of the producing mines in British Columbia.

RECLAMATION LEGISLATION

Section 10 of the Mining Regulation Act and Section 9 of the Coal Mine Regulation Act set out the requirements of legislation for reclamation in British Columbia and are administered by the Ministry of Energy, Mines and Petroleum Resources, Inspection and Engineering Division, Reclamation Section. Legislation covers mineral exploration, coal

exploration, placer mining, quarries, gravel pits, metal mines and coal mines.

As a basic statement of policy, both Acts begin:

"It is the duty of every owner, agent, or manager of a mine to institute and carry out a programme for the protection and reclamation of the surface of the land and watercourses affected thereby, and, on the discontinuance or abandonment of a mine, to undertake and complete the programme to leave the land and watercourses in a condition satisfactory to the Minister..."

Briefly, both Acts provide for the following:

1. A report to be submitted to the Minister of Energy, Mines and Petroleum Resources prior to the commencement of operations containing:
 - a. A map showing the location and extent of the mine, and the location of lakes, streams and inhabited places in the vicinity.
 - b. Particulars on the nature of the mining operation including the anticipated area to be occupied during the lifetime of the mine.
 - c. Particulars on the nature and present uses of the land to be used.
 - d. A programme for land reclamation and conservation with particular reference to:
 - i. the location of the land.
 - ii. the effect of the programme on livestock, wildlife, watercourses, farms and inhabited places in the vicinity of the mine, and the appearance of the mine site.

- iii. the potential use of the land, having regard to its best and fullest use, and its importance for existing and future timber, grazing, water, recreation, wildlife and mining.
2. Review of the report by a standing committee composed of other resource agencies in the case of producing mines and coal exploration, and a referral system to those agencies in the case of mineral exploration.
3. A bond not exceeding \$2,500 per hectare of disturbance.
4. Issuance of a surface work permit with such special terms and conditions as the Minister sees fit to prescribe.
5. Continual and progressive reclamation over the life of the mine, and the annual submission of a report on the progress of reclamation research and operations.
6. Closure of the mine and forfeiture of the bond in the case of non-compliance with any sections of the Act or permit.

Table 1 and Table 2 outline the process of the permit system.

In essence, the approach taken in formulating the legislation was to avoid setting any firm regulations until investigation and research had been carried out by each mining company to determine what could and must be done to adequately reclaim the disturbed land. In recognition of the varied geographic and environmental conditions that prevail across the province, the onus was placed on the industry to develop reclamation technology in cooperation with the Ministry of Energy, Mines and Petroleum Resources.

Closely associated with reclamation of disturbed lands is the construction of tailings impoundments and mine dumps, because in the final stage of these structures, revegetation will be necessary. In these projects, where their size can place them amongst some of the largest man-made structures, it is incumbent on the Inspection and Engineering Branch to ensure that these structures are being designed and constructed in accordance with acceptable engineering practices. An example is the construction of the L - L starter dams for Lornex Mining

TABLE 1

PERMIT PROCESSING FOR COAL EXPLORATION, COAL AND METAL MINES

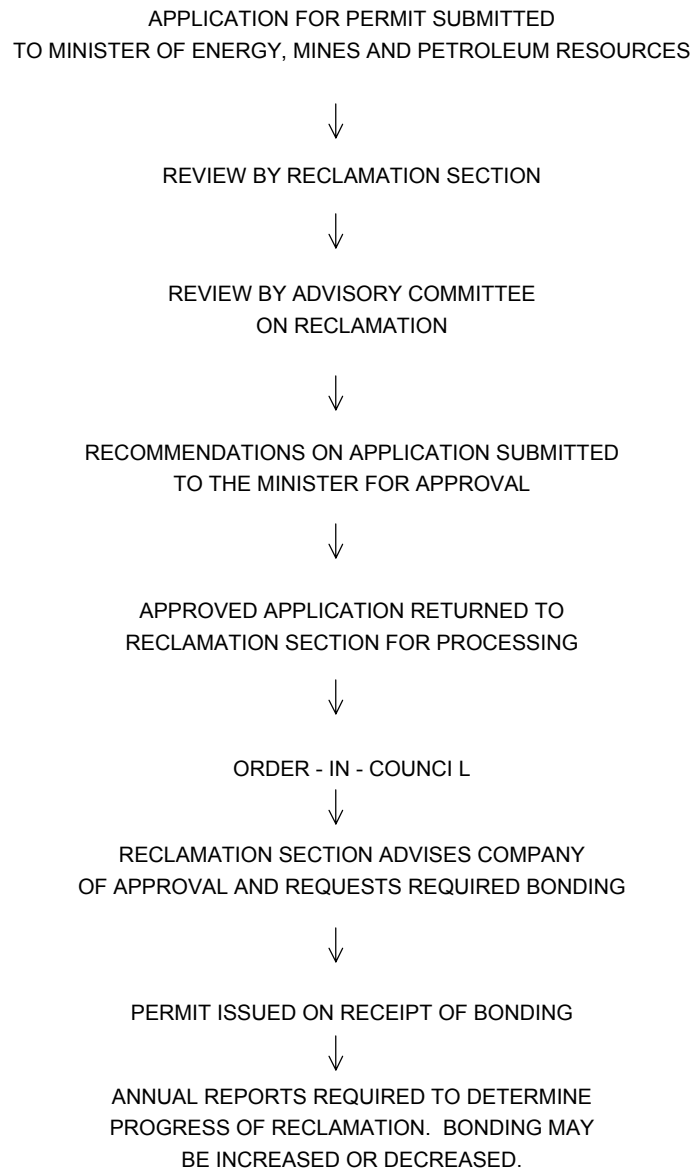
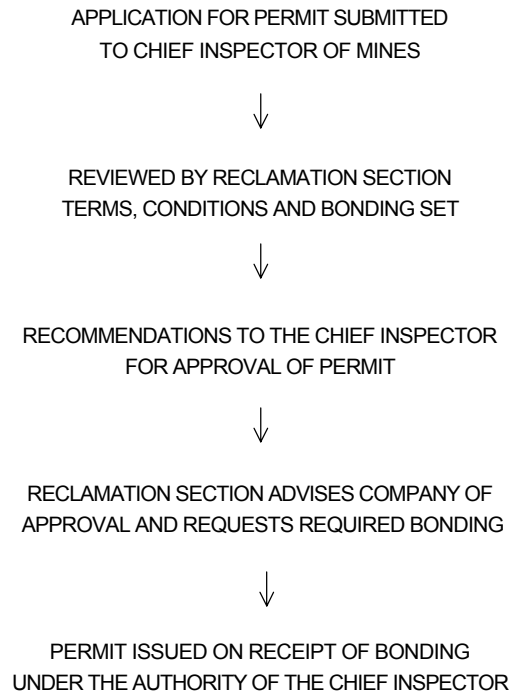


TABLE 2

PERMIT PROCESSING FOR MINERAL EXPLORATION, QUARRIES, GRAVEL PITS, PLACER MINING



Note:

1. Permits are only required when there is more than minimal disturbances and mechanical equipment is used.
2. For large mining companies with a number of exploration projects a General Reclamation Exploration Permit is issued covering all projects. A \$5,000.00 bond is required.

Corporation Ltd., which when completed in the final mining phase, will be 320 meters long, 160 meters high and will impound 1.8 billion tonnes of tailings.

GUIDELINES FOR COAL DEVELOPMENT

Large-scale coal mine developments will have considerable impact on the natural, social, and economic conditions in the region of development. In recognition of this fact, a comprehensive set of guidelines has been prepared to assist coal companies in the preparation of environmental impact assessments of their proposed developments.

It should be noted from the outset that the guidelines for environmental impact studies are broad in scope, covering the major economic, social, and natural environmental implications of coal development. Coal developments should conform to the principles of integrated resource planning, principles which seek a balance between economic, social, and environmental goals. Thus, net economic benefits of coal development must be carefully weighed against the environmental and social costs before final decisions are made.

It should also be noted that the guidelines cover all related components of the coal development program, not just the coal mine, waste dump areas, processing plants, etc., but also off-site activities such as new transportation networks, shipping terminals, community development, power and power supply corridors, and any ancillary industrial activity generated in the region as a result of the coal development impetus.

Thus, the environmental impact assessment should not be received as a set of narrowly based studies on the impacts of coal development on the natural environment, prepared late in the engineering feasibility study process. Rather, it should be thought of as a planning tool that shapes the whole development program from its inception to be responsive to the economic, social, and environmental goals of the region of development.

The environmental guidelines for coal development are produced under the authority of the Environment and Land Use Committee, a Cabinet Committee of the Government of British Columbia. The Environment and Land Use Committee comprises seven ministers representing nine departments that are responsible for resource use and economic development, as well as matters dealing with major public facilities such as highways, settle-

ment, and public health services. Under the Environment and Land Use Act, the Committee is responsible for integrated land and resource use planning in the Province and ensuring that the environmental impacts of all major resource developments are fully assessed.

Although the Environment and Land Use Act supersedes all other Provincial legislation, various departments are responsible for Statutes relating to specific aspects of coal development. Coal companies are required to apply for permits and licences for both exploration (under the Coal Act) and for development and reclamation (under the Coal Mine Regulation Act).

PROCEDURES FOR OBTAINING APPROVAL OF METAL MINE DEVELOPMENT

A guidelines procedure was instituted by the Ministry of Energy, Mines and Petroleum Resources in 1979 for proposed metal mine projects. The procedure calls for a preliminary feasibility (Stage I) and the final project design (Stage II) and is similar in many respects to the Guidelines for Coal Development. Because metal mining projects may vary widely in their size and in the magnitude of environmental impact, the procedure was designed to be flexible. Projects of low environmental and social impact are able to by-pass the Stage II review and apply directly for permits.

GUIDELINES FOR COAL AND MINERAL EXPLORATION

In order to accommodate the requirements of other Ministries, and to provide general guidance to companies, procedures of administration and good practice were summarized in a booklet entitled, "Guidelines for Coal and Mineral Exploration." These guidelines will be replaced by separate guidelines for coal exploration and for mineral exploration. These guidelines must be interpreted in the light of site-specific conditions. In general they recommend that the following points must be considered in the construction of roads, drill sites, adits and trenches:

- Minimization of the extent of land disturbance through geological mapping, pre-planning and engineering of layout, and close supervision of work.

- Utilization of the least disturbing means available when working in areas with sensitive resource conflicts, such as wildlife and fisheries.
- Drainage control by provision of ditching, culverts, and water bars where necessary.
- Minimization of disturbance in alpine areas.
- The necessity for site preparation prior to seeding and fertilizing.

New exploration techniques are now available for the minimization of land disturbance and in the provision of access into remote areas. Helicopter supported drilling costs including crew transportation vary from \$50 to \$100 per foot drilled and may go as high as \$200 per foot drilled. This procedure eliminates the cost of road construction and the necessity for reclamation and protective measures. Helicopter supported drilling is not feasible where concentrated drilling is required.

The reclamation section encouraged and in some cases requested hand trenching as opposed to trenching by mechanized means. Where mechanical trenching is required, the use of a back-hoe is required, as this machine reduces the area disturbed, and it can be more selective in the excavation and replacement of rock, overburden and top soils.

With respect to adit sites, proposed locations were inspected and approved prior to start of work. Directions were given for adequate disposal of rock spoil and oxidized coal waste. Adits on steep terrain sometimes require waste rock or coal to be hauled to flatter terrain for burial.

Drill sites have proved to be easier to reclaim than adit sites. Except for the need to create a flat work space, they have not generated large amounts of disturbed earth. Only on steep slopes have problems been encountered.

Reclamation inspection is now more rigorous, resulting in more stringent requirements than in past years. Instructions are routinely given for site preparation and methods for the revegetation on sensitive areas, in

particular, alpine regions. These instructions have included resloping and recentouring of roads, trenches and adit sites. Companies are required to return topsoil where possible, harrow and apply site-specific seed mixtures and fertilizers where necessary.

RECLAMATION ACHIEVEMENT IN BRITISH COLUMBIA

The Ministry of Energy, Mines and Petroleum Resources has directed most of its activity toward enforcement of reclamation of coal mines. The many proposed coal projects have necessitated that a strong emphasis be placed on coal mine reclamation.

There are many examples of excellent progress in reclamation within the British Columbia mining industry. For the past four years a mine reclamation award and two to three citations have been presented each year for outstanding achievement.