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Brief on

THE ENVIRONMENTAL IMPACT OF SURFACE MINING IN ALBERTA

submitted to the

Environment Conservation Authority

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INTRODUCTION

Coal deposits of late Jurassic to early Tertiary ages underlie much of the Alberta Plains and Foothills at depths ranging from 0 (i.e. at the surface) to 10,000 feet. Although much of this coal is buried too deeply to be considered as an exploitable mineral resource in the foreseeable future, an estimated 25 to 50 billion tons can be recovered by conventional underground and surface mining techniques. This constitutes a major source of potential mineral wealth for the Province of Alberta, and it is assumed in presenting this brief that these coal deposits will be extracted and utilized in accordance with the material requirements of the people of the province and with due regard to protection of the environment.

DISTRIBUTION OF COAL

Potential coal-bearing strata in Alberta vary widely in their geologic, physiographic, and climatic settings. The geologic aspects are summarized briefly in table 1, in which the major coal deposits are classified by the rock units or formations containing them.

Plains

Although most of the concern about the effects of coal mining on the environment is focused on the Foothills, a much larger area of the Alberta Plains is underlain by potential coal-bearing formations. These formations (Edmonton, Belly River, and Wapiti Formations) outcrop as an arcuate belt

Formation	Age	Extent	Structure	Coal Quality
Wapiti	Upper Cretaceous	Northwest-central Plains	Simple (flat-lying)	Subbituminous to high volatile bituminous
Edmonton	Upper Cretaceous	Central Plains	Simple (flat-lying)	subbituminous
Belly River	Upper Cretaceous	Southeast and east-central Plains	Simple (flat-lying)	Lignite to Subbituminous
(Various names)	Upper Cret.-Tertiary	"Outer" Foothills - N. Sask. to Athabasca Rivers	Moderate to complex	High volatile bituminous
Luscar	Lower Cretaceous	"Inner" Foothills - Red Deer River north	Generally complex	Med. to low volatile bituminous

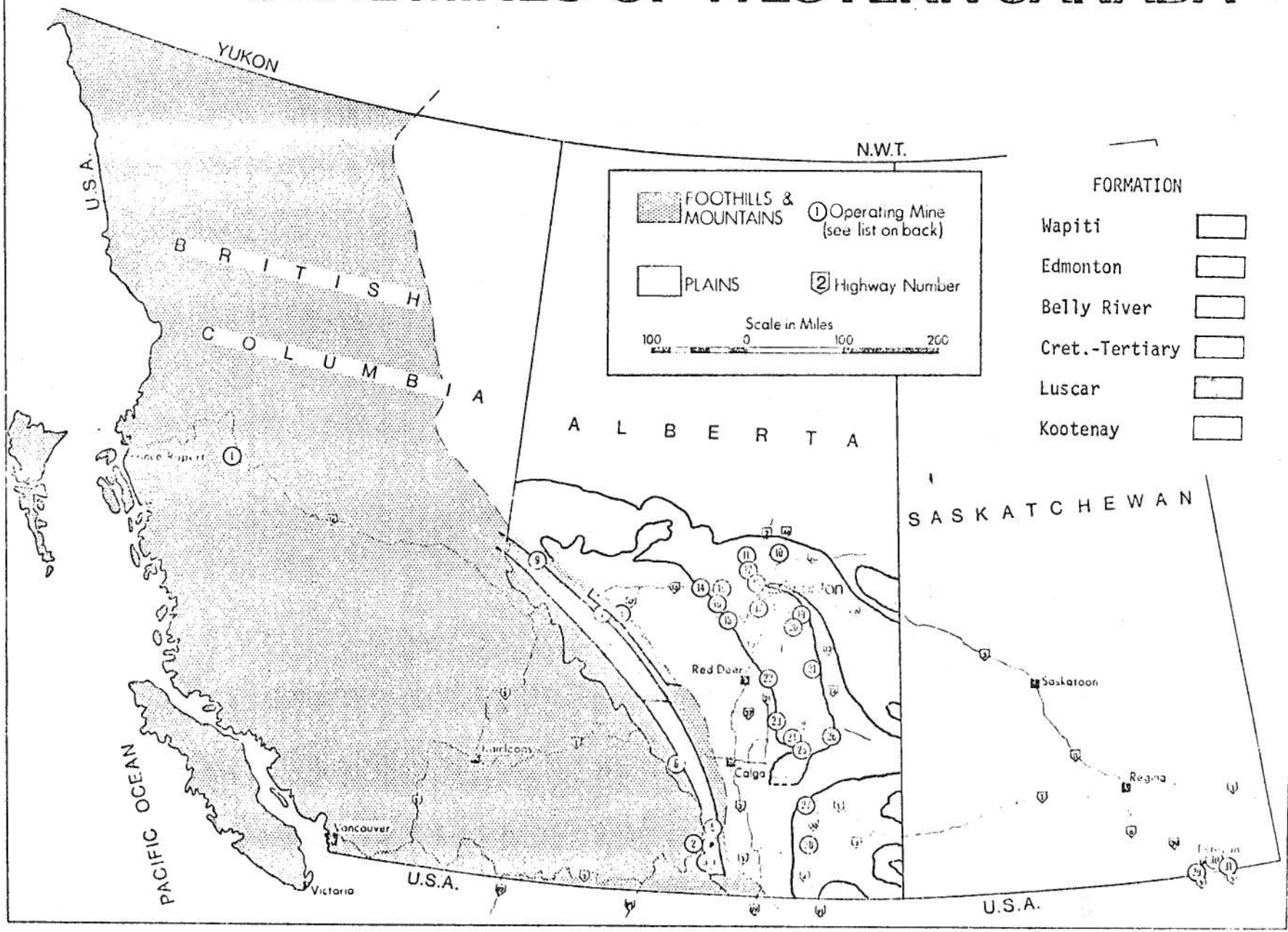
COAL-BEARING FORMATIONS OF THE ALBERTA PLAINS AND FOOTHILLS

of strata from 30 to 140 miles wide which extends from the International Boundary in southeastern Alberta, northward through east-central Alberta, then west across the north flank of the Swan Hills to the British Columbia border. The beds are nearly flat-lying to very gently dipping, and in most places are covered with a veneer of unconsolidated glacial deposits from a few to several hundred feet thick. They extend across a variety of climatic and vegetative zones, ranging from dry open prairie in the southeast, through the parkland of central Alberta, to the boreal forest in the northwest. The topography, although generally subdued, is relatively rugged in some areas -- for example, about the flanks of the Swan Hills and near the confluence of the Kakwa and Smoky Rivers in the northwest.

The potential coal-bearing nature of these rocks is stressed, for it is obvious that in much of the region underlain by these formations that coal seams will be either absent or too thin or deeply buried to constitute an economic deposit. On the basis of present knowledge, that portion of the province between township 77 (inclusive) and the International Boundary, excluding the Rocky Mountains and Foothills on the west, can be categorized in terms of its mineable coal potential as follows:

Coal potential	Square miles	Percentage
(1) Moderate to high potential - (Edmonton, Belly River, and Wapiti Formations)	13,250	10.4
(2) Low potential - (Edmonton, Belly River and Wapiti Formations)	48,000	38.1
(3) Non-coal-bearing bedrock - (Paskapoo, Willow Creek, and Bearpaw Formations)	65,050	51.8
Total area considered	126,300	100.0

COAL MINES OF WESTERN CANADA



Much of the high potential coal area is found in the upper part of the Edmonton Formation along the western edge of the outcrop belt: the so-called Ardley coal zone which extends from east of Calgary northward to the Wabamun-Whitecourt area, about the flanks of the Swan Hills westward to the Simonette River. Other substantial deposits are found in the lower part of the Edmonton Formation in central Alberta, in the Wapiti Formation south of Grande Prairie, and in the Belly River Formation of southeastern Alberta. However, in assessing these areal estimates of potential coal-bearing strata, the interested observer should keep in mind that the figure of 13,250 square miles is an absolute upper limit on the moderate to high potential area; in all likelihood that portion of the Plains that may be subject to surface mining in the foreseeable future is probably closer to 1,000 square miles (approximately 0.4 per cent of Alberta's area).

Foothills

The Alberta Foothills is a narrow belt of folded and faulted sedimentary strata extending along the eastern margin of the Rocky Mountains from the International Boundary in the south to the British Columbia border in the north, a distance of approximately 450 miles. This belt is approximately 20 miles wide on the average and thus encompasses in the order of 8,000 to 10,000 square miles of relatively rugged terrain.

Potential coal-bearing strata are exposed throughout almost the entire Foothills region, from Pincher Creek in the south to Kakwa River in the north. They outcrop as a series of narrow, en echelon belts of strata trending in a

north to northwesterly direction, parallel to the regional strike of the Foothills. The strata tend to be complexly folded and faulted, and steep dips predominate in contrast to the flat-lying coal beds of the Plains. Consequently, exploring for and developing coal resources of the Foothills present some complex geological and engineering problems, requiring as a rule closely spaced drilling programs and possibly geophysical surveys to determine precisely the distribution and amount of coal in place.

Most of the Foothills coal is confined to the "inner" or western part of the Foothills, extending in some areas into the Front Ranges of the Rocky Mountains. The coal is medium to low volatile bituminous in rank and is the source of metallurgical or coking coal now being mined in the Crowsnest Pass and at Canmore, Luscar, and Grande Cache. South of the Red Deer River, the deposits are confined to the Kootenay Formation; north of the Red Deer River they are found in the Luscar Formation which extends as a coal-bearing unit into northeastern British Columbia.

In addition to the coking coal deposits of the "inner" Foothills, coal of high volatile bituminous (non-coking) rank is found in strata of Late Cretaceous-Paleocene age along the eastern or "outer" margin of the Foothills. These deposits crop out in a narrow zone which extends approximately from the North Saskatchewan to the Athabasca Rivers and possibly northward towards the Smoky River. Although the geologic structure in this region tends to be less complex than in the "inner" Foothills to the west, bedrock in the eastern Foothills tends to be covered with glacial deposits, and good

exposures of coal-bearing strata are scarce. This makes prospecting difficult, especially in areas of complex structure.

The total area of the Foothills that ultimately may be subjected to surface mining for coal deposits is difficult to predict; prospecting for coal is quite active, but the results of exploration programs are generally not available owing to the highly competitive nature of the industry. Nevertheless, Peterson and Etter[1] have estimated that at least 32,000 acres (50 square miles) could be strip-mined for coal in the Foothills over the next 20 years, which probably is the correct order of magnitude. Although this area is small compared to the total area of the Foothills and Rocky Mountains, the estimate does not take into account the potential area that could be altered by access roads, plant sites, townsites and other service facilities. Thus if surface coal mining ultimately extends throughout the entire length of the Foothills, the associated activities will have much more significant impact on the development of this region than the actual strip-mining operation themselves.

Summary

In summary, near-surface coal deposits have a wide distribution throughout the Alberta Plains and Foothills. They exhibit great diversity in:

(1) quality and rank, and hence potential markets and economic value to the province;

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[1] Canada Dept. of the Environment: Forest Research Laboratory Information Report A-X-34, 1970.

(2) geologic setting:
- distribution (outcrop pattern);
- structure (dip, strike, and folding of beds);
- bedrock stability;
- thickness and type of overburden;

(3) surface and groundwater conditions;

(4) elevation and topography;

(5) climatic, vegetative, and faunal zones.

Because of this diversity, we suggest that no all encompassing detailed regulations should be set up which purport to deal with all phases of surface reclamation of land disturbed by strip-mining operations. Rather, we suggest that the Government enact a set of broad principles or guidelines for the restoration of disturbed land that permits a reasonable degree of flexibility in planning and implementing reclamation procedures for specific operations.[1] This approach seems particularly relevant in view of the lack of knowledge which exists with respect to preferred reclamation procedures in many cases.

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[1] For example, the authors of this brief have been told that one of the coal mine operators in the province has been required to replace the "topsoil" in the area to be reclaimed subsequent to mining activities. No topsoil exists at the proposed minesite; only rock rubble is available for reclamation.

RECLAMATION: DEFINITION AND OBJECTIVES

Reclamation of disturbed land implies:

(1) that the land be returned to its original natural state as closely as possible; or

(2) that the land be reclaimed for some alternative use -- recreation, game management, agriculture.

The authors of this brief feel that too much stress has been placed on the first item (that the land be returned to its natural state), especially in connection with reclamation in the Foothills. This approach appears relatively simple at first glance, requiring:

(1) that the abandoned mine be filled with rock rubble;

(2) that the "topsoil" -- carefully scraped aside and preserved during the mining operation -- be replaced on top of the rock rubble;

(3) that the mine site be reseeded to grasses, shrubs, or trees.

Although this procedure will never completely restore the mined area to its original state, the net results presumably will satisfy most people.

The authors agree that this procedure may well be the preferred approach to reclamation in some areas of the Foothills but point out that alternative land uses should be given serious consideration in other areas. As earth scientists, we do not have an aversion to bare rock walls (as opposed to spoil heaps) that may expose strata and geologic structures of interest to professional and amateur geologists alike.[1]

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[1] Appended at the end of the brief is a description of a unique rock cut made during highway construction near Birmingham, Alabama (from "Geotimes," October, 1970). The rock cut has since been designated a geological monument to preserve rock strata and structures that otherwise would not be observed in the natural exposures of the area.

Some of these may be worth preserving, for the features which they display may not be duplicated by natural rock exposures in the area, or, if present, may not be easily accessible.

Similarly, lakes and ponds are relatively uncommon in the Foothills and parts of the Plains. Thus, it is possible that mine excavations in certain situations could be impounded to hold water and possibly stocked with fish to provide a recreational area where none existed before. The main requirements in such situations are to ensure that the surrounding area is cleaned up (litter removed, spoil heaps stabilized and revegetated) for aesthetic reasons and that safety hazards are removed.

In summary, we do not regard surface coal mining in portions of the Foothills as an unmitigated environmental disaster. Mining activities will provide access to regions that normally would be inaccessible to the great majority of citizens, and may well create situations for recreational land use that otherwise would not exist.

ADMINISTRATION AND IMPLEMENTATION OF RECLAMATION PROCEDURES

We recommend:

(1) that a survey of the proposed mine site, access routes (roads, railroads), plants and townsites be carried out in advance of mining and development operations.

(2) that the survey consider the following aspects:
- distribution and properties of bedrock and surficial materials;
- surface and groundwater regimes;
- fauna and flora.

(3) that the survey be carried out by an independent investigating body composed of experts in relevant fields and responsible directly to

the Environment Conservation Authority. In this connection we are concerned that inadequate emphasis in the past has been given to the geologic, hydrologic, and engineering aspects of reclamation.

On the basis of the survey results and the proposed mine operation, recommendations can be drawn up with respect to preventing or minimizing environmental damage during all phases of the operation, including exploration, extraction, and reclamation. These recommendations should be forwarded to the Authority for discussion and approval, who then will forward them to the mine operator. Differences of opinion concerning the proposed reclamation procedures and other environmental precautions presumably would have to be reconciled within guidelines set up by the Department of the Environment.

We note that the procedures outlined above are at variance with the concept expressed in the Department of the Environment's position statement of November 26, 1971 (item 2.3) that the "proposed legislation would place the responsibility on the resource user to identify the nature and extent of damages ....."

COLLECTION AND DISSEMINATION OF INFORMATION ON RECLAMATION PROJECTS

What is the status of coal mine reclamation projects in Alberta to date? For example, what has happened or is happening to:

(1) old surface mine excavations and spoil heaps in the Crowsnest Pass and the Coal Branch? Is there any evidence of water pollution, revegetation, or erosion in these areas?

(2) present reclamation projects at Wabamun, Forestburg, Canmore, and Luscar? What are the problems, successes, and failures?

Data on both disturbed and reclaimed terrain should be documented fully and made available in a central data file to those involved in investigating, planning, and implementing future reclamation projects. Reclamation is expensive, and failed efforts should not be duplicated.

COMMENTS ON SPECIFIC ASPECTS OF ENVIRONMENTAL CONTROL

Removal and Replacement of Overburden and Topsoil

The thickness and composition of overburden vary widely from one coal deposit to the next. In general "overburden" consists of:

(1) bedrock - mainly sandstone and shale, which varies widely in composition, engineering and weathering properties from one locality to another;

(2) unconsolidated surficial deposits - mainly of glacial origin, such as till, outwash sand and gravel, lake clay, etc.

"Topsoil" conventionally refers to the upper few feet or inches of weathered material developed on the surface of bedrock or, more commonly in Alberta, on glacial deposits. Although reasonably thick over most of the Plains, soil profiles and glacial deposits tend to be much more erratically distributed in the Foothills, becoming as a general rule thinner or absent altogether at higher elevations. Thus, in many parts of the Foothills where coal-bearing formations are present, the "soil" cover consists of a few inches or feet of rock rubble mixed with small

amounts of sand and clay (colluvium). Where possible this material should be preserved and replaced after mining to provide some sort of soil-like rubble for revegetation of the area.

One of the most important duties of those involved in planning and recommending reclamation procedures will be to assess the distribution, thickness, and composition of the surficial deposits at and adjacent to proposed exploration trails, mine sites, and access roads.

Design of Spoil Banks and Erosion Control

We commend to the Environment Conservation Authority and to other interested parties a report on "Stability of Waste Embankments" compiled by a subcommittee of the Canadian Advisory Committee on Rock Mechanics (dated September 24, 1969).[1] The report states:

> "In view of the recent major failures of waste embankments, the recent increase in Canada of major mining development, the lack of mining regulations in Canada and the limited background of mining engineers in stability engineering the sub-committee believes that a potential serious problem does exist and that urgent action is required to control the problem."

The report includes the following salient recommendations:

(1) develop a design guide for the investigation, design and construction of waste embankments;

(2) project (research) proposals on the stability of waste embankments should be given favorable consideration;

(3) encourage existing mining research programs in Canada to expand to include practical research relating to site

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[1] A summary of the report's findings and recommendations is appended to the brief.

investigations, design, construction, maintenance and inspection of waste embankments.

Prospecting Procedures

Trenching and drilling, supplemented by outcrop mapping and geophysical surveys, are conventional techniques for coal exploration and assessment of reserves. The relative merits of these techniques and the spacing or intensity of exploration surveys vary from one coal deposit to another, depending primarily on geologic conditions (overburden thickness, structure, lithology) and on accessibility. Thus, we must accept the fact that in areas of complex structure and thick overburden -- a situation that applies to many parts of the Foothills -- there can be no hard and fast regulations to govern the spacing and intensity of exploration activities. If a company has been granted a lease by the Government, it must be allowed to assess its economic potential within standards generally accepted by geologists and mining engineers. This philosophy does not absolve the coal companies from their reponsibility in reclaiming or compensating for land disturbed by exploration activities, an area in which some detailed investigations are required.

However, if the Government decides, for aesthetic or other reasons, that conventional exploration activities are undesirable in certain areas, these areas should be withdrawn from leasing and the companies involved compensated for their expenditures.

Construction and Location of Roads, Trails, and Campsites

Planning and construction of roads, trails, and campsites should be subject to the same general guidelines governing the planning and implementation of actual mining activities. Again, we stress the necessity for proper geological and soil surveys during the planning stages of these activities, to avoid some of the problems encountered, for example, in construction and maintanence of the road built south from Highway 16 to the Luscar minesite.

Hydrologic Problems

(1) Protection of streams, creeks, and rivers

Problems caused by exploration or mining activities in the vicinity of creeks and rivers can be best prevented by excluding lands within a certain distance of major creeks and rivers from leasing. At present this procedure is not followed; lease boundaries contain stream valleys and beds as well as the interfluvial areas. Undoubtedly, some disputes will arise concerning the definition of a major stream, which points out the need to define and interdict these areas prior to exploration.

(2) Groundwater disruption and pollution

In the prospectus prepared by the Environment Conservation Authority dated November 12, 1971, the following statement is made:

> "It has been suggested that they [environmental effects of coal mining in Alberta] may already have caused serious disruptions to the subsurface hydrology of certain areas and that this in turn could endanger the water supply to the Prairies."

We ask what is meant by this statement, which in its present form is

liable to mislead and unduly alarm the general public. If it is taken to mean "adverse effect on the groundwater regime" implying a deterioration in quality and quantity of available groundwater, there is no tangible evidence to support the statement.

Groundwater regimes to depths much in excess of the depths of surface mine excavations are associated with and contained within local drainage basins, i.e. within the valley of a single stream. Systems of groundwater flow originate and terminate within the boundaries of these basins, and generally any contaminent entering the local groundwater system will surface again (if at all) in the same valley. Any interception of the flow will cause a decrease in underground flow rates in the same watershed only. There is no basis to the suggestion that neighboring groundwater systems, let alone those in distant prairie areas, will be significantly affected by localized mining operations in the Foothills.

With respect to contamination of surface water supplies through discharge of noxious effluents by local groundwater systems, it is pointed out that chemicals are not used in surface mining operations and that the sulphur content of Foothills coal is generally low (less than 0.3 per cent pyritic sulphur). Thus, problems associated with acidic or other undesirable mine effluents -- serious in some coal mining regions of the world -- are unlikely to be met in Western Canada in any case.

INVESTIGATION REQUIREMENTS

In view of the uncertainty that exists with respect to the effects of coal surface mining in Alberta and to the procedures for reclamation of

disturbed land, we suggest that some need exists for study into those matters bearing on:

(1) costs and benefits of coal surface mining to the Province and to the community as a whole;

(2) effect on alternate land uses;

(3) various technical aspects of surface mining and reclamation, such as
- erosion potential and control;
- surface and groundwater pollution;
- waste embankment design and construction;
- potential safety hazards;
- revegetation and other reclamation techniques.

Although some knowledge on these matters can be obtained from the results of land reclamation projects performed elsewhere, the economic, geologic, and ecologic conditions associated with coal mining in Western Canada are quite different from those associated with coal mining in Europe or the eastern United States. Even within Alberta, the diversity of settings in which coal-bearing strata are found indicates that reclamation procedures that have proved successful in one area of the province will not necessarily be successful elsewhere. Therefore, we recommend that the Government set up a task force to survey the need for research into problems associated with surface coal mining in Alberta and to undertake a systematic study of those problems for which solutions currently are uncertain at best.

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