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ELK RIVER COAL PROJECT

STAGE I REPORT

TEXT

ELCO MINING LIMITED

January, 1977

ELK RIVER COAL PROJECT
STAGE I REPORT
TEXT

prepared for the

ENVIRONMENT AND LAND USE COMMITTEE
as prescribed by the
GUIDELINES FOR COAL DEVELOPMENT
BRITISH COLUMBIA

by

ELCO MINING LIMITED

January - 1977

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SUMMARY

The Proponent

Elco Mining Ltd., a Canadian company incorporated in the province of British Columbia in 1975, is a wholly owned subsidiary of six European steel companies (see Introduction Page ii), which are incorporated in Germany, Italy and the Netherlands. The Company holds a 50% interest in forty-two coal licences comprising part of the coal deposits in the Elk River Valley, with a Canadian Oil and Gas Group and the Steel Company of Canada Ltd., each holding a 25% interest in these licences.

In October 1976, Elco Mining Ltd. was appointed manager of a Joint Venture created by the Steel Company of Canada Ltd. (25%), Home Oil Ltd. (15%), Scurry-Rainbow Oil Ltd. (10%) and Elco (50%) for the purpose of mining coking coal reserves in the Elk River Valley and hereinafter referred to as the Elk River Coal Project. At the present time, and as part of the overall objective of the Joint Venture, Elco is determining the feasibility of this project with the aim of marketing coking coal for the Eastern Canadian, the European and other international markets.

The Coal Deposit

The licence area is situated in the upper Elk River Valley, approximately 50 km to the north of Elkford. Geologically, the coal deposits belong to the Kootenay Formation and are distributed over a 900 m thick bedding sequence. The coal bearing strata are folded into a NNW-SSE trending syncline that underlies the Elk River valley. The coal seams are exposed on both sides of the valley.

The proven, probable and inferred coal reserves in the licence area are approximately 2200 X 10^6 tonnes. Recoverable clean coal reserves are about 680 X 10^6 tonnes.

The proven surface minable reserves of non-oxidized coal in the area, for which development is now under study, are 107 X 10^6 tonnes. A northward extension of the development area could recover an additional 15 X 10^6 tonnes. Moreover, at least 67 X 10^6 tonnes of surface mineable clean coal are present to the south of the proposed development area. Additional reserves can be recovered by underground mining.

In the licence area, the quality of the metallurgical coal deposit varies from low-volatile with poor coking capacity to high-volatile with excessive coking capacity. Generally, the coal with poorer coking capacity occurs deeper in the deposit and outcrops on the eastern valley slope. The seams with better coking properties are found nearer the top of the coal bearing zone; these underlie the valley floor, and the best seams are locally overlain by the channel of the Elk River. The coal with inferior cokeability occurs in thicker seams with fewer splits while the better cokeability is generally found in thinner seams with more splits. The currently proposed mining area would imply the recovery of coking coal from 18 coal seams with about 50 splits.

The Project

The principal objectives of the feasibility study and planning phase are the determination of the economical recovery of quality blended metallurgical coal from the licence area in a socially and environmentally acceptable manner. The blending of coal from so many, in quality and thickness highly variable, seams into a marketable coking coal of constant quality presents a considerable challenge. In essence, the Elk River Project contemplates the mining of a type of coal deposit hitherto viewed by many to be out of economic reach. Therefore, should this project be successful, it would not only add about 190 million tonnes of metallurgical coal to the producable reserves of British Columbia, but also demonstrate the feasibility of the eventual recovery of coal from similarly difficult to exploit coal deposits within the licence area and elsewhere.

The challenges facing the project manager include the concurrent mining of 18 coal seams with about 50 members over a width of approximately 600 m from a formation dipping westerly at 38-42 degrees; the blending of raw coal from highly variable seams into a feed for the preparation plant; the preparation of coal of this type with the aim of achieving a coking coal blend of quality properties acceptable to the Eastern Canadian, European and other international coal markets; the transport of coking coal to the steel mills of the Canadian and European Joint Venturers via railway connections in part yet to be established, and probably using new port facilities on the Great Lakes and the West Coast while at the same time establishing overseas shipping links between Western Canada and Europe in a combined traffic pattern. Moreover, substantial environmental concerns and community development problems will have to be met. The technical, socio-economic and environmental problems appear to require costly solutions. Elco Mining Ltd. is aware that the Elk River Coal Project is marginal under present conditions, particularly with regard to shipments to Eastern Canada and Europe.

The benefits to the East Kootenay Region, to British Columbia and to Canada, however, will be considerable. Current projections foresee a workforce of about 1100 persons during the peak of plant construction and a manpower requirement of 1400 permanent operating employees, to attain a target production of 3.6 million tonnes of clean coal. The procurement of goods and services for the construction and operation of the mine and the plant will stimulate the economic activity in the Region, the Province and Canada and create jobs in the manufacturing, support and service industries as well as the transportation sector. Canada's balance of trade will be favourably influenced by the replacement of imported metallurgical coal with domestic supplies and by the export of coking coal to European and other consumers at competitive world market prices. Locally, the communities in the Elk River Valley will benefit from increased economic activity. The project will also create work for an additional 350 persons in the service and support functions.

Other benefits to be derived from the realization of the Elk River Coal Project are:

- a strengthening of federal/provincial cooperation for the purpose of foreign market development;
- the promotion of income stability over a long period of time;
- the creation of secure employment not hazarded by fluctuations of the international coal markets;
- the reduction of structural unemployment in an area where jobless percentage traditionally has been higher than the provincial average;
- the encouragement of a greater balance in the mineral sector structure including a more broadly based ownership of the industry in which the Canadian people can participate financially;
- the sharing of investment capital and highly specialized skills between Canada and other industrialized countries;
- economic diversification, i.e. the growth of a regional economy based on minerals;
- increased revenues to various levels of government;
- the fact that the Elk River Coal Project is being developed by the owners of steel mills in Eastern Canada and Europe, in addition to a major Canadian Oil and Gas Group, and not only by developers who have to sell their product on the open and widely fluctuating world markets, guarantees a stable market for the bulk of Elco's future production and provides Canada's growing coking coal industry with a very important alternative to the present market pattern.

The Mine

Elco Mining Ltd. proposes to mine the east limb of the syncline with open pit methods. To obtain maximum recovery of the coal reserves in the licence area, yet ensure a product of acceptable quality, some of the seams with good cokeability near and under the Elk River must be included in the mining plan. Several mining alternatives have been evaluated since 1971 in order to find the optimal trade-off between cost-effective resource conservation, product quality and environmental protection. The preliminary mining plan presented in this report, although more acceptable from an environmental perspective than previous schemes, cannot avoid some measure of diversion of the Elk River.

This report outlines a mining alternative whereby an open pit would be started about 1 km south of the confluence of Cadorna Creek and the Elk River. Mining would progress southward at a rate of about 200 m per year and would extend down to 160 m below the valley floor. Concurrently, the western slope of Little Weary Ridge would be excavated ahead of the southward advancing pit. For approximately seven years the overburden and the pit waste would have to be deposited outside the pit boundaries, on the western valley flank as well as on the eastern slopes above the pit. Backfilling and reclamation of the pit would begin as soon as space is available and immediately following the mining activities.

Because of the many seam splits, the largest generation of excavation equipment cannot be used for this deposit. Generally, the equipment will have capabilities in the order of 25 m^3 per unit. Transport of overburden, waste and raw coal will be by rear- and bottom dump trucks with capabilities in the order of 150 tonnes.

The Preparation Plant

The Elk River Coal Preparation Plant is proposed to handle about 1100 tonnes of raw coal per hour to produce about 740 tonnes of clean product. It would use heavy media circuits for the cleaning operation. In its basic design, the plant would be similar to the Fording Coal and Kaiser Resources plants. The water supply would be drawn from a closed circuit which includes the tailings pond. Make-up water to compensate for losses in reject coal, clean coal, tailings pond and thermal dryer evaporation, would be drawn from the Elk River. The design of the plant and its operational procedures will be sensitive to and protective of the environment.

The Transportation Corridor

The transportation developments required to serve the plant during the construction and operation phases are the building of a rail link with the Canadian Pacific Railway Fording Branch line near Elkford and the upgrading and partial relocation of the Forestry Road that runs the length of the upper Elk River Valley.

The Residential Community

Project staff and their dependents as well as the employees of support and service industries are expected to number approximately 4500 persons in the initial production stage of the project. About 165 ha (420 acres) of developable land are considered required to house this number of persons, should they be placed in a residential development at an appropriate distance from the project site. About 140 ha (350 acres) of developable land would be required initially if the residential community should be attached to the existing town of Elkford, which lies about 48 km to the south of the project site.

Near the confluence of Forsyth Creek and the Elk River, about 20 km downstream from the project site, there is sufficient land available to accommodate not only the initial community development requirements of the Elk River Project, but also substantial subsequent growth. Current indications are that land development costs would be less than in Elkford. Social and socio-economic factors as well as future growth possibilities appear to favour the Forsyth Creek site for community development. The economies of scale deriving from the attachment to an existing community, however, tend to make Elkford a viable alternative for the initial period of time.

The Environment

The Elk River Project is located in the north-south trending, glaciated valley of the Elk River. In the licence area, the valley floor has an approximate elevation of 1500 m; the adjacent mountains rise to about 3000 m.

Between the valley floor and about 2400 m elevation, the natural climax vegetation is that of the Engelmann spruce-subalpine fir zone. The effects of a disastrous forest fire in 1936, however, are still much in evidence, in that the forest cover is dominated by immature lodgepole pine and decaying timber.

This forest fire has also adversely affected the wildlife potential of the area. The terrain of, and around the licence area and the proposed transportation corridor is frequented by moose, elk, mule deer, white-tailed deer, grizzly bears, black bears, cougars, and bighorn sheep. Grouse, ptarmigan, coyote, lynx, wolverine, mink, beaver, muskrat, red squirrel and snowshoe hare have also been reported.

In general, the licence area and its immediate environs have moderate big game range capability; prime overwintering areas do not occur in the upper Elk River Valley above Elkford. Waterfowl capability is virtually non-existent.

The prime alpine recreation areas of the headwaters of the Elk River, Cadorna Creek and Forsyth Creek are currently underutilized. This potential might be unlocked by the establishment of a residential community to the north of Elkford.

The licence area and its environs are frequented by hunters and fishermen, which confirms its capability for recreation of this type.

The water quality of its streams is good and the fish habitat characteristics have also been judged to be valuable.

The only apparent land use conflict would be with a guiding and outfitting facility on the proposed minesite. While some adjustment of recreational land use modes would have to be made to accommodate the mining project, this would not lead to unacceptable pressures on the potential of its environs, under current usage conditions.

The Environmental Effects

Given the current design of the mine and the plant, and the present knowledge of the existing environment and its biota, no critical environmental effects have been identified to date. The environmental studies are continuing and the opinions expressed in this report may require subsequent modification. It would appear, however, that the Elk River Project will not have irreversible effects on the environment outside the licence area. The salient environmental effects are all contained within the licence area and comprise certain modifications of the landscape, a diversion of the Elk River and its relocation after completion of the open pit operations, diversion of tributary streams and rivulets and the loss of forestry production during the period of mine production. The mitigative options identified in this report are consistent with sound engineering design and operational procedures as defined to date and reflect sound environmental protection practices, and comply with basic government requirements.

Leaving aside the benefits of resource extraction, the compensating environmental effects are the eventual establishment of wildlife habitats that can be expected to be at least as productive as those now existing, while the areas that will be restored to managed forestry land uses can be expected to yield a greater supply of commerically desirable timber than available from the present vegetation cover in its regenerating, fire-afflicted state. In contrast with some mining projects in a mountainous environment, the Elk River Coal Project offers the prospect of more than adequate land reclamation since end-dumping of waste will be minimal. Moreover, the nature and thickness of the overburden would suggest that a more than sufficient supply of good soil materials is available for reclamation which, together with salvaged topsoil, peat and forest slash and duff, allows the creation of a satisfactory growth and rooting medium on the surface of the reconstructed landforms.

The draining of marshy and swampy sections of the valley floor ahead of mine development will be compensated by the creation of substantial expanses of open water of good quality both within and without the mine pit. These open water bodies, while created partly to perform a project-related environmentally protective function, will enhance the variability of the reconstructed landscape and contribute to the diversification of the land use potential of the reclaimed landscape.

DOCUMENTATION

PREVIOUS STUDIES AND REPORTS RELATED TO THE ELK RIVER COAL PROJECT AND THE REGION IN GENERAL INCLUDE THE FOLLOWING:

A. DOCUMENTATION OF PROJECT REPORTS

Techman Ltd.:

Elk River Coal Project, Report on Preparation and Preliminary Flowsheet, March, 1975.

Elk River Coal Project, Mining and Environmental Planning Concepts. Alternative A, May, 1975.

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Elk River Coking Coal Project, Coal Quality Analysis, March, 1976.

Program Outline for Feasibility, Design and Procurement Phases of Elk River Coal Project, April, 1976.

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Western Canadian Coal Transportation, September, 1974.

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Elk River Metallurgical Coal, Elk River Valley, British Columbia, Canada, March, 1971.

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- Volume I, Geology
- Volume II, Appendix 1, Maps & Drawings
- Volume II, Appendix 2, Geological Mapping
- Volume II, Appendix 3, Sampling & Analysis Summary Tunnels Trenches
- Volume II, Appendix 4, Sampling & Analysis Summary Boreholes

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INTRODUCTION

Location

The Elk River coking coal deposit is located in southeastern British Columbia, about 43 km north of the town of Elkford. The licence area comprises 77 km^2 of crown land.

The licence area is linked via a 43 km forestry road with the road connecting Elkford and Sparwood. The railroad line nearest to the Elk River deposit is the Fording River branch line of the Canadian Pacific Railway.

Historical Background

The Elk River deposit has been known since 1883 and was investigated for the first time in 1920. In 1967, Scurry-Rainbow Oil Ltd. acquired the coal licences for the deposit. Emkay Canada Natural Resources Ltd. subsequently acquired a 50% interest in these coal licences.

In December 1973, Exploration und Bergbau GmbH, of Duesseldorf, West Germany, acting on behalf of a group of European steel companies, initiated negotiations with EmKay relative to participation in a development project. In 1975, Elco Mining Ltd., a Canadian company, was incorporated and an agreement reached in May 1975 between Emkay and Elco Mining Ltd. on the acquisition of Emkay's interest in the coal licences by Elco.

In 1975, Scurry-Rainbow and the Steel Company of Canada reached an agreement in principle whereby Stelco would acquire a 25% share of the property, i.e. half of the interest in the coal licences previously held by Scurry-Rainbow Oil Ltd.

In 1975/76, a prefeasibility study was executed by Elco. Based on this study, a decision was reached in 1976 to continue to investigative work and to initiate the present planning phase.

In October 1976, a Joint Venture Agreement was concluded between:

Elco Mining Ltd.	(50%)
The Steel Company of Canada Ltd.	(25%)
Home Oil Company Ltd.	(15%)
Scurry-Rainbow Oil Ltd.	(10%)

as holders of an interest in the Elk River Project.

The beneficial shareholders of Elco Mining Ltd. are six European enterprises:

	August Thyssen-Huette AG, of Germany	(13.158%)
	Mannesmann AG, of Germany	(13.158%)
	Ruhrkohle AG, of Germany	(13.158%)
	Stahlwerke Peine-Salzgitter AG, of Germany	(13.158%)
	Hoesch Werke AG, of Germany and the Netherlands*	(21.052%)
and	Finsider SPA, of Italy	(26.316%)

Forty-two individual coal licences are held by Elco Mining Ltd. on the property, namely Coal Licence No.'s 64, 65, 421-434, 481-489, 515, 771-779 and 951-957.

As project manager, Elco Mining Ltd. intends to proceed with the project through the planning phase, which concludes with the completion of the Stage II Report and the Feasibility Study.

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*Hoesch Werke AG is affiliated with Hoogovens N.V. of the Netherlands.

As soon as Approval-in-Principle has been granted by the Government of British Columbia, and if the Joint Venturers agree to proceed beyond the Feasibility Study, design work will be commenced. Should the Government of British Columbia accord its final approval to the Elk River Project after submission of the Stage III Permit Applications, and should the Joint Venturers decide to continue the project, a Development Agreement will be concluded. The objectives of the Joint Venture will then comprise all aspects of the development, construction, operation and maintenance of the Elk River Project.

Work Status

From the documentation of project reports it can be inferred that a considerable amount of investigative work has been completed during the prefeasibility phase. The main objective of these studies was to determine whether the Elk River coal will allow production of a metallurgical coking coal product that will be acceptable for coke production in the coking plants of the Joint Venture partners and possible customers, and whether environmental concepts as studied and proposed would be viable and acceptable to the Governments and the public. The outcome of the studies was generally positive.

A report on Mining and Environmental Planning Concepts was presented to the Government of B.C. in May 1975 and a public meeting held in Fernie immediately afterwards. The reactions by government agencies and the public were encouraging.

In accordance with the "Guidelines for Coal Development in British Columbia", a Prospectus was submitted to the Environment and Land Use Committee in November 1976.

Work Schedule

The following milestone dates are planned:

Completion of Feasibility Study and Stage II Report	October 77
Submission of Stage II Report	October 77
Project Approval-in-Principle	February 78
Design and Engineering	March 78-December 78
Submission of Stage III Applications	August 78
Final Project Approval	December 78
Procurement, final design, construction	January 79-March 82
Start of coal production	March 82

Deposit Potential

Although the full extent of the coal deposit has not yet been determined, the total in situ reserves are believed to be in the order of 2200 X 10^6 tonnes of which approximately 680 X 10^6 tonnes (measured, indicated and inferred) are recoverable by open pit and underground mining methods. The currently planned open pit will permit extraction of approximately 107 X 10^6 tonnes of measured recoverable clean coal. Substantial additional open pit coal is available to continue operations.

The potential of the deposit allows gradual development of production from 3.6 X 10^6 tonnes/year to a greater capability in the future. The mine life is expected to extend to over 100 years.

Areas of Concern

Although the coal deposit has great potential, the problems relative to mining, coal blending, coal preparation, coal transportation and community development appear to require costly solutions, which indicate the project to be marginal under present conditions, particularly with regard to shipments to Eastern Canada and Europe.

Some of the major areas of concern are:

- mining of about 18 coal seams with up to 50 splits dipping at about 38^{o};

- moving large quantities of rock and overburden without being able to utilize the largest generation of draglines or electric shovels due to the constraints imposed by thin seams and quality requirements;

- remedying the problems associated with the blending of a constant raw coal feed from 18 seams;

- preparing a final product with constant quality and acceptable coking properties while the better quality seams underlie the Elk River and are of lesser thickness than the fair quality seams;

- transporting coal over considerable distances to the consumers in Eastern Canada, Europe and other markets;

- attracting and developing a new labour force of about 1400 and creating a residential community for a population of about 4500.

The mine will be located on the east limb of a large syncline underlying and parallel to the Elk River Valley. This report develops a mining concept believed suitable to obtain a medium quality coking coal blend in an environmentally acceptable manner. The assessment of environmental effects is preliminary and will be updated as study programs are completed. To the extent that undesirable environmental effects were identified to date, the concept incorporates environmental protection measures either as part of the engineering design intentions or as operational procedures that were adopted in principle.

In addition to the open pit concept discussed in this report, there is a possibility to develop certain areas by underground methods. Feasibility studies will be undertaken in the future, since underground mining, where practicable, allows the extraction of substantial volumes of coal not accessible to open pit methods.

Large scale underground operations are not feasible initially, as a specially trained labour force is required for underground work. These skilled men are not available in adequate numbers at the present time. Many years of operating a pilot training mine are required to gradually build the necessary skills and output. Moreover, the initial capital cost prohibits early underground operations.

Mining in the East Kootneay Region has been viewed as conflicting with the environment, especially with big game production, forestry and recreation. The environmental planning concepts presented here are believed to form the best possible conservation approach to ecosystem protection and enhancement at the Elk River site.

Considerable site-specific field studies have been initiated and the preliminary results summarized in accordance with the Stage I requirements. Possible environmental effects have been identified using existing information, and mitigative options, activities and effects are described. Ongoing environmental programs will contribute to better definition of undesirable effects and to mitigative activities including reclamation planning to fulfill the Stage II requirements.

A study was made of the land requirements for residential community development to house project personnel. Alternative locations were evaluated and the results incorporated in this report.

All potential resource and land use modes were surveyed. The currently available information base does not allow the development of a meaningful socio-economic impact matrix at this time. The results of socio-economic studies will be presented in the Stage II Report.

1.0 PROJECT DESCRIPTION

1.1 Local and Regional Context

The Elk River Coal project is located at 50° 24' north and 114° 55' west, in a north-south trending, glaciated valley at an elevation range of approximately 1500 m to 2100 m with adjacent mountains extending to 3000 m (Photo 1). The licence area encompasses 7733 ha in 42 contiguous coal licences on Crown Forest Land. The project area lies in the East Kootenay Area as designated by the Canada Land Inventory; it is located in the southeastern part of British Columbia (Appendix A - Map 1).

The topography of the area produces significant variability of climate, soils and related vegetation over short distances. The predominant zone, as described in Krajina and defined by the parameters of climate, soil and climax vegetation, is an Engelmann spruce - subalpine fir zone extending from the valley floor to approximately 2400 m (Krajina, 1965).

"Moderate Big Game Range" (Appendix A - Map 4), consisting of Class 3 range and Class 3 winter range, occupies 19% of the licence area.

The Canada Land Inventory did not survey the project area for agricultural or native range capability, both being severely limited by physical and biological factors, especially the dominance of heavy forest growth. Although forestry capability forms the largest single resource block within the licence area (58%), it is of relatively low value relative to productive capability at the provincial level.

The East Kootenay Region offers a wide range of outdoor recreation opportunities. The presence of mountains and lakes provide both alpine and water-oriented recreation opportunities. Of the permit

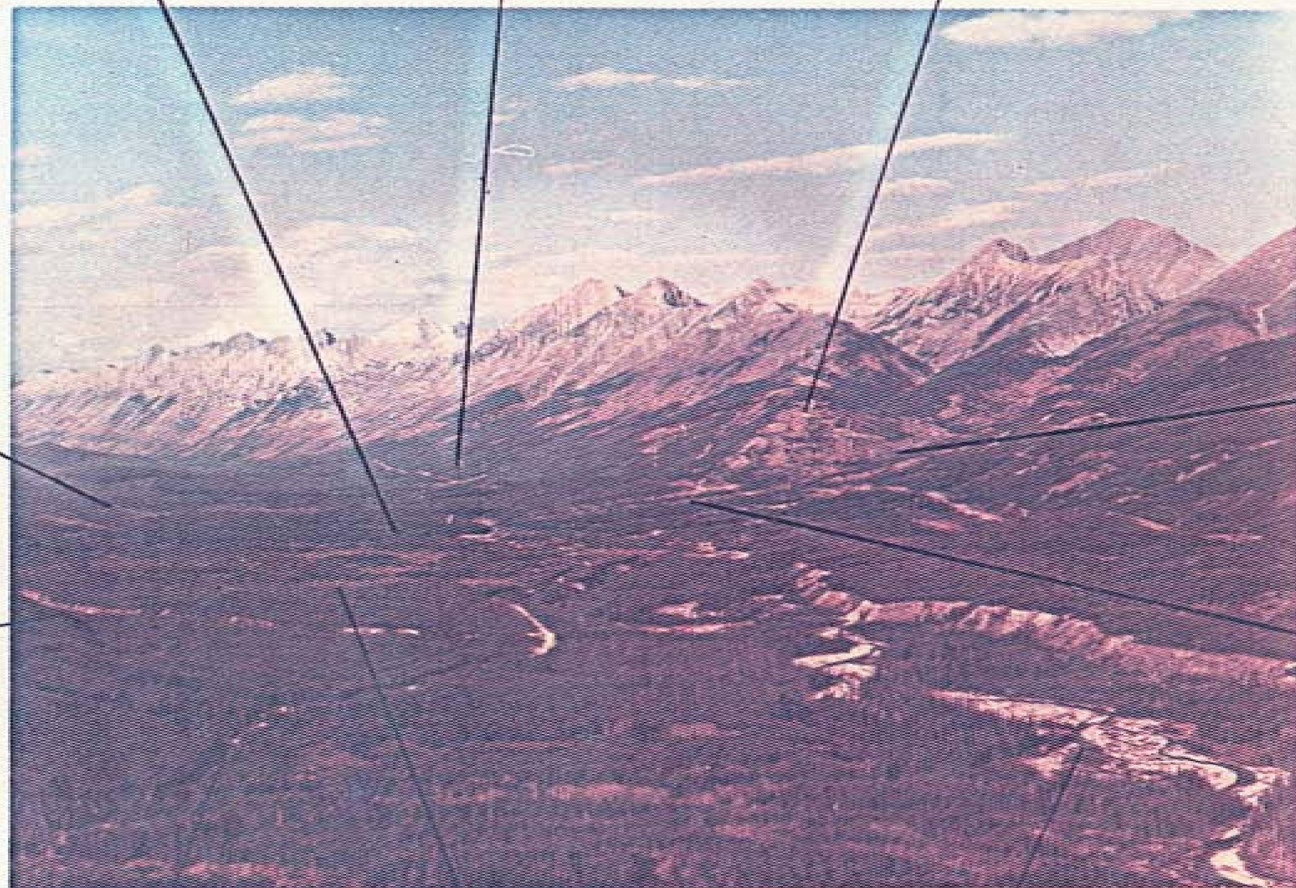


PHOTO 1:
View of entire mining area from the south - October, 1974.

area, 10% is classified as "Moderate Recreation" capability and 5% as "Extensive Recreation" capability. The remaining 8% has been classified as "Highland" which has capabilities for big game range, primarily summer range, and "extensive" recreational use. The Resource Analysis Unit of the British Columbia Environment and Land Use Committee has a Southeast Coal Study underway which should be completed in early 1977. The regional data base resulting from this effort will provide substantial assistance in placing the proposed mining project in a regional social and environmental context.

1.2 Exploration

Exploration programs to date indicate the presence of a zone of coal measures, approximately 900 m thick, folded into a NNW-SSE trending syncline underlying the Elk River Valley. Coal bearing strata on the limbs of the syncline are exposed on both sides of the Valley. The lower 600 m of this sequence contain approximately 20 coal seams subdivided into as many as 60 splits with a combined coal thickness of approximately 90 m. The productive part of the coal measures probably extends 600 to 1200 m below the valley floor. The coal measures of the project area belong to the Lower Cretaceous Kootenay Formation 4; the stratigraphy and geology of the area is presented in Table 1 and Figures 3 and 4 of the Prospectus, which was submitted to respective government authorities in November 1976.

Reserves and quality data have been developed from the results of the original Emkay Canada Natural Resources Ltd. and Scurry-Rainbow Oil Ltd. drilling and exploratory adit program of 1970-71, two previous programs, and from the 1975-76 drilling and adit development program of Elco Mining Ltd. The earlier programs drilled 98 holes totalling 16,800 m, trenched 6866 m and obtained 22 bulk samples from adits. The Elco Program drilled an additional 24 holes totalling 5343 m, trenched 805 m, reopened old adits and drove 228 m of new adits to obtain 201 short tons of bulk samples.

The total licence area reserves (proven, probable and inferred) are estimated to be about 2200 X 10^6 tonnes, of which 680 X 10^6 tonnes are recoverable clean coal.

Proven open pit reserves of non-oxidized coal in the area north of Sta. 170, updated to reflect preliminary assessment of 1976 data, and augmented by the volume that can be recovered by dragline trenching of the pit bottom are:

	tonnes X 10^3
Raw Coal in Place	160,000
Recoverable Raw Coal	139,000
R.O.M. Coal (Diluted)	165,000
Clean Coal Recoverable at Plant Yield of 65%	107,000
Total Till & Rock Waste	654,000 m^3
Ratio	4.7 m^3/tonne

In addition, the portion of Big Weary Ridge between Sta. 100 and 170 lying within the licence area contains the following coal volumes that can be recovered with open pit methods:

	tonnes X 10^3
Raw Coal in Place	105,000
Recoverable Raw Coal	94,000
R.O.M. Coal (Diluted)	103,000
Clean Coal Recoverable at Plant Yield of 65%	67,000
Total Till & Rock Waste	565,000 m^3
Ratio	5.4 m^3/tonne

The reserves in Big Weary Ridge can be classified as proven, but on the basis of less data than the reserves in Little Weary Ridge. Further exploration drilling is required for detailed mine planning in this area.

All open pit reserves have been calculated to about 120 m below the valley floor, except for dragline trenching reserves which in the thicker seams extend another 40 m below the truck pit bottom.

Additional coal can also be obtained by underground mining methods from the areas to the north and the south of the open pit, from the west limb of the syncline and from below the open pit. The limits between open pit and underground mining reserves will be determined during the Feasibility Study. The total recoverable coal reserves are sufficient to maintain large mining operations for over 100 years.

The 1976-77 exploration program is an extension of the 1975 program. The objectives are to obtain additional subsurface information for planning purposes as well as bulk samples from the licence area.

The initial phase of the present exploration program runs from October through December 1976. During this period the following work was completed:

- 42 diamond drill holes with a combined length of about 6851 m.
- 4 rotary holes with a combined length of about 488 m.
- 2 exploration trenches.

Exploration work will continue during early 1977 with approximately 10,500 m of diamond drilling and 7000 m of rotary drilling.

An exploration camp has been established near Weary Creek on the east side of the Elk River on the location used during the 1975 exploration program.

Details of exploration related reclamation programs are recorded in the "Annual Report 1975 on Reclamation Operations" submitted to the Department of Mines and Petroleum Resources on January 26, 1976.

1.3 Coal Quality and Blending Requirements

One of the primary areas of concern of the Elk River Coal Project is the quality of the coal to be produced. An extensive drilling and bulk testing program is underway to establish the variability of the coal within and between seams and to determine the coking characteristics of the coal.

The raw coal characteristics have now been established for the anticipated mining area (Appendix C, Section 1.3 - Figure 1). The ash content will range from 19% to 60% and will amount to about 30 or 40% in the R.O.M. coal. This depends on the number of partings and the amount of dilution rock in each seam. One can better appreciate these variations when it is realized that about 50 coal members as thin as two feet will be recovered from 18 seams.

In addition to the highly variable raw coal ash content, the 18 seams vary in rank and volatile matter from 19.5 to 34% on a dry ash free basis (Appendix C, Section 1.3 - Figure 2). Thus, much variation in the coking characteristics of the seams is indicated. The seams were classified as follows:

Coal Type	Coking Capacity	Seam No.
low-volatile	moderate to good	2, 3
low-volatile	moderate	8, 9, 10
low-volatile	poor	4, 6, 7
medium-volatile	good	11, 12, 13, 14, 15
high-volatile	excessive	16, 17, 18, 19

To produce an acceptable coking coal product of constant quality from the many mined seams, a large blending bed is required. The actual size is still under study.

The admixture of higher-volatile coal from seams 11-18 must be maintained to compensate for the poor coking capacity of seams 4, 6 and 7, and the moderate coking capacity of seams 8, 9 and 10. Consequently, Elco must continuously mine the upper seams. This necessitates diversion of some stretches of the Elk River. One of the earlier diversion alternatives proposed to place the river channel in a tunnel. This alternative has now been abandoned. Other alternatives which are now under study trade-off a minimal river diversion against access to sufficient reserves of high-volatile coals to obtain the acceptable coking coal blend.

The currently projected specifications of the final coal product are:

Ash content (db)	9.5%
Volatile matter (db)	19-21%
Free swelling index	6 1/2
Sulphur content (db)	0.6%
Plant recovery	60-65%

The coking capacity improves considerably when including a greater quantity of coal from seams numbered # 11 and up. As can be seen from Figure 3 (Appendix C, Section 1.3), the product has a lower ash content, a higher free swelling index and a greater fluidity. The test results obtained to date indicate that mining schemes can be developed which allow production of a coking coal blend that meets the requirements of the Canadian and European users.

1.4 Mining Plans

1.4.1 Basic Open Pit Mining Concept

The most favourable location for open pit mining is the east limb of the syncline. In this area, the coal is distributed over approximately 20 seam groups comprising 40 to 60 splits, which dip to the west at about 38^{o}. The present mining concept proposes to include 18 minable seam groups with up to 50 splits.

Studies made in 1971 proposed to mine this coal with draglines along the seam strike. However, the Elco mine studies indicate that quality control and blending of all seams is essential to produce a blend of satisfactory coking quality. An appropriate blend cannot be obtained with a standard dragline operation.

To date, the Elco studies have produced two mining plans for the same general area. The first plan proposed to mine more of the higher-volatile seams to the west by excavating seams 2 to 19 or 21 from Sta. 375 south to Sta. 175, to a depth of about 160 m below the valley bottom. This mining plan, designated Alternative A, produced the best coking capacity coal obtainable from the deposit. The geological information available for the formulation of the plan indicated that the problems attending the recovery of many thin members, the deep till in the initial mining area, the overall mining/overburden ratio, and the necessity to divert the Elk River via a tunnel during mining operations had an unacceptable effect on project economics; other alternatives were therefore evolved.

Alternate B investigated mining from south to north, but found this to be unfeasible.

Alternate C, shown on Figures 1 and 2 (Appendix C, Section 1.4) mines from Sta. 340 south to Sta. 175, and far enough west to recover only seam 13 at the pit base and coal from the pit slope up to seam 17 or 18. This plan avoids the tunnel diversion of the Elk River, lowers the stripping ratio, and reduces the glacial till overburden problem in the north; it produces the minimally acceptable blend quality. During the initial years, however, the product will be below the average quality. The year-to-year variations in the mined coal and in the relative contribution to the product by individual seams could result in below average quality also at other times.

The concept of Alternate C is being further refined at the present time to improve the coal blend quality as well as the project economics. Pit limits are being modified and supplementary mining areas identified. Placement of a small dragline on the pit bottom allows trenching ahead of the backfilling, thus obtaining additional coal at lower overburden ratio. However, the blend quality would be reduced, since a higher percentage of low-volatile and poor coking quality seams would be excavated. Mining further westward across another 90 to 120 m might allow the incorporation of a greater proportion of higher-volatile coal at acceptable stripping ratios.

The first results of the 1976-77 drilling program indicate a favourable trend in the higher-volatile seams to the north of Sta. 340, while the lower-volatile seams are less favourable in that area. The higher-volatile seams become thicker with fewer splits, while the lower-volatile become thinner with more splits. The more favourable overburden ratio and cokeability of the seams was found particularly at Sta. 370. Drilling farther to the north is needed to establish the northern limit of the open pit and to clarify the coal quality in this area. Moreover, neither seam correlation and dip nor the presence of faults in this area are satisfactorily determined. Thus, the exact conditions, stripping ratio, etc. are not yet definite, but appear encouraging.

This coal with excess coking capacity located north of Sta. 340 is needed particularly to blend with the low-volatile coal with deficient coking capacity. The latter must be mined initially from the higher slope of Little Weary Ridge ahead of the advance of the valley floor box cut; this box cut cannot advance southward until the high slope mining above it is completed.

Farther south, some low ratio pit bottom coal is available, but as the percentage of low-volatile coal from Little Weary Ridge increases, some additional higher-volatile coal must be taken from the west side of the pit limit shown for Alternate C (Appendix C, Section 1.4 - Figure 2).

At the present time, it seems therefore that the cokeability, and possibly the stripping ratio, can be improved further by modifying the mine boundaries shown for Alternate C. Completion of the 1977 drilling program will allow determination of the final layout of the open pit. Should the northward extension of the favourable trend be confirmed, an additional volume of 17-26 million tonnes of coal might be recovered.

In summary, the current indications are that the recoverable reserves for Alternate C (107 X 10^6 tonnes) may be increased considerably and the product cokeability improved not only during the early years of operation but also later. Figure 3 (Appendix C, Section 1.4) presents several possible modifications of Alternate Plan C.

Apart from the improved total recovery, the inclusion of the coal to the north with the attendant northward move of the pit boundary offers other significant environmental and economic advantages:

- the rate of mining of Little Weary Ridge can be reduced substantially, thus improving the flexibility of the mining scheme;

- the cokeability of the blend might be improved;

- the dilution rock can be reduced due to the greater thickness of the higher-volatile seams in that area;

- the size of the outside dumps can be reduced by avoiding inclusion of part of the lower slopes of Little Weary Ridge during the initial years;

- the waste haul across the valley can be reduced.

1.4.2 Preliminary Mine Planning

As discussed previously, the Elk River Coal deposit presents a unique mining problem because the selected 18 seam groups, comprising about 50 minable members, dip at 38^{0} - 40^{0} and vary in quality from very deficient to excessive cokeability with substantial variation in other properties as well. Factors which must be considered in the design of the Elk River coal mine are:

- quality;

- the circumstance that much of the high-volatile coal required for an acceptable blend lies under the Elk River;

- the operational problems attending the separation of the many thin coal members from associated partings;

- the relatively high dilution resulting from mining so many thin members and the dilution effect on preparation plant recovery;

- the circumstance that the mandatory concurrent mining of the many thin seams and splits requires the opening up of a large working face;

- the circumstance that the frequent changes from rock to coal across each mining bench require a high amount of equipment moving; as many as 100 coal and overburden members will be excavated across the strike over a width of 600 m.

- the 40^0 incline of thin seams which requires special mining techniques and equipment to obtain acceptable coal recovery with minimum dilution;

- the objective of backfilling with a minimum lift for waste rock;

- the circumstance that material from the slope of Little Weary Ridge must be removed in advance of the valley floor mining;

- the necessity to utilize a mining method that extracts all seams in their desired relative proportions, yet with the shortest possible cycle to minimize the size of the blending bed.

The preliminary mining scheme developed to date proposes a total of sixteen benches operated simultaneously, half above (Little Weary Ridge Pit) and half below the valley floor (Valley Bottom Pit).

A mining method has been chosen which exposes all the seams on benches of sufficient size to yield the required annual production in an efficient manner, as shown on Figure 1 (Appendix C, Section 1.4). In the valley bottom pit, eight 15 m benches, each 150 m wide, are proposed to be mined in two 7.5 m lifts.

The open box cut would move southward at a little over 200 m per year. During the initial development of the box cut, waste must be placed outside the pit. During this period, which lasts about 7 years, the top 250 m of Little Weary Ridge must also be moved to outside dumps in the Weary Creek Valley and in the north. Waste produced after the initial pit development, however, will be used to backfill the open pit.

The working face of each bench of the lower eight will advance across the strike at a distance of about 75 m in front of the next lower bench. Crossing one quarter of each bench will produce one cycle through all of the coal seams. The maximum size of the blending pile would be one that accommodates one cycle in one blend. Studies are in progress to determine whether an acceptable quality of blend should be produced from a full cycle or can be obtained from less.

The blending pile layout shown in Figure 2 (Appendix C, Section 1.4) is an example. It is based on piling by seam group for the purpose of feeding the plant by group. At the present time, it appears more favourable to blend from the individual seams rather than from groups with similar properties. Another blending method might be more suitable. Various methods are now under review, and since the detailed analysis of blending schemes has only just commenced, the details of the proposed system cannot be presented at this time.

Due to the special mining conditions, five to six front end loaders of 20 to 24 m^3 capacity will be used for the overburden. In addition, it may prove cost-effective to use two or three electric shovels of 20 to 25 m^3 size for the largest overburden members, notwithstanding the unusually high equipment moving time with attendant idle truck time. The smaller partings and most of the coal will be loaded with hydraulic shovels. This equipment can reach all the coal from the bench level and can dig accurately on any required dip. Thus, coal dozing will be eliminated thereby reducing coal losses, dilution and degradation. Overburden is currently envisaged to be hauled by 150 tonne rear dump trucks and coal by 130 tonne bottom dump trucks.

Drill selection is under consideration because of the many benches and shallow holes. The large percentage of inclined holes required to break the inclined toe of each parting requires suitable inclined-hole capability. The ideal type of drill for the job is not available. The shallow benches will not permit using holes larger than 10-5/8" to advantage. The thinner partings will be drilled by inclined holes using smaller percussion drills of 3-5" size.

It is probable that a walking dragline will be selected to trench the larger seams in the pit bottom. In order to match the blending effort by the truck and shovel fleet, the dragline will have to mine each 150 m section across the pit bottom in 8-19 m segments along the strike, thus requiring much movement.

The Elk River pits can be designed so that placement of most of the waste material in lifts is economically feasible. About 75% of the material from between 150 and 240 m above the pit bottom, however, will be placed in a 75 m lift as the top layer of backfill in the mined out area. Selectively handled overburden will be placed in separate lifts. The major portion of each terrace in the Weary Creek Valley also will be placed in one deep lift. Should stability concerns require modifications of this procedure, these will be made following completion of geotechnical studies.

Figure 6 (Appendix C, Section 1.4) shows the annual movement volumes of overburden and coal, for the Alternate Plan C on the basis of 1971 drilling data. Additional data obtained in the period 1976-1977 will probably change the Alternate C pit limits. Substantial changes should be anticipated therefore in Figure 6 (Appendix C, Section 1.4).

1.4.3 Drainage Relocation

The plans for the Alternate C mining scheme (Appendix C, Section 1.4 - Figures 1 and 2) show the proposed two-staged diversion of Weary Creek, and the interception of various small streams near waste dumps. Swamps and ponds on the valley floor are proposed to be drained well ahead of the mining. A small lake of about 40 ha is proposed to be created to compensate the loss of water areas to the mining operation. All mine and waste dump runoff is proposed to be passed through settling ponds to protect the quality of downstream water courses. The final portion of the mined-out area would not be backfilled but become a lake. The ultimate location of this lake depends on the ultimate southern limit of the Valley Bottom Pit.

Substantial volumes of groundwater are expected to be intercepted in the valley floor at the north end of the pit and to a lesser extent along the sides. Geotechnical studies are underway to define these conditions and to arrive at satisfactory solutions.

1.4.4 Elk River Diversion

To the extent that mining alternatives have been formulated to date, it was concluded that no feasible mine plan can be formulated without requiring some measure of diversion of the Elk River. Since the valley floor is wide and flat along most of the length of the proposed open pit, there is considerable latitude for the design of a landscape in which such diversions as are unavoidable can be placed. Careful design of the channel and proper attention to the landscaping and vegetation grouping on the banks can ensure that the scenery near the diverted river sections takes on an almost natural appearance.

A definite location for the river diversions will not be proposed at this time. The proposed location for Alternate C as presented in Appendix C (Section 1.4 - Figures 1, 2 and 3) is an example only.

Through most of the required diversion length, the present river would be located somewhere in the flat valley to the west of its present course; in some places it can probably remain in its present channel. Geotechnical studies are underway to establish the most suitable subsurface conditions as these will be an important consideration for the final channel route proposal.

The northern limit of unavoidable river diversion will depend upon the northward extent of the economic mining limit of the coal reserves. It seems probable that north of station 340, the base of the pit will not extend west of seam 13. Therefore, by removing a shallow slice only from the hillspur, which projects locally into the valley, the river could be moved westward sufficiently to create space for the pit.

Between the river and the mine there would be the moderately sloping river bank, a berm between the river and the pit drainage collection channel, and then a mine access road at the pit crest. A tentative cross-section would look as shown in Figure 5 (Appendix C, Section 1.4).

From about Station 340 southward, the river could be meandered if desired and geotechnically feasible, to maintain gradients similar to those now existing naturally. The more meanders are created and the more closely the original gradient is followed, however, the more material will have to be excavated and the more land disturbed.

A tentative profile of the diversion channel for Alternate C is shown in Figure 7 (Appendix C, Section 1.4). This profile contains a 700 m section of channel on a 2.0% grade, which is 0.5% steeper than currently occurring in the natural channel nearby. This design allows the creation of slack water from Sta. 88 to 122. The slack water area will eventually fill with sediment, and the river is expected to create a natural channel pattern within the original pond bank limits. By eliminating the pond and constructing a channel 50% deeper and 40% wider, however, the 2% gradient can be reduced to 1.1% between Sta. 120 and 148.

Feasibility studies will assess geotechnical, hydrological and terrestrial and aquatic environmental factors to formulate a channel configuration compatible with the final pit and plant locations, that also presents the best trade-off between environmental protection, optimal pit layout, and cost-effective plant locations.

1.4.5 Reclamation

As stated previously the Elk River pits can be designed so that most of the waste material can be economically placed in lifts. Backfill will be placed in the mined-out pits in 17 m lifts. The initial outside dumps at the north end of the project will also be placed in shallow lifts.

The Valley Bottom Pit is different from most open pit mines, because of the valley bottom location. Therefore, material lifted out from a lower level is most economically placed in lifts from dump bottom upwards, thus eliminating the problems of steep, moving and unstable dumps that have sometimes been observed in other mines. Furthermore, depending on the ultimate limits, from 38 to 54 million m^3 of glacial till, topsoil and muskeg will be excavated and placed in proper sequence as a non-rock cover over the waste dumps. This abundance of soil is in marked contrast to conditions existing in many high level rock mines where little is available. Figure 8 (Appendix C, Section 1.4) shows the backfill and dump placement sequence for the Valley Bottom Pit.

1.5 Coal Preparation Plant

The Elk River Coal Preparation Plant will be designed to produce a total of 3.6 X 10^6 tonnes/year of clean coal. Because the product coal is to be used for metallurgical coke preparation, heavy media cleaning circuits are proposed to be employed; in this manner, optimum recovery of coal meeting the product impurity (ash) specification is achieved. Despite the large blending facilities, significant variations are nevertheless expected in the run of mine coal. To accommodate these, the specific gravity of separation must also be varied; in Western Canada, the most flexible and well-proven system is the heavy media circuit.

A heavy media circuit employs a water suspension of fine magnetite to separate rock or high-ash coal from pure coal. The suspension density is controlled to permit the lighter coal to float, and the waste to sink. The circuit schematic is shown in Chart 1 (Appendix C, Section 1.5) and incorporates the following major components:

- a heavy medium vessel, to separate coarse clean coal;
- heavy medium cyclones, to separate finer clean coal;
- two stage, water-only cyclones/froth flotation cells, to separate and recover the very fine coal.

Screens, filters and centrifuges will be utilized as well, to separate size fractions and remove water from the various streams. The partially dewatered coal will be dried in a fluidized thermal dryer, and then stored in large silos prior to loading into unit trains for shipment. This basic type of plant is similar to that currently used by Fording River Coal and Kaiser Resources.

Coarse rejects will be disposed of in the mined-out areas, and fine refuse will be thickened and pumped to a settling pond.

Significant quantities of water are utilized in a circuit of this nature and fresh make-up water is required to maintain the process. This amount is estimated at 3,500 - 3,900 litres per minute. A supply of clarified water will be obtained from the tailings pond, and the make-up is proposed to be obtained from the Elk River. Thus, the plant is proposed to be operated with a closed water circuit. The water losses will be to reject, clean coal, tailings pond percolation, and evaporation from the thermal dryer.

The final plant flowsheet will be drawn up after further testwork and analysis has been completed. Moreover, new developments in gravity-separation and dewatering equipment are under continuous review, and full advantage will be taken of those offering reliable improvements in efficiency and environmental protection.

Studies will be undertaken to analyze the following concepts and components, and determine their applicability to the operation:

- jigs versus heavy medium vessels for the cleaning of coarse coal;
- combinations of centrifuges, filters, thickeners, and tailings ponds for optimum tailings disposition;
- various screen combinations within the plant such as Derrick Screens, Sieve Bends and Vorsivs;
- centrifuges versus disc filters for dewatering clean coal, in conjunction with the thermal dryer;
- dryer design parameters, including pulverizing versus stock systems, and fuel type (gas versus coal);
- various thickener designs, such as Lamella and Enviroclear.

The foundation investigation for the plantsite, ancillary facilities, settling ponds and freshwater intake structures will be carried out during the exploration phase. This will include geotechnical drilling under the major plant buildings and dams; an investigation for suitable fill materials for the raw coal storage area; and a search for concrete aggregates in the area.

During the construction phase a camp will be maintained very near the plantsite. This camp will have full sanitary facilities and a regulation sewage treatment plant that will subsequently treat the sanitary sewage from the operating mine and preparation plant. The plantsite will be adequately drained during construction with sedimentation ponds at suitable locations.

In addition to the closed preparation plant water circuit, other environmentally protective measures were included in the preliminary concept. An emergency dump pond would be located in the vicinity of the thickener, to receive process overflow in case of thickener blockage. This pond would be cleaned out as required. Provision would be made to add water to the raw coal stockpiles, should dust be a problem. An enclosed blending bin could be used for mixing and crushing the raw coal. The refuse could be handled through a bin and trucked and dispersed through the waste dumps. The thermal dryer would be equipped with large diameter primary cyclones and a high energy scrubber, if necessary to meet particulate emission standards. All the conveyors of the plant could be totally enclosed by galleries. A small proportion of wet coal could be made to bypass the dryer and be laid on top of the dried coal in the product conveyor to prevent dusting there. A latex or oil emulsion car topping could be sprayed on railway cars to eliminate dust losses during transportation. Control rooms and vacuum pumps in the plant could be enclosed to minimize noise in working areas.

Adequate offices, washhouse, canteen, warehouse, maintenance facilities, and mechanical and electrical training facilities will be located in the general area. A proposed laboratory for coal testing could also be equipped and staffed with personnel to handle the envrionmental monitoring and control functions. Waste oil from the machinery is proposed to be containerized and sold, or otherwise disposed of in an environmentally acceptable manner.

1.6 Transportation and Utilities

1.6.1 Railway

In 1971, a railway route from the minesite through the Elk Valley, connecting to the Fording Branch Railway about 6.4 km north of Sparwood, was evaluated. This route was modified in 1975 by moving the section through the town of Elkford to the east side of the townsite; by relocating the route elsewhere to eliminate a large number of road crossings; by placing the proposed new highway and railway in a common corridor; and by reducing adverse grade summits and excessive excavation volumes.

During the past few years, the valley north of Sparwood has become more developed and the town of Elkford has grown.

Therefore, in 1976, the railway study was expanded to look at all possible routes in light of the altered circumstances. Seven routes were examined in the fall of 1976. Three routes requiring tunnels connecting to the Fording Branch Railway were soon abandoned as too costly and difficult to construct and maintain. A modification of the Tunnel routes to eliminate the Tunnel was still much more expensive, barely within design parameters, and presented severe operating and maintenance problems.

Three routes remained, which promised more favourable costs, but one of these, along the east side of the Elk River opposite and south of Elkford, encountered highly unstable, water saturated slide conditions, and was rejected because of severe construction and maintenance problems, and anticipated service interruptions.

Therefore, of the seven routes investigated in 1976, only two remain as shown on Maps 12 and 12a (Appendix A). They are:

a) Westside Route

b) Boivin Pass Route

The Westside route now utilizes about 16 km of the existing Fording Branch Railway; it now avoids the small ranches on the west side of the Elk River north of Sparwood. The improved Westside route is 61 km long. To avoid the east bank instability, the route must pass along the west bank of the Elk River on the eastern edge of Elkford. This route has favourable railway grades and the most stable soil conditions. It offers the lowest capital costs and the lowest cost per tonne for coal transport.

The Boivin Pass route is 47 km long and utilizes about 35 km of the Fording Branch Railway. From its junction with the Fording Railway, this route makes use of the pass between the Fording River Valley and the Elk Valley where the private highway to Fording Coal is located, crossing both this road and the river near the railway junction. The first 6.4 km ascend on a very modest grade, before descending 16 km on a - 0.7% grade northward along the steep eastern slope of the Elk River Valley to the valley floor. The route then crosses the Elk River and climbs on moderate grades to the Elk River Coal mine.

The major advantage offered by the Boivin Pass Route is that it requires the least new railway construction. The disadvantages of the route are:

- 16 km of adverse loaded grade which increases haulage costs;
- 16 km of expensive construction on the steep eastern slope of the Elk River Valley, where some unstable slope conditions exist, with corresponding risks to the railway;
- a deep ravine on the mountain side at km post 11 requires an expensive crossing if a bridge is necessary. However, unavoidable surplus mountain side excavation volumes would be sufficient to fill the ravine;
- unit excavation costs will be higher on the steep portion of this route.

Despite the risks and higher construction and operating costs, Elco realizes that problems are associated with a railway through the perimeter of the town of Elkford, and is therefore prepared to seriously consider and investigate the Boivin Pass Route as its preferred alternative. However, should severe problems be identified through this investigation, Elco may have to consider the westside route with the objective of determining ways to reduce conflict with Elkford to the minimum possible.

1.6.2 Port Facilities

Three alternatives in the Vancouver area are under consideration. At this date it is premature to comment on any details.

1.6.3 Highway

A gravelled forestry road provides access from Elkford to the minesite. In 1975, a highway route was laid out to highway standards from Elkford to the minesite on 1" = 1000' scale maps. This route has a maximum horizontal curvature of 3^{o} and only occasional short sections of grade reaching 4% to 6%. Much of the route follows parallel and adjacent to the Westside railway route. The highway route can be easily constructed with modest excavation volumes and no serious problems are anticipated. Maps 12 and 12a (Appendix A) show the proposed railway and highway route alternatives.

1.6.4 Electrical Power Supply

The Kan-Elk powerline presently passes through the minesite and will require re-routing. The amount of power required is under study at the present time. The main power requirements are for the preparation plant, the maintenance facilities and the townsite. The mine will have a relatively lower power consumption since a major part of the material will be moved by diesel powered equipment.

1.6.5 Natural Gas Pipeline

At present, the Columbia Natural Gas Company system between the Natal area and Elkford consists of a 20.3 cm line from Natal to Line Creek and a 15.2 cm line from Line Creek to Elkford. To handle an estimated 10×10^6 scf/d of natural gas required for the coal dryer and other uses, it will be necessary to loop the existing 15.2 cm section of line some 16 km in length, and install a new 20.3 cm line from Elkford to the minesite 45 km away. Pressure at the sales tap at Michel is adequate to supply existing requirements and still meet the mine requirements if the mentioned lines are installed. It has yet to be determined whether additional looping is required to serve the community development that will house project personnel.

2.0 DESCRIPTION OF EXISTING CONDITIONS

2.1 Climate

The project area is located in the Mountainous Subsection of the Southeast Climatic Region of British Columbia, and experiences a mean daily temperature of less than 13^{0}C in July, and less than -7^{0}C in January. Frost-free days in the upper portion of the valley range from less than 50 to a maximum of 100 days. Precipitation is high during the winter, with a secondary peak occurring in the spring; summer precipitation is relatively low and is characterized by frequent thunderstorms (British Columbia Natural Resources Conference, 1956). Climatic data of the upper Elk River Valley are very general in nature since there is no permanent weather observation station in the area.

Data from six snow courses in the East Kootenay drainage basin are shown in Figure 1 (Appendix C, Section 2.1). The snow course closest to and best approximating conditions within the licence area is located 2-1/2 km southwest of Upper Elk Lake, 14 km northwest of the licence area at an elevation of 1750 m. Here the average accumulated snow depth in March, the month of maximum snow depth, is 36.5 cm (Water Investigations Branch, B.C. Department of Lands, Forests and Water Resources). Snowfall data from the upper Elk River (Elkford), Mount Assiniboine, Fernie, New Fernie and Morrissey Ridge (Appendix C, Section 2.1 - Figure 1) provide additional information for elevations within the range of those of the project area.

In view of the dearth of site-specific climatic data, reference will be made only to generally prevailing mountain valley climatic circumstances. High elevations, at and above timberline, experience lower mean annual temperatures, higher precipitation, lower potential evaporation, and higher available moisture. Wind is a major limiting parameter for vegetation and wildlife. At night, valley bottoms commonly harbour subsiding cool air which tends to form temperature inversions. Consequently, frost-free days are less frequent and the growing season may be shorter than at a slightly higher elevation.

2.2 Surface Water

2.2.1 Drainage Basin Description

The Elk River originates in the glacier-fed upper and lower Elk Lakes (115^{0} 06', 50^{0} 35') (Photo 2). It is predominantly a graded, meandering stream showing some evidence of degrading or aggrading tendencies depending on local geology or local changes in the transport load. It meanders southeasterly across a brush-covered valley floor about 0.75 km wide for about 16 km upstream of the Cadorna Creek confluence (north of the minesite). From there to Aldridge Creek, a distance of 8 km, the river gradient is steeper and the channel relatively straight. From Aldridge Creek to Round Prairie the valley is wider, the river meanders and contains occasional log jams and boggy stretches. From Round Prairie to the confluence with the Fording River the flow velocity is higher and streamside vegetation is mainly trees with lighter underbrush (B.C. Department of Environment, 1976). The stream continues southward to Natal, then turns and flows southwest to join the Kootenay River about 16 km from the Canada-United States border.

Cadorna Creek (Drainage Basin B on Map 5), the major tributary of the Elk River upstream from the minesite, originates near Mount Cadorna and flows southeasterly joining the Elk River in the northern portion of the licence area. Within the licence area, downstream from the Cadorna Creek confluence, the Elk River has four main tributaries - Gardner, Weary, Bleasdell and Aldridge. Small streams, most of which are intermittent, occur between these well defined tributaries. Discharge data for each of the watercourses are tabulated in Figure 4 (Appendix C, Section 2.2).

Within the minesite, the Elk River is a high velocity stream, while upstream (above Station EL 46.5) and downstream from the minesite (below the Weary Creek confluence) the stream gradient and flow velocity are much lower. In general, the channel tends to be influenced by the underlying geologic structure, as numerous stretches parallel the bedding strike.

In the vicinity of the Cadorna confluence, the valley floor is constricted to about 600 m but widens to about 1200 m near the Gardner Creek confluence. In this reach, the banks of the Elk River are low, and during high water the stream may overflow (Photo 3). In the vicinity of the Forestry Road Bridge (Station EL 43.0) the valley is also broad, but the river has eroded a narrow channel through the glacial till to bedrock creating banks of 8 to 16 m and leaving very minimal floodplain (Photo 4). Downstream from Weary Creek, the floodplain once more becomes broader, often exceeding 350 m (Appendix A - Map 2). In low gradient reaches, there is evidence of old channels and cutoffs, and oxbow lakes are present.

The drainage off the west flank of the valley (Photo 5) is collected by six principal channels. The southern four combine to form Gardner Creek. The two northern streams, which are unnamed, maintain separate channels. The gradients of the upper reaches of these streams are steep. The lower reaches have low gradients; Gardner Creek has a large beaver pond and muskeg area of about 225 ha along its lower course (Photo 6).

Weary Creek (Photos 7 and 8) originates behind Little Weary Ridge and collects all the runoff from the southwest side of Mt. Bishop, the west side of Mt. McPhail, the northwest side of Mt. Muir and the north side of Weary Ridge. The upper reaches of Weary Creek are steep but contain a large number of pools created by the logs and debris that entered the stream from burned-off hillsides.

Only minor rills and gullies have developed on the slopes of Little Weary Ridge. The eastern flank of the valley to the north of Little Weary Ridge, where valley walls extend to much higher elevations, is deeply dissected by a number of seasonal streams. Runoff from these slopes maintains the water level of beaver ponds and muskeg areas along the Elk River Valley floor.

2.2.2 Hydrologic Regime

The Water Survey of Canada has calculated the discharge rate of the Elk River, upstream from the Fording River confluence (about 72.4 km downstream from the minesite) to range from a low of 3.14 m^3/s to a high of 68.53 m^3/s in 1971 and a low of 4.11 m^3/s to a high of 100.24 m^3/s in 1972. The peaks for both years occurred in early June; the lows occurred in February and March.

During 1972, B.C. Research determined the discharge rates of the Elk River at the Upper Bridge and the Forestry Bridge and of all the tributaries within the licence area. The method used was timing a floating object through a measured reach.

The discharge rates recorded by B.C. Research (Appendix C, Section 2.2 - Figure 2) indicate a marked difference between high water and low water. The difference in the discharge rates, tabulated below, record an important contribution from other sources, and can only be explained as contributions from the intermittent streams located within the drainage basins C, D and E (Appendix A - Map 5) and groundwater.

	July HWF m^3/s	August m^3/s	September LWF m^3/s
Elk River (Upper Bridge)	8.75	8.30	1.61
Cadorna Creek	11.86	10.48	4.30
Gardner Creek	0.79	0.28	0.14
Sum Discharge	21.40	19.06	6.05
Elk River at the Forestry Bridge	30.72	16.99	8.50
Difference	9.31	2.07	2.44

The Weary, Bleasdell and Aldridge channels have discharge characteristics similar to the Elk River upstream from Cadorna Creek (Appendix C, Section 2.2 - Figure 2). The data suggest that the catchment above the Forestry Bridge contributes about two-thirds of the discharge recorded above the Fording River confluence.

Techman Ltd. determined the discharge at four locations along the Elk River and its tributaries during the early summer, fall and winter of 1976 (Appendix A - Map 10; Appendix C, Section 2.2 - Figure 4). The depth and velocity were determined at several points across the stream channel and the discharge for each location was calculated by the mid-section method (U.S. Department of the Interior, 1967, p. 127).

Four stations were established on the Elk River - two stations upstream from the minesite (EL 47.5 and EL 46.5), one within the minesite area (EL 43.0), and one downstream from the minesite (EL 40.0). The discharge rates of the major streams within the licence area and all the streams to be affected by the mining development are summarized in Figures 3 and 4 (Appendix C, Section 2.2). The data indicate:

1. Cadorna Creek carries more water than the upper reaches of the Elk River.

2. During the summer, there appears to be a markedly larger discharge at the Forestry Bridge (EL 43.0) than at the station upstream from the minesite (EL 46.5). This confirms the B.C. Research finding (Appendix C, Section 2.2 - Figure 2). The discharge rates measured on December 3, 1976, indicate a smaller discharge at the Forestry Bridge than at EL 46.5. Continuing data collection might clarify the apparent discrepancy.

3. The discharge at the Forestry Bridge (Station EL 43.0) probably exceeds a HWF of 30 m^3/s; the LWF might in effect be less than 1 m^3/s. Present data are inadequate to allow a more definitive statement.

The discharge rates of the intermittent streams draining the northwest end of Little Weary Ridge were determined in May, 1976; the total was found to be 0.06 m^3/s. During the autumn and winter none of these streams were flowing.

The sediment discharge (Appendix C, Section 2.2 - Figure 2) of the Elk River at the upper Bridge, upstream from the Cadorna Creek confluence, ranged from 15.6 g/s in July to less than 2.3 g/s in September (B.C. Research, 1974c). The largest proportion of this was suspended sediment. The Cadorna Creek sediment discharge for August was greater than the Elk River and was mostly bedload. During September however, the suspended sediment in Cadorna Creek was almost double that of the Elk River. The suspended sediment of the Elk River at the Forestry Bridge, downstream from the Gardner Creek confluence, was greater than the sum of the suspended sediment in the Elk River and Cadorna Creek, indicating there may be a significant contribution of suspended solids from the C and D drainage basins (Appendix A - Map 5).

B.C. Research (Appendix C, Section 2.2 - Figure 2) reported 65% of the banks of the Elk River in the licence area are stable. Those banks which are unstable consist of glacial tills, which are susceptible to erosion (Appendix C, Section 2.2 - Figure 2; Photo 4).

2.2.3 Water Quality

Since 1972 there has been considerable data gathered on the water quality of the Elk River in the vicinity of the minesite. The B.C. Pollution Control Branch reported on samples collected upstream and downstream from the minesite during 1972 as well as on additional samples collected from the downstream station during 1973 and 1974 (B.C. Research (1974c)). B.C. Research, under Emkay-Scurry contract, collected water samples from the Elk River and its tributaries in the vicinity of the minesite during the summer and autumn of 1972. Techman Ltd., under an Elco Mining contract, collected water samples from the Elk River and its tributaries in the vicinity of the minesite during May, October and November, 1976. The data collected are summarized in Figures 5, 6, 7, 8, 9 and 10 (Appendix C, Section 2.2).

According to the B.C. Department of Environment (1976, Page 47), interpretation of the data collected by B.C. Research and the B.C. Government indicates that the Elk River upstream from the Cadorna Creek confluence and Cadorna Creek has a lower pH, specific conductance, and total carbon than the downstream stations or any of the tributaries of the Elk River. They consider this difference to be explainable from source variations, the upper reaches being fed by glacier and snow melt while the lower reaches receive a considerable amount of runoff. Furthermore, they state the alkalinity of the Elk River upstream from the minesite is low (B.C. Research, 1974c, Tables 5, 6 and 7, reports alkalinity ranges from 78-106 mg $CaCO_3$/1), therefore offering only limited acid buffering capacity.

Data collected by Techman do not confirm these findings. More sampling is required before conclusions can be drawn. The data (Appendix C, Section 2.2 - Figure 8) indicate that Cadorna Creek exerts a major influence on water chemistry of the Elk River. There is also a strong indication of significant groundwater discharge to the Elk River.

The river's tendency to undermine the till banks downstream from the Forestry Bridge (Photo 4) and deposit the material in the calmer reaches, downstream from the Weary Creek confluence, contributes to the increase in suspended solids at locations downstream from the minesite.

Chemical analysis of the water samples (Appendix C, Section 2.2 - Figures 8 and 9) indicates that mercury and lead are the only heavy metals present in detectable quantities. However sediment samples (Appendix C, Section 2.2 - Figure 10) collected downstream from the minesite contained other heavy metals in detectable concentrations.

In order to establish a better statistical mean on existing water quality, three samples will be collected during January, April, June, July, August and October 1977 from at least three stations on the Elk River - two upstream and one downstream from the minesite (EL 47.5, EL 46.5 and EL 42.0) in addition to critical tributaries. The parameters recommended by B.C. Department of the Environment (1976) will be determined on all water samples in addition to analysis for heavy metals.

During the 1977 Water Quality Program, samples of groundwater will be collected from natural discharges (springs and seeps) in addition to mine adits and trenches in order to obtain a better indication of chemical constituents in the groundwater.

2.2.4 Water Use and Waste Water Discharge

At present there is very little use of the water of the upper Elk River. The licence area does not contain any permanent residents, but one hunting camp, located about 1.5 km downstream from the Cadorna confluence (Photo 9), operates during the summer and fall, with the maximum number of hunters being lodged in late fall.

Elco's exploration camp, near Station WE 0.5, south of Weary Creek extracts 9,080 liters/day from Weary Creek. Waste water from the camp kitchen and washrooms is discharged to a septic tank (capacity 48,900 l) which in turn drains into a disposal field.

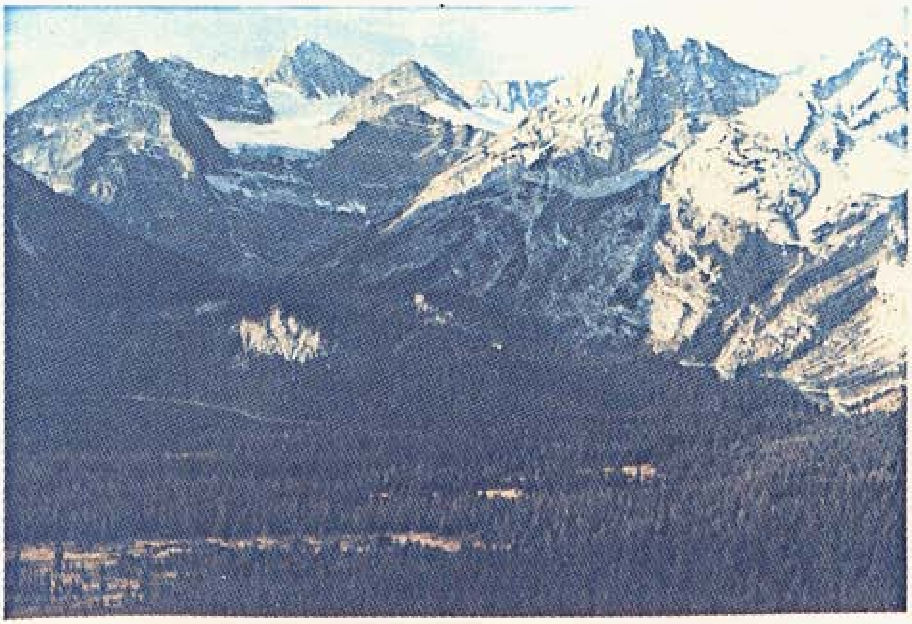


PHOTO 2: Elk Lakes - October, 1974

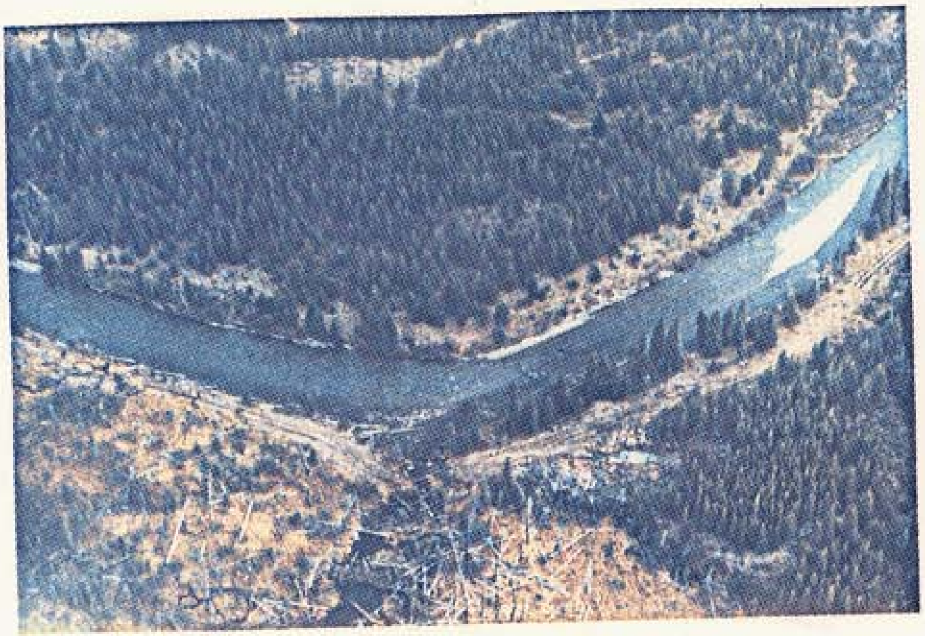


PHOTO 3:
Elk River at Gardner Creek - October, 1974.

PHOTO 4:
Elk River looking south from Forest Service Bridge - October, 1974.

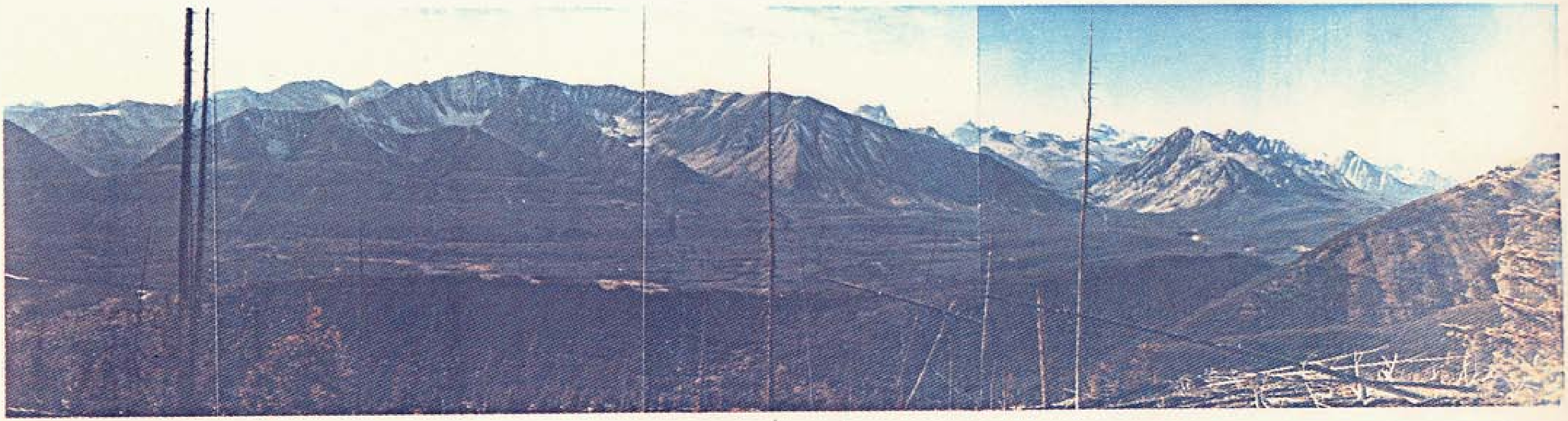


PHOTO 5: Northwest view of Elk Valley at minesite - October, 1976

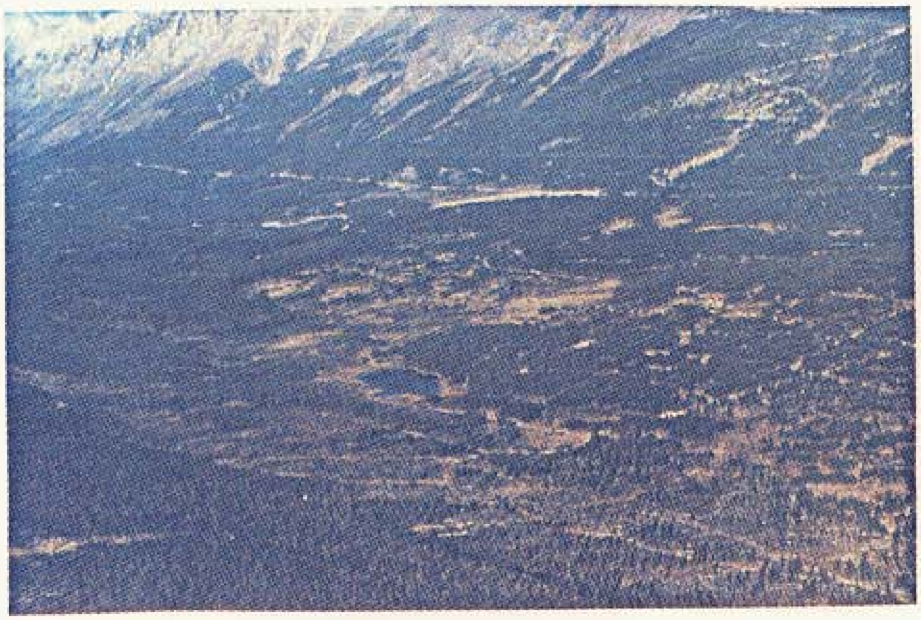


PHOTO: 6:
Muskeg and beaver pond area at the proposed "clear water lake" site - October, 1974.

PHOTO 7:
Weary Creek at the proposed dump site - October, 1974.

PHOTO 8:
Weary Creek at road crossing - October, 1974.

PHOTO 9:
Hunting and fishing guide facilities at the north end of proposed open pit site - October, 1974.

2.3 Groundwater

A preliminary assessment of groundwater conditions within the project area was carried out by Golder, Brawner and Associates Ltd. in conjunction with a slope stability study prepared in September, 1971. The groundwater portion of that investigation included measurements of groundwater levels in exploratory drill holes and installation of piezometers in selected drill holes. The groundwater table was reported to lie within 61 m of the ground surface of the valley slope and near the ground surface of the valley bottom. Artesian conditions were indicated by water flowing from exploratory drill holes and readings taken from the piezometers installed at depth.

The sandstone and siltstone beds were judged to be more permeable at depth than the coal seams. The permeability within the sandstone is controlled by the jointing within the rock. The less permeable coal seams dipping parallel to the surface slope act as a water barrier causing high groundwater pressure at depth within the slope. Estimates indicate that the permeability of the sandstones parallel to the seams is an order of magnitude larger than normal to the seams.

The analysis of the data collected during the 1971 groundwater study indicates that Weary Creek and its associated tributaries may be significant controllers of groundwater conditions within Little Weary Ridge, particularly once mining operations proceed below the existing Elk River Valley. On a subregional basis, the Weary Creek catchment seems to act as an upstream control of the groundwater table. Next to local precipitation, the recharge from the Weary Creek system might control the drawdown pattern established during excavation.

Little information is presently available on aquifers and existing groundwater tables in the overburden materials. Data produced by the current exploration program indicate that overburden depths are generally 20 to 25 m and locally more than 35 m. In some drill holes, the overburden materials are predominately dense, dry, glacial tills with some interbedded coarse granular sand and gravel. Should these coarse granular deposits prove to be beds rather than pockets, they could act as water-bearing conduits within the overburden.

Many of the muskeg areas, which dot the valley floor in the vicinity of the minesite, are considered to be groundwater discharge areas. The hydrological and water quality data and the recorded water temperature differences for the Elk River indicate moreover, that this stream receives a considerable amount of groundwater while passing through the licence area.

Detailed, long-term groundwater records for the project area are not available. The initial investigations indicate that the available groundwater reserves are not being utilized at the present time.

2.4 Physiography

The project area is located within the Front Ranges of the Rocky Mountains, which consists of a succession of folded overthrust sheets between southwesterly dipping faults. Subsequent erosion of these thrust blocks has produced numerous parallel ranges composed mostly of Upper Devonian and Carboniferous limestones which form 30 to 45 degree dip slopes facing southwest, and steep outcrop slopes facing northeast. Pleistocene glaciation has accentuated the sharpness of the topography of the east and northeast facing scarps.

The Elk River Valley is a broad, U-shaped, north-south trending, glaciated valley flanked by rugged mountains reaching approximately 3000 m above mean sea level. The elevation of the valley floor within the project area is approximately 1560 m above mean sea level. The valley width within the project area ranges from 0.6 km near the Cadorna Creek - Elk River confluence to 1.0 km near the Weary Creek - Elk River confluence.

Recent glaciation has deposited some glacial till (Appendix A - Map 2) on the valley slopes and thicker deposits (up to 43 m deep) in the valley bottom. The till (Photo 10) is an impervious assortment of angular rock fragments, in a dense clay matrix, interbedded and underlain by pervious water-bearing glacial outwash deposits.

Prominent landscape features in the area include the alluvial fans of several tributary creeks and terraces on the valley bottom south of Aldridge Creek. A rock slide, possibly related to faulting, is located on the west face of Big Weary Ridge, approximately 1.5 km south of Weary Creek (Golder, Brawner and Associates Ltd., 1971).

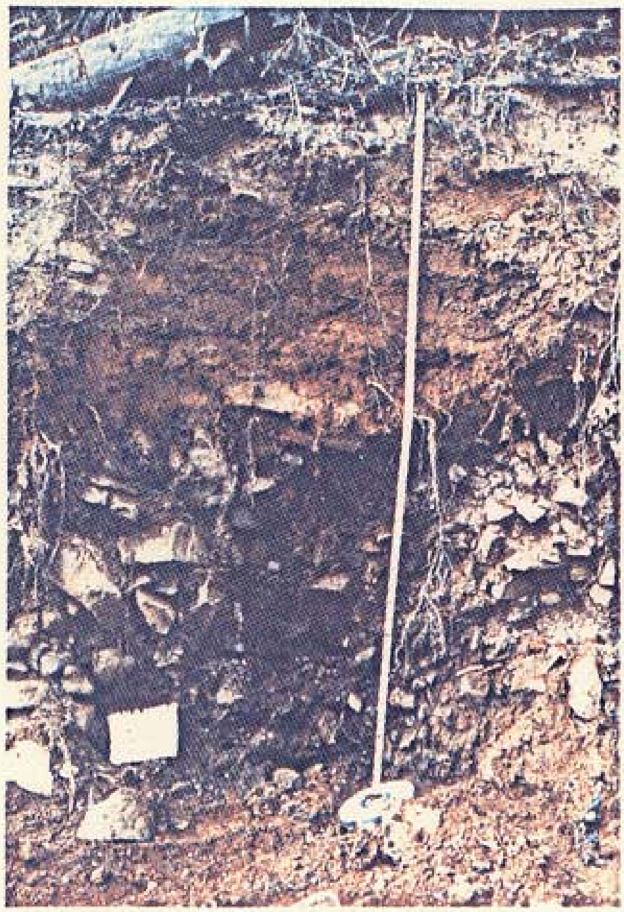


PHOTO 10: Typical glacial till overburden - October, 1976.

2.5 Geology

2.5.1 Structural Geology

The coal seams of the Elk River Valley are a part of the Kootenay Formation which was folded into a northwest trending syncline (Appendix C, Section 2.5 - Figure 1). This syncline is probably the northern extension of the Alexander syncline which can be traced into the Fording River coal mining area and beyond for a distance of 48 km to the south. The syncline is assymetric with beds on the western side folded to near vertical at the surface, while beds exposed along the eastern side of the valley dip westward at 35 to 45^{0}.

The Lewis Thrust may be in the order of 2400 to 3000 m below the Elk River (Dahlstrom et al., 1962). The synclinal structure in the Elk Valley appears to be overridden and truncated along the west flank of the Elk River Valley by a fault which has been designated as the Elk River Thrust. The Kootenay Formation beds exposed on the west side of the valley could have been displaced along this major thrust fault from a distance of approximately 8 km to the west. If such activity occurred it is considered to be west of the proposed open pit mine.

2.5.2 Stratigraphy

The coal bearing strata of the Elk Valley are contained within the Kootenay Formation of Upper Jurassic to Lower Cretaceous age. The Kootenay Formation (Appendix C, Section 2.5 - Figure 2) consists of a massive basal sandstone approximately 60 m thick, a sequence of shale, siltstone and fine grained sandstone with several thick coal seams totaling approximately 600 m thick, and an upper sequence of shales with several thin coals seams approximately 300 m thick.

Immediately overlying the Kootenay Formation, in the center of the syncline, is the Blairmore Formation of Cretaceous age, which consists of a hard pebble conglomerate about 60-90 m thick.

Approximately 490 m of the Kootenay coal measures are mineable. This section contains 20 groups of seams with the number of members over 0.6 m thick varying from 40 to over 60 as seams sometimes split and recombine. Prominent coal seams are persistent laterally, although the detailed lithology between the coal seams is irregular.

2.5.3 Geology of the Proposed Open Pit Area

The average total thickness of all mineable seams in the initial pit is 90 m through seams 2 to 19.

The beds strike generally North 20^{o}W, but with the strike increasing westerly from the south end of the pit to the north end. The dip ranges between 35 to 45^{o}, but is more often 38 to 40^{o}. Strike and dip vary somewhat locally.

Very little folding or faulting has been observed within the Little Weary Ridge area. However, several thrust faults cutting up-section from west to east, with accompanying minor folding, are present in Big Weary Ridge, particularly in the central portion.

A brief description of the coal seam formation is presented in Figure 2 (Appendix C, Section 2.5). The total coal thickness shown for seams over 0.6 m thick are the average of all thicknesses obtained from drill holes and test pits along the proposed mining section.

2.6 Soils

The Canada Land Inventory (Soil Capability for Agriculture Map) classifies the soils of the Elk Valley as mainly Gray Wooded (Luvisol), while the alluvial soils range from Eutric Brunisols to Regosols and Gleysols. North of Sparwood, the best ratings obtained are Classes 4 and 5: both indicating severe limitations that restrict the range of crops, although "improvement practices are feasible".

Soil profile descriptions undertaken by B.C. Research during a preliminary soil survey at selected vegetation macroplot sites are provided in Figure 1 (Appendix C, Section 2.6). The distribution of soil groups within the licence area is generally related to the vegetation communities and habitat types (B.C. Research, 1974a). In the "Coniferous Forest", the "Deciduous and Coniferous Forest" and the forested portions of the "Forest and Shrub" habitat types, the Degraded Eutric Brunisol as described for Plot 1 (Appendix C, Section 2.6 - Figure 1) is the dominant soil subgroup. Organic soils of the Terric Mesisol Subgroup are associated with the "Forest and Shrub" habitat type, Melanic and Degraded Eutric Brunisols with the "Open Forest" habitat type, and the Orthic Regosol subgroup occurs on terraces and fans in various locations on the valley bottom. In the shrub and sedge areas, poor soil permeability and water impoundment by beavers have induced the accumulation of organic material.

2.7 Terrestrial Life

2.7.1 Vegetation

The proposed minesite and minesite to Elkford corridor areas (Appendix A - Map 12) are located within the East Kootenay regional study area (Canada Land Inventory, 1970). Vegetation-related capabilities mapped for the minesite and corridor areas include forestry and moderate big game range. Agricultural and native range capability were not mapped.

The minesite and corridor areas have the characteristic of the Interior Subalpine Forest Region, a typically fragmented forest type (Rowe, 1972), with components of Douglas-fir Montane Forest (for example, the Forsyth Creek drainage area, Appendix A - Map 13).

Mapping of vegetation for the licence area (Appendix A - Map 1) was carried out by B.C. Research (1974a). Vegetation mapping units (cover types) were delineated on the basis of dominant overstory species, composition and maturity. A map of existing vegetation on the minesite based on this work is presented here (Appendix A - Map 8). In general, the plant communities of the licence area also occur to some extent elsewhere in the Valley (B.C. Research, 1974a).

Coniferous forest is dominant in the Elk River Valley on well-drained sites. The most prevalent cover type (842.9 ha) on the minesite is immature lodgepole pine with some immature spruce forest (17.6 ha). Small pockets of mature pine and mature spruce timber, representing survivors of the 1936 forest fire, occur elsewhere in the licence area.

A pine-aspen type (23.0 ha) is found above the valley bottom on the western face of Weary Ridge and further south on the east side of the Elk River Valley. An aspen-pine type is present on the Weary Creek alluvial fan.

An open forest cover type occupies the more steeply sloping portions of the licence area. It comprises mainly open stands of immature pine, and immature pine-spruce, with an abundance of shrub, and shrub-grass communities. This cover type occupies 298.8 ha of the minesite area.

The forest-shrub type, which occupies 352.5 ha of the minesite area, is found on the valley bottom and on poorly drained benches. Characteristic is the abundance of moisture with restricted soil drainage. Typical communities are pine or pine-spruce with willow-sedge or shrub birch-sedge.

The fen or meadow type occupies poorly drained flat or nearly flat areas of the valley bottoms or around beaver ponds (45.9 ha of the minesite area). Representative species include sedges, willows and scrub birch (Photo 6).

The alpine type (15.5 ha) designated is the "snow patch" or "slide" type. Representative communities are fireweed-wild rye and shrub dominated alder-willow.

Plant and community composition data are provided in B.C. Research (1974a) and, as indicated in Section 5.0 of this report, additional information will be collected.

Exploration drilling and trenching, mainly during 1971, (Photo 11) have imparted an open and linear vegetation pattern (Appendix A - Map 2) to the minesite area. Reclamation introduced exotic grasses and clover, including timothy, bearded wheatgrass, fescue, inland bluegrass and white clover, in reclaimed areas (Photo 12). A preliminary evaluation of these reclaimed areas, particularly with respect to forage yield and reclamation planning, is provided in Section 3.8.2.

The vegetation cover patterns of the Elk River Valley reflect natural and human disturbance factors. As a result of a widespread forest fire in 1936, large tracts of immature lodgepole pine, essentially a disturbance or subclimax (seral) vegetation type, predominate in the area. In addition, the forest landscape contains substantial deadfall litter (Photo 4). The combined effects of a uniform and dense forest cover and deadfall, both outcomes of the 1936 fire, and subsequent fire control, have limited ungulate range capability by restricting interspersion of more open vegetation types. Horse trail development, coal exploration, and power transmission and transportation developments have been the principal agents opening up the forest cover, thus improving ungulate carrying capacity.

2.7.2 Wildlife

The Canada Land Inventory Land Capability Analysis for the East Kootenay area (1970) shows strips with "Moderate Big Game Range" capability between the minesite and Elkford, generally located along the Elk River floodplain and at or below 1680 m on the adjacent slopes (Appendix A - Map 4). "Moderate Big Game Range" capability is described as having "slight limitations to the production of ungulates but are important year-round or seasonal use areas". Key wintering areas, or "Prime Big Game Range Capability", which are relatively abundant in the East Kootenay region, do not occur in the upper Elk River Valley above Elkford, however (Appendix A - Map 12).

For waterfowl, the Canada Land Inventory characterizes the upper Elk River Valley as Class 7, which indicates such severe limitations that almost no waterfowl are produced. A Class 6 habitat, with low capability for waterfowl production, occurs halfway between Cadorna and Aldridge Creeks along the Elk River. Seasonal use of this region by waterfowl has been observed.

Field investigations, conducted by B.C. Research (Report No. 4, 1975a) and Techman Ltd. biologists, recorded the following large mammals for the minesite and corridor areas: moose, Rocky Mountain elk, mule deer, white-tailed deer, grizzly bear, American black bear, and cougar. Conservation officers (Campbell and Williams) stated that about 30 bighorn sheep have been using Weary Ridge (Appendix A - Map 11) recently.

Other observed wildlife are: upland game birds - blue grouse, spruce grouse, ruffed grouse, and white-tailed ptarmigan (Photo 13); fur bearers - coyote, lynx, wolverine, mink, beaver, muskrat and red squirrel; small game - snowshoe hare.

A small mammal trapping study program was initiated in the fall of 1976. Preliminary returns indicate the presence of white-footed mouse and red-back vole on Little Weary Ridge, including reclaimed exploration sites (Trapping Area 1, Appendix A - Map 10), and long-tailed vole in the forest and shrub cover type (Trapping Area 2).

A regional British Columbia Fish and Wildlife survey (Demarchi, 1968) summarized big game distribution in the study area. In general, elk herds apparently winter in the riparian habitat along the Elk River; small herds are placed on the various open slopes between Aldridge Creek and Chauncey Creek (Fording River tributary). The south facing slopes above Aldridge Creek possess grassland and open forest range features with significant ungulate capability. A moose winter range is placed along the base of the Greenhills Range (Appendix A - Map 12). Patterson (1969) reported mountain goat sightings on slopes above the minesite.

In order to fully document and evaluate seasonal use and migration patterns of wildlife, and particularly large mammals, field studies were initiated in the spring of 1976. Map 10 (Appendix A) records specific "Observation Lines" used in conjunction with more general observations for minesite area wildlife utilization assessment. The Observation Lines will form the basis for pellet-group and browse plant utilization Transect Lines to be established throughout the study area, pending full evaluation of preliminary studies and consultation with Provincial Government wildlife managers. The Transect Lines will provide information on habitat use and relative use patterns and intensity throughout the Elk River study area and will allow the assessment of environmental effects of the proposed mining project. Preliminary results are summarized in Figure 1 (Appendix C, Section 2.7) and discussed in the following paragraphs. Figure 2 (Appendix C, Section 2.7) summarizes the plant species observed to have been browsed by ungulates.

Observation Lines traversed all cover types in the licence area. Recorded pellet-group and browse utilization observations support the view of B.C. Research (1975a) that resident habitat utilization is predominantly on the flats and lower slopes of the valley, and mainly by moose. Elk use is judged to be mainly transitional: elk tracks were observed along various roads, cutlines and trails, generally unaccompanied by substantial pellet-groups or browsing evidence in adjacent habitats.

With the exception of the forest-shrub cover type, a relatively low level of winter and summer range use by ungulates seems characteristic for the minesite. This is explained with the large areas of pine forest in the area with distinct forage deficiencies. Significantly, the highest concentration of elk pellet-groups observed in the minesite area during the spring 1976 survey, was located on a reclaimed and revegetated exploration site on Little Weary Ridge (Photo 12).

The value of the pine forest as wildlife cover is limited by extensive deadfall in the understory which restricts movement. Consequently, the majority of wildlife movement sign and ungulate sightings occurs on manmade trails.

Observations in the licence area indicate substantial bear habitat capability and use. Both grizzly and black bear sign is common throughout. The ungulate habitat limitations and enhanced bear habitat capability are related. For example, the prevalence of buffalo-berry, the most abundant shrub throughout the minesite area and a non-forage species for ungulates, and the abundance of deadfall containing ants and other insects provide a widespread food supply for bears.

PHOTO 11:
South end of Little Weary Ridge showing exploration disturbance - October, 1974.

PHOTO 12:
Revegetated site, seeded 1971, on Little Weary Ridge - October 1976.

PHOTO 13:
White-tailed ptarmigan -
Upper Weary Creek -
November, 1976.

2.8 Aquatic Life

Considerable information on the aquatic life of the upper Elk River is available from previous studies. These studies include the macroinvertebrate data collected by Hooton et al. (1971), Bull et al. (1972) and B.C. Research (1975b); and the fish creel census conducted by the B.C. Fish and Wildlife Branch in 1971 (Hooton, 1971). Techman Ltd. between October 5-7, 1976, collected macroinvertebrates (using a Surber sampler) and algae (water sample and stone scraping samples) from critical locations in the upper Elk River and critical tributaries.

2.8.1 Algae

The algae data collected by Techman Ltd. (Appendix C, Section 2.8 - Figure 1) indicate that, upstream from the proposed mining area (Station EL 46.5), there is a significant difference between the algae species of the Chlorophyta found near the east side and those found near the west side of the Elk River. The east side supports four species of Chlorophyta, while only one species was found near the west side. Also, Hydrusus foetidus of the Class Chrysophyceae is absent on the east side, but abundant on the west side. Diversity and relative abundance of species of the Bacillariophyceae is identical for both east and west sides. This difference is probably attributable to water quality differences between Cadorna Creek and the Elk River and the absence of mixing at the sampled location.

Within the minesite area, at Stations EL 43.6 W, EL 43.0 E and 43.0 W, there is a reduction in species diversity, but an increase in observed density.

Downstream from the minesite (Station EL 42.0), the species and their relative abundance near the west side are similar to that of the west side of the upstream location (Station EL 46.5 W). However, there is a notable difference between east and west sides of the stream with the east side having a denser growth of Stigeoclonium sp. and species of the Cyanophyta, but fewer Chrysophyta species. This comparatively thicker growth of Stigeoclonium on the east side may be an indication of organic enrichment, but it does not appear to be influenced by the inflow from Weary Creek, since Weary Creek (Station WE 0.5) did not contain Stigeoclonium sp. These samples were collected prior to the establishment of the exploration campsite so any nutrient enrichment is considered to be from natural sources.

B.C. Research's (1974b) list of vegetation species (Appendix 2) includes streambank and marshland species.

2.8.2 Macroinvertebrates

Differences between sampling locations, sampling dates, collection methods, and mesh sizes of the net and sorting method make it difficult to compare the macroinvertebrate data collected by different workers. However, since each worker used the same method at each of the locations to collect organisms, thus filling the equal effort requirement, one can compare the diversity and abundances between different stations sampled by that worker.

Data collected by Hooton et al. (1971) (Appendix C, Section 2.8 - Figure 3) indicates that there are fewer macroinvertebrates below the minesite (Station 2 - upstream from Aldridge Creek). However, he points out that the conditions at Station 2 differed from the other stations in that the gradient was steeper (thereby producing a swift current) and the substrate was bedrock, cobble and sand, rather than gravel, which may account for this difference in relative abundance. He also found there was a shift in population as the summer progressed, with mayflies (Ephemeroptera) and stoneflies (Plecoptera) becoming more and more dominant.

Bull et al. (1972) found Station B within the minesite to be more productive than Station A, located upstream from the Cadorna Creek confluence. The extremely large number of Diptera present at Station B and complete absence of Diptera at Station A indicates Station B was probably receiving a large amount of organic material.

The most extensive sampling was conducted by B.C. Research (1975b). The results (summarized in Appendix C, Section 2.8 - Figure 3) indicate a considerable reduction in macroinvertebrates downstream from the Cadorna Creek confluence, with the greatest reduction occurring at two stations - one downstream from the Gardner confluence (Station WS 3) and the other immediately upstream from Aldridge Creek (SW 5, close to Station 2, used by Hooton et al., 1971). During August the Elk River within the licence area appears to be as productive as upstream locations, with the exception of the area directly below the Weary confluence (Station WS-4a is Station WS-4 relocated to the west side of the river). October samples indicate a possible return to the springtime conditions; the area downstream from Gardner and Bleasdell Creeks is again less productive than the areas upstream from the minesite.

The B.C. Research macroinvertebrate sampling of the tributaries during the three sampling periods found the Gardner Creek location to have the lowest number of organisms. The community structure in Aldridge Creek remained fairly constant throughout the period, but the productivity was lower than that of Bleasdell and Cadorna Creeks. For Bleasdell and Cadorna Creeks, productivity and diversity were found to be similar.

In the tributaries, there is a definite shift in community structure as the summer progresses. The warmer weather appears to favour all the organisms, but especially stoneflies, which become quite abundant by fall.

Techman Ltd. data allow comparison of the relative productivity of each side of the Elk River, in addition to the different reaches of the Elk River and the tributaries. These data (Appendix C, Section 2.8 - Figure 2) indicate a detectable difference between productivity of the east and west sides of the Elk River. It is most pronounced downstream from the minesite (Station EL 42.0), the east side being similar to the east side at Station EL 46.5 but containing considerably more mayflies. The west side has a smaller number of individuals of each of the groups with the greatest reduction occurring in the mayflies. The results indicate a trend toward fewer organisms on the west side of the Elk River at the downstream locations.

The differences in stream conditions between EL 42.0 and EL 46.5 are, a lower velocity at EL 42.0 and a cobble-gravel-sand substrate at EL 42.0 versus a rubble-cobble substrate at EL 46.5.

Techman Ltd. results indicate that productivity of all of the tributaries is higher than the Elk River. The low diversity and the complete absence of caddisflies in Aldridge Creek may be linked to observed scattered growths of filamentous bacteria, an indication of organic enrichment.

2.8.3 Fish

ELK RIVER: The Elk River drains southwardly, joining the Kootenay River before crossing the United States border. The Kootenay River has several dams, with the Libby Dam impoundment, namely Lake Koocanusa, extending into Canada. The Elk River contains one dam, at Elko, which provides an impassable barrier to fish (N. Ringstad, B.C. Fish and Wildlife, Personal Communication).

The fish species which Clark (undated) found to be present in the Elk River are summarized in Figure 4 (Appendix C, Section 2.8).

A fish creel census conducted by the B.C. Fish and Wildlife Branch (Andrusak et al., 1970; Hooton et al., 1971) found that fishermen visiting the Elk River upstream from Michel Creek confluence (near Sparwood) were catching mountain whitefish during the winter while summer catches consisted mainly of cutthroat trout. A few mountain whitefish were also caught during the summer.

The Elk River, upstream from the Aldridge Creek confluence, was considered by the Fish and Wildlife staff to provide a greater number of catches per effort than the lower reaches (B.C. Department of Environment, 1976).

The Elk River upstream from the Cadorna Creek confluence is a braided stream with considerable potential for trout spawning (Clark, undated). B.C. Research (1974b) reports that downstream from Cadorna Creek the stream-bed becomes narrow and straight, thus creating a swift current with a substrate composed mainly of large boulders and rubble. The bed does contain a number of pools, most of which are quite large and deep and offer adequate fish shelter. The stream bank vegetation consists mainly of pine forest and brush (mainly willow).

Downstream from the Weary Creek confluence, the Elk River again becomes a meandering braided stream with a bed composed of finer material, rubble and gravel. Clark (undated) describes the side channels of braided streams as being important spawning and rearing areas, and, since they provide a proportionately larger river bottom area than single channel beds, the macroinvertebrate productivity potential would probably be higher.

TRIBUTARY STREAMS: In general, those tributaries running year-round support resident populations of cutthroat. Movement between the Elk River and its tributaries is often limited by waterfalls, but cutthroat are usually present above and below them. Use of intermittent streams is unknown and probably variable. Dolly Varden, eastern brook trout and whitefish may also be present in tributary streams.

Hooten et al. (1971) conducted a visual stream habitat inventory of tributaries of the Elk and Fording Rivers including Boivin, Forsyth, Quarrie, Aldridge, Bleasdell and Cadorna. He found all of these streams, except for Boivin and Aldridge, to contain abundant spawning and rearing habitat.

a. Cadorna Creek

This stream has a waterfall about 1.8 m high, 0.8 km from the Elk River confluence, which appears to divide fish populations into two groups. Below the falls spawning gravel and holding pools are scarce and the river is swift over a boulder substrate. The pool below the falls however is a productive, popular fishing spot. Fishermen report good catches of cutthroat trout and large Dolly Varden from this pool. B.C. Research (1974b) reports Cadorna Creek has the lowest number of pools per mile. Above the falls, spawning ground and holding pools are abundant. A horse trail follows the creek for several miles, and a four wheel drive road also provides access. The fish in this section of the creek are probably resident. The valley of Cadorna Creek receives parties of fishermen and hunters led by a local guide, who maintains the horse trail.

b. Gardner Creek

The lower end of Gardner is ponded by beaver dams, which provide good rearing habitat. These ponds are fed by several springs and three tributaries. All of these tributaries have extremely steep gradients and would therefore be of limited value to the fisheries except in the lower portions. The substrate of the streams is composed mainly of coarse material - boulders, rubble and gravel, providing limited spawning habitat. Most of the stream bank vegetation along the upper reaches of this creek is forest, with the balance being brush. The stream bank vegetation along the ponds consists of willows, grasses and sedges (B.C. Research, 1974b, lists species in Appendix 2).

c. Weary Creek

At its upper reaches, Weary Creek has a steep gradient (109 m/km) and offers little potential for fish spawning or rearing. In addition to several log jams, it contains a waterfall, and other high velocity sections, which may impede fish migration. However, a good-sized cutthroat was sighted upstream from these barriers (Clark, undated). There is a number of pools (26) of which half are large and deep. The substrate consists of medium-sized material and fines, therefore, offering some potential for spawning. Since this catchment was badly burned during the 1936 fire, the stream bank vegetation is predominantly brush.

d. Bleasdell Creek

Bleasdell Creek has a steep gradient ranging from 40 m/km at the lower reaches to 250 m/km at the upper reaches. It contains a variety of substrate sizes. The habitat is mainly riffles with the stream bank vegetation being dominated by small pine trees and occasional willows (B.C. Research, 1974b).

The lower reaches consist of alternating pools and riffles, therefore providing suitable fish habitat.

e. Aldridge Creek

Clark's survey of Aldridge Creek found the gradient to be moderate, ranging from 65 m/km to 140 m/km. Near the mouth, the stream breaks up into a braided stream and the stream banks contain a thick cover of willows. There are numerous locations in this area which would be suitable for spawning.

Upstream from this area the creek is made up of a pool-riffle habitat with a variety of substrate sizes, but contains only pockets of spawning-sized gravel (Clark, undated).

f. Forsyth Creek

The Connor Lakes, the headwaters of Forsyth Creek, contain large cutthroat trout which are fairly lightly fished, and are the source of cutthroat trout eggs used in the Kootenay trout hatchery at Wardener. Fish movement between Elk River and the lakes is probably blocked by a 1.2 m high waterfall. Parts of the stream bank are cluttered with burned timber, old beaver dams or heavy bankside vegetation (Clark, undated). Techman Ltd. has observed the lower reaches of this stream to be open during the winter, therefore providing suitable overwintering habitat.

g. Bingay Creek

This stream appears to be blocked by old logging and sawmill debris near the confluence. Spawning and rearing habitat upstream is favourable (Clark, undated). Techman Ltd. records indicate that this creek freezes solid during the late winter.

The B.C. Department of Environment (1976) assessment of a limited amount of data which was available to the end of 1974 concluded that the Elk River is capable of supporting a self maintaining sport fish population.

2.9 Social and Cultural Factors

2.9.1 Heritage Resources

Historic references to the Elk River date back to the Palliser Expedition of 1858 (Spry, 1963). Palliser completely circumvented the upper Elk River Valley. He entered present British Columbia through the Kananaskis Pass and proceeded west along the (present) Palliser River to its confluence with the Kootenay River. The return to the prairies involved re-crossing of the Elk River near its junction with the Kootenay, and subsequent eastward movement, south of the Elk River, through the North Kootenay Pass. Palliser's associate, Blakiston, is recorded as having crossed the Elk River near Wigwam River.

Passes in the area, such as Elk Pass, Weary Creek Gap and Fording Pass, may have served as hunting and trading routes for local Indians trading fur at posts in Alberta (Nelson and Chambers, 1969). Patterson (1969) reports a Stoney legend about the Weary Gap trail and tells of early twentieth century hunting trips through this and Elk Pass to the Cadorna Creek area.

There is no archaeological or historical inventory of the area.

2.9.2 Settlement Land Uses

The proposed minesite area and the 43 km corridor to Elkford contain no permanent settlements except for one ranch at Round Prairie, just north of the town, and a semi-permanent hunting camp on the minesite.

The potential land uses of the project and corridor areas are mining, forestry and particularly, outdoor recreation. Mining and recreation are the most likely influences on evolving settlement patterns. Because of the widespread fires of 1936, another 40 years might lapse before substantial timber harvesting will take place in the valley.

2.9.3 Natural Resource Land Uses

Mining, forestry, limited ranching, and recreation provide the economic base for the East Kootenay region. This is one of the fastest growing regions in British Columbia, with a 29.2% population increase in the five-year period between 1967 and 1972, twice the Provincial average.

The upper Elk River Valley is situated close to a number of population centers in both British Columbia and Alberta, allowing some 0.5 million people to make day trips to the Valley.

The Synoptic Land Capability Map (East Kootenay Region) indicates the importance of the big game and recreational capability in this area. "Moderate big game range" occupies 19% of the licence area; other big game ranges are classified as "high" or "moderate yield forest" land. Recreational values in this region are associated with scenic river valleys, uplands and mountains; however, the licence area includes only 10% "moderate recreation" and 5% "extensive recreation" as primary use designations. Forestry rates high in local importance, but is of relatively low value when compared to production at the provincial level. Forestry forms the largest single resource capability block - 58% of the licence area - in the following groups: high yield forest, 23%; moderate yield forest, 21%; and limited yield forest, 14%. The remaining 8% of the project area has been classified as "highland" which has capabilities for big game range, primarily summer range, and extensive recreational activities (Appendix A - Map 4).

Aside from the hunting and fishing facility near the Elk River - Cadorna Creek confluence (Photo 9), there are no commercial recreation developments in the upper Elk River Valley, but there are sites naturally suited for camping. The access and the fishing on almost all the creeks is impeded by deadfall, thick growths of brush along the banks and/or steep gradients (Photos 4, 7 and 8). The natural scenery of the project area has been modified by roads and exploration scars (Appendix A - Map 2; Photo 11).

There are two visitor access routes to the upper Elk River Valley: a main southern entry from Elkford, British Columbia and a low standard seasonal access road via the Elk Pass from the Kananaskis Lakes in Alberta. No information is available at the present time on the number of vehicles travelling to and through the licence area, or on the degree of recreational use. Winter use of the valley will undoubtedly expand with growing winter recreation. As many as 50 to 200 snowmobiles on a weekend day have been reported for the upper Elk River area. Wilderness use, focusing on the Elk Lakes Provincial Park and the developing Great Divide Trail, is probably a growing activity in the area also.

A British Columbia Fish and Wildlife creel census undertaken in 1971 (Hooton, 1971; as quoted in the Department of Environment Water Resources Service, 1976) surveyed the Elk River above Aldridge Creek (upper Elk) and from Fernie to Michel Creek (lower Elk). The summer catch indicated primarily a cutthroat trout fishery with some Dolly Varden, brook trout and mountain whitefish being caught. The estimated catch effort for the upper Elk was 2.26 fish/hour/angler for July and 1.29 fish/hour/angler for August; estimated catch effort for the lower Elk was 0.85 fish/hour/angler for July and 0.64 fish/hour/angler for August.

3.0 ENVIRONMENTAL EFFECTS, MITIGATIVE OPTIONS

3.1 Introduction

The purpose of Section 3.0 is to outline the major environmental effects of the proposed development, to the extent that these are identified to date. A lack of information on some aspects of the physical environment and on the biota that are dependent on the local ecosystems prevents this assessment from being anything more than preliminary. There is a good probability that some environmental concerns have been overstated and others understated.

The Company has adopted the preliminary assessment of effects as its guide in the development of environmental design objectives and the formulating of operational procedures that are sensitive to and protective of the environment. Elco recognizes that an improved environmental information base may necessitate modification of the views expressed in this report. The Company has initiated a substantial program of environmental studies. This program is additional to substantial regional studies undertaken by government agencies. Thus, it would appear that an adequate environmental research and monitoring effort is underway to provide the data base necessary for the making of well-founded environmental design decisions by the proponent.

3.2 Climate and Air Quality

3.2.1 Atmospheric Emissions

The nature of the materials handling in an open pit mine tends to produce dust. To the extent that mining equipment will be powered by combustion engines, gaseous emissions, such as water vapour, carbon dioxide and minor amounts of nitrogen oxides will be released. Some carbon monoxide, hydrocarbons and combustion products of fuel additives will also be emitted.

Materials handling and processing around and through the coal wash plant facilities and product loading and transport produces similar particulate and gaseous emissions although not in the same relative proportions as the mining operation.

Dust will be associated with:

- the loading, unloading and other mechanical handling of overburden, mine waste and coal;
- general traffic, and the transport of all stripped and mined materials;
- the blending, cleaning and processing of coal;
- wind activity on exposed overburden, coal deposits and stockpiles.

The Company recognizes that unacceptable quantities of dust imply problems relative to industrial health, safety, landscape aesthetics and plain annoyance. Moreover, dust, in excessive quantities, may impair photosynthesis and consequently, plant growth. Dust also changes the albedo of snow surfaces which induces earlier thaw with attendant changes in runoff volumes and timing.

The magnitude of the onsite and offsite effects of dust emissions depends on the volumes involved, the frequency, direction and velocity of local winds, and the frequency and magnitude of the temperature inversions in the valley. Elco has initiated a program of site-specific weather data collection to determine the existing climatic conditions.

Provided that combustion engines are adequately maintained and tuned, the gaseous atmospheric emissions of mobile equipment are considered to be environmentally acceptable.

The dispersion climatology of the Elk River Valley will be measured and analyzed for the project area and its environs. Neither the vents and stacks for the coal preparation and washing complex have been designed, nor the dispersion and absorptive capacity of the local airshed determined at this time. The effects of the operation of the coal processing complex cannot be stated quantitatively at this time, but the principal emissions will be water vapour and particulates. Elco is sensitive, however, to the necessity to evaluate the design of all static atmospheric emission sources in this complex in dispersion climatological terms.

3.2.2 Mesoclimate

Substantial bodies of ponded water will be created for the purpose of operating the complex and as a result of landscape reconstruction concurrent with and upon completion of the mining operation. Increased atmospheric humidity near the ponds and lakes is expected to lower the air-temperatures somewhat during summer and to increase the number of frost-free days during spring and fall. The frequency of radiation fog is expected to be somewhat enhanced. Although this effect is considered to be minor, the fog potential will nevertheless be assessed as part of the climatic studies.

3.2.3 Mitigative Options

Depending on the magnitude and nature of the potential problem, Elco has identified and might select any or all of the following mitigative options:

Dust

- water spraying at the minesite;
- physical soil stabilization prior to revegetation;

- use of tree and shrub belts to lower near-surface wind velocities;
- surface treatment of haul roads by spraying water or oil, by spreading dust-suppressing compounds, by paving, and by limiting travel speed;
- spraying raw coal stockpiles;
- enclosing the blending bin;
- handling large rejects through a bin;
- enclosing plant conveyors;
- covering dried coal on conveyors with wet coal that would bypass the dryer;
- spraying of latex or oil emulsion on railway car loads;
- scheduling of revegetation programs to follow closely upon construction-related land disturbance;
- providing face mask filters to Company personnel.

Revegetation is regarded as the most practicable approach to the stabilization of soil in disturbed areas. Fertilizer and seeding treatments will be influenced by the timing of favourable and unfavourable precipitation periods to minimize erosive loss of fertilizer, seeds and seedlings. Selection of plant species for revegetation purposes will take account of their tolerance limits and adaptability to local climatic conditions.

Incorporation of dust control programs is recognized as a primary factor in a good mine operation because dust control is essential to safe mining operations.

Combustion Engine Emissions

- maintenance and operation of all engines to attain optimal fuel economy and keep emissions within acceptable limits;
- installation of newly evolving pollution control technology;
- utilization of electrically powered excavation and transport equipment, where feasible.

Preparation Plant Emissions

- designing stacks and vents in a manner that recognizes the atmospheric dispersion characteristics of the local airshed;
- equipping the thermal dryer with large diameter cyclones and a high energy scrubber.

3.2.4 Spontaneous Combustion

Studies of other coal producing operations in the region indicate that the gestation period for clean stockpiles and raw coal from mines is about 18 months before spontaneous combustion occurs. Because this final product will not be stored in any one pile for that period of time, fires in clean coal or raw coal stockpiles are not expected to be a problem.

At present Elco Mining Ltd. is not planning to create reject waste dumps. The coal preparation plant reject will instead be dumped along with the pit waste rock and will become part of the pit backfill. In this manner, the reject will be diluted and so deeply covered that it will not present spontaneous combustion problems.

3.3 Noise

3.3.1 Recognized Effects

Elco Mining Ltd. recognizes that excessive machinery and blasting noise may adversely affect its personnel, the aesthetic enjoyment of the natural environment by visitors to the general area of the project, and the habitat utilization by wildlife migrating through or inhabiting the ecosystems in the environs of the project. Wildlife may associate mining activity, and especially exploration, with off-road vehicle hunting activity and other harrassment. Data relative to the noise effects of similar mining operations are yet to be collected to establish the magnitude of this potential problem.

The noise of mining and vehicular activities will not be perceived by wildlife as threatening, as animals habituate to people engaged in non-harrassment activities. Recent studies conducted by Renewable Resource Consulting Services, Ltd. (1974) have examined the reaction of some wild ungulates to noise disturbances, and they suggest habituation responses to industrial noise sources.

The National Parks provide an example of wild, but unhunted, populations of ungulates habituating to landscape alterations and human use (Geist, 1970). Recreation control programs can promote general wildlife acceptance of mining related noise so as not to compromise utilization of available habitat in areas immediately adjacent to mining. These programs will require government support to be successful.

3.3.2 Mitigative Options

Depending on the magnitude and nature of the potential noise problem, Elco will select any or all of the following options:

- enclosing vacuum pumps;

- sound proofing of control rooms;
- provision of ear protectors to Company personnel;
- establishing a no-hunting zone around the project area to dissociate noise and "hunting/harassment";
- restricting snowmobile use around the project to essential trips only such as survey, environmental monitoring and emergency use.

3.4 Surface Water

3.4.1 Recognized Effects

The preliminary mining concept requires considerable modification of the natural drainage system. This concept, which adopted the minimum diversion option as stated in Section 1.4, includes diverting the Elk River in three locations for a total distance of about 3.3 km, intercepting and diverting Weary Creek, intercepting and diverting the small intermittent streams draining the northwest end of Little Weary Ridge, intercepting and diverting tributaries EL-T44.1 and EL-T43.7 and the construction of settling ponds as indicated on Map 6 (Appendix A).

Three diversion alternatives were considered (Section 1.4), two of which provide for the same gradient as the existing stream. The third alternative, although less expensive, would increase the gradient. The latter diversion concept is illustrated in Figure 7 (Appendix C, Section 1.4) superimposed on the natural stream profile.

The environmentally protective practice of segregating drainage from undisturbed land from project area drainage was adopted for the preliminary mining concept. This requires the construction of interception ditches particularly to the east and to the north of the project area.

Where needed, diverted drainage from undisturbed land and from the project area will be passed through sedimentation ponds to avoid or minimize adverse turbidity effects for the Elk River.

The preliminary mining concept would result in a little more than 3% (69 ha) of the total area of the Weary Creek catchment (2200 ha) being covered by overburden. The runoff from the higher slope within the catchment would be intercepted and directed around the dumps and south of the mining pit into the Elk River. At completion, the creek could be allowed to flow over the dump in a newly prepared channel and into the remaining mining pit, creating a large deep lake (Appendix A - Map 6). However, since the diverted Weary Creek would be well established, it may be desirable to leave the creek in that channel.

Prior to construction of the western dump, Tributary EL-T44.1 will be directed around it and into a sedimentation pond. This pond will drain into the clear water lake. Upon completion of the dump, the upper reaches of Tributary EL-T43.7 will be directed into a pond on the initial waste dump, the overflow from which is directed into the main Gardner Creek channel into the new lake and hence into the Elk River. The remaining runoff from drainage basin D will be collected along the road and directed to the clear water lake as indicated on Map 6 (Appendix A).

Runoff from the upper level of the plantsite could be directed into the tailings pond. Runoff from the lower level and blending bed could be collected into a small settling pond.

If the mine intersects significant aquifers which are recharged from the upper end of the valley, the pit will have to be pumped out into the Elk River, which may cause an increase in the water level of the stream.

3.4.2 Mitigative Options

Geotechnical and hydrological data are being collected in conjunction with engineering feasibility studies of diversion alternatives. The general objective is to select the alternative(s) that maximize the safety of mine operation, minimize the environmental hazards to the operation and optimize the protection of the quality of the aquatic environments in as well as downstream from the project area.

The upper Elk Valley has few lakes and other natural impoundments that dampen the fluctuation extremes of the annual discharge variation. Therefore, the creation of large open water surfaces in the project area is considered to be a beneficial environmental effect.

Furthermore, the interceptor ditches in the Weary Creek catchment and above the mine pit would have a much lower gradient than the existing channel, thus reducing the velocity and the erosive power of the run-off. The slack water created at each of the Weary Creek tributary entries would provide quiescent conditions which would reduce the sediment load of the stream (Appendix A - Map 6).

To control the undesirable turbidity effects of land disturbance on streams, Elco will select any or all of the following mitigative options:

- directing high volume flows from disturbed lands to sedimentation ponds;
- directing low volume flows from disturbed lands to woodlands or rock filter beds;
- riprapping beds and banks of interception ditches and diversion channels to control scour;
- placing energy dissipators in ditches and channels;

- protecting banks with rock gabions;

- leaving buffer zones of vegetation along natural streams;

- minimizing clearing in areas where diversion ditches and channels are proposed to be located;

- scheduling revegetation of construction-disturbed land to follow closely upon the completion of the construction of channels, ditches and pond dykes.

Elco recognizes the environmental hazard posed by the extremes in flow volumes that are characteristic for mountain streams. The design parameters for this project will be selected to avoid the possibility of breaching of channel banks.

3.5 Water Quality

3.5.1 Recognized Effects

Elco is sensitive to the commonly recognized water quality hazards associated with open pit coal mining, i.e. siltation, acid mine drainage and heavy metals. The siltation hazard was addressed in Section 3.4. To adequately assess potential problems relative to mine and dump drainage and the presence of environmentally undesirable heavy metals, the 1977 water quality monitoring program will also sample and analyze groundwater discharges on the proposed minesite. The results will be included in the Stage II Report.

The major portion of the sulphur content of western Canadian coals is predominantly organic (80% organic, 20% pyritic). The chemical analysis of coal from the minesite indicates that this generality applies to the Elk River coal. It would appear, however, that coal from the licence area contains sulphur in higher concentrations than most western Canadian coals, but only seams 13E and 13F were found to have noticeable amounts of pyrite (ferric and ferrous sulphur), which suggests that acid mine waters are not likely to be a problem.

The results of the water quality monitoring program in combination with geotechnical data are expected to provide the basis for quantifying the potential acid drainage problem, if any.

The coal wash plant will not discharge its effluent into the Elk River. Process water will be recycled via the tailings ponds. Since natural filtration occurs in the tailings ponds, leachates in seepage water might have a noticeable effect on the quality of Elk River water at low flow.

The B.C. Department of the Environment (1976) assessed the water quality data related to the Kaiser Resources tailings ponds and concluded that "the seepage from the tailings ponds is not having a detrimental effect on the water quality of the Elk River". It seems unlikely that seepage from the tailings ponds at the Elco minesite would unacceptably impair the water quality of the Elk River.

Solid wastes from the campsite will be deposited in an impermeable landfill site. Therefore, contaminants from this site are not expected to reach the Elk River.

The domestic sewerage from the minesite will be treated in an approved sewage treatment plant. The only potential effect of discharge to the Elk River could be some measure of increased nutrient levels in the receiving waters. This treatment facility will be installed and operating during an early stage of construction.

Petroleum fuels, lubricants and used oil will be stored in a manner satisfactory to the B.C. Government. The used oil will be sold for re-refining or disposed of in an environmentally acceptable manner. If the latter is followed, the method will be chosen after consultation with regulatory agencies.

All drains for areas where petroleum products are stored or handled will be equipped with oil traps. Moreover, suitable pollution control equipment and sorptive materials will be stored near locations along drainages where containment of accidental spills would likely be undertaken.

Notwithstanding the application of construction practices that are environmentally protective, some release of silt from disturbed stream banks and from the beds of diversion channels and ditches will be unavoidable. This effect is expected to occur during construction only. Upon completion of the engineering works, embankments and streambed and - banks will stabilize rapidly under a re-established vegetative cover.

Other recognized potential effects on water quality are the escape into the receiving waters of: - coal (major source could be the mining operation and stockpiles) - phenols (might be present in pit water and drainage from overburden dumps) - oil, if not properly controlled (from machine maintenance sheds and oil storage areas) - organic or nutrient rich waters (from the sewage treatment plant which would treat the wastewater from the campsite washrooms and kitchen) - inorganic fertilizers leached from the reclamation sites.

Groundwater flowing through the dump slopes and backfilled pit will eventually reach the final pit lake. Should this water contain a high concentration of dissolved solids, it would remain near the bottom of the lake thus inducing stratification (creating stable conditions which would resist mixing between the surface waters and the deep waters).

3.5.2 Mitigative Options

Siltation: The mitigative options for control of waterborne particulate matter were discussed in Section 3.4.

Acid Drainage and Heavy Metals: Both potential problems are currently under investigation. Since neither magnitudes nor the precise chemical nature have been determined, no mitigative options will be identified in this report. The Stage II Report, however, will address the subject and formulate options, should a problem be found to exist.

Sewage Plant Effluent: Should the effect on nutrient levels in the Elk River be found to be environmentally unacceptable, Elco will consider whether:

- discharge to the tailings pond can be accommodated in the process water and chemical balances;
- discharge into rock waste dumps might reduce nutrient levels sufficiently to allow return to the Elk River with dump seepage.

Hydrocarbons: Consistent application of control procedures described in Section 3.5.1 appears adequate to ensure avoidance of undesirable environmental effects of the storage and use of petroleum fuels and lubricants.

Tailings Pond Leachates: Should leachates have undesirable effects on the water quality of the Elk River, Elco will consider whether seepage volumes can be reduced by:

- lining part or all of the pond dykes with an impermeable blanket of natural or man-made materials;

- covering part of all of the pond floors with an impermeable blanket of natural or man-made materials;
- installing filter blankets with suitably small pore-size to induce impermeability of dykes and floors using the self-puddling effect of fines-loaded seepage.

3.5.3 Water Use and Waste Water Discharge

Recognized Effects

The coal wash plant utilizes a large volume of water, which will be drawn from a closed circuit requiring a make-up of about 3500 l/min. A slurry of fine rejects will be discharged into the north end of the tailings pond. Water will be withdrawn from the south end of the tailings ponds and returned to the process circuits after solids removal (flocculant will be added at the thickener).

The make-up requirement is caused by losses to the coal product, to entrapment in the sludge pores, to evaporation in the thermal drier and from the pond surface.

Make-up water might be withdrawn from the clear water lake, or from a well adjacent to the Elk River. Other possible sources are the de-watering wells along the perimeter of the mine, the mine pit, or the Elk River. If the latter is selected, a wing dam with a diamond in-take structure in the middle of the river, or a forebay on the bank and a pump house would have to be constructed. Withdrawal from the clear water lake appears to be the environmentally preferable alterna-tive.

Ancillary facilities requiring water are the vehicle maintenance shop, the showers and washrooms, the kitchens, dust control programs and tree nursery areas, should the latter be developed on the project site. The water requirement of the ancillary facilities is not expected to exceed 1200 l/min.

The total water usage is thus estimated at about 4700 l/min. or about 0.077 m^3/sec. In terms of the as yet highly tentative discharge numbers stated in Section 2.2.2 of this report, project water usage would be in the order of less than 0.25% of the maximum Elk River discharge at the Forestry Bridge (Station EL-43.0) and more than 7% of the minimum discharge at this location. The latter percentage is very tentative indeed, but indicates a potential problem requiring further study.

Mitigative Options

Water Supply: Should the results of continuing hydrological work on the Elk River discharge at the project site indicate that direct water withdrawal during low flow is environmentally unacceptable, and should winter discharge into the proposed clear water lake also prove insufficient to sustain the plant water supply throughout the year, Elco will investigate whether:

- aquifers on the project site can be utilized;
- the potable water supply should be obtained from the Elk River or the proposed clear water lake and the process water supply from elsewhere on the project site.

Emergency Dumping of Process Water: An emergency dump pond will be constructed, in the vicinity of the thickener, of a sufficient size to contain all the water in the process circuit should the need arise.

3.6 Groundwater

3.6.1 Recognized Effects

A modification of existing groundwater conditions will occur as excavation intersects and partially or totally removes existing aquifers in both the overburden and the bedrock. Excavation of an open pit on the valley floor below the existing groundwater table will create a large natural drainage sink. Seepage control will be necessary to intercept groundwater which would otherwise enter the excavation and interfere with the mining operation. Drainage will also be utilized to improve stability of the pit slopes. The overall result will be a significant depression of the natural groundwater table at and adjacent to the pit.

Interception of Weary Creek by an artificially constructed cut and fill channel along the eastern and southern side of the Weary Creek catchment will affect the groundwater flow pattern in the catchment and the eastern side of the valley at the minesite. The till-lined relocation channel will allow little or no seepage into underlying aquifers. In addition, construction of a waste dump on the eastern slope and across the narrow valley of Weary Creek will further reduce groundwater recharge in this area by retarding natural infiltration. Construction of an interception ditch along the east flank of the valley north of Little Weary Ridge will reduce surface runoff on the lower slopes, resulting in decreased infiltration to underlying aquifers.

In the long term, the Weary Creek waste dumps and the interceptor ditches will cause a drop in the piezometric levels within the aquifers which were being recharged within this area. However, the degree of change is probably small considering the size of the entire recharge area. The significance of this effect is considered minor in view of the large quantity of surface water available in the Elk River watershed, and the small water demands within the region.

There is a strong indication that the valley floor is a groundwater discharge zone; therefore, the likelihood of water impoundments of the valley floor recharging the aquifers is small. However, the creation of a large lake in the reclaimed pit would probably act as an exchange zone maintaining a high groundwater table along the valley floor.

The possibility that the Weary Creek drainage acts as an upstream control for groundwater conditions in Little Weary Ridge will be further investigated during geotechnical studies related to stability of the footwall slope. In addition, ongoing investigation during the mine design phase will produce data relative to groundwater flow and aquifers below the Elk Valley floor.

Subsequent backfilling of the pit as mining proceeds may create new aquifer recharge because of the increased permeabilities in the backfilled material. However, increased weathering of the backfilled material could result in increased dissolved and suspended solids in this water, thus affecting groundwater quality. This increase of suspended solids may result in silting-over of the base rock, thus reducing the degree of recharge of the existing aquifers.

3.6.2 Mitigative Effects

The creation of a large lake in the southern portion of the pit on completion of mining will allow the groundwater levels in the valley floor in the vicinity of the pit to return to existing levels. Initially this lake would tend to recharge the aquifers.

The B.C. Pollution Control Branch, 1976, monitoring at similar coal operations in the region which use exfiltration as a means of reducing the water level of their tailings ponds has not identified a serious degradation of groundwater in the vicinity of tailings ponds and waste dumps. Therefore, seepage from the tailings ponds at the Elk Valley Project is unlikely to seriously affect groundwater.

3.7 Landform Modification

3.7.1 Recognized Landscape Effects

Successful coal extraction, as outlined in this submission, will necessitate permanent landform alterations. Only the floor and lower flanks of the valley below 1920 m elevation will be altered. The most prominent landscape alterations (Appendix A - Map 3) are:

- relocation of a portion of the Elk River west of its present channel around the pit area;

- excavation of an open pit on the valley floor (as indicated on Alternative C);

- excavation of the west flank of Little Weary Ridge and the creation of an approximately 450 m high slope dipping parallel to the bedding at approximately 38^{0} which is interrupted by a single 30 m bench at mid-slope.

- construction of waste dumps:

  i. on the east side of the Elk Valley north of Little Weary Ridge.
  ii. west of the Elk River on the valley floor and on a bench above it.
  iii. on the east flank of Little Weary Ridge across the Weary Creek drainage.

- subsequent backfilling of the northern end of the pit area to more than 100 m above the existing valley floor.

- creation of a 135 ha lake in the southern end of the pit on completion of mining.

- construction of interim topsoil and muskeg stockpiles to be utilized during reclamation.

- the creation of two tailings ponds in the southwest corner of the minesite.

- the creation of water retention ponds, at various locations within the project area.

- relocation of Weary Creek from its present channel around the proposed waste dumps constructed across its natural drainage.

- interception of several intermittent watercourses that drain the east flank of the Elk Valley, around the proposed waste dumps.

The overall effects of these landscape modifications (Appendix C, Section 3.7 - Figure 1) are:

- the introduction of terrace-like landforms in the northern end of the project area immediately adjacent to the relocated Elk River. A valley approximately 500 m wide, and narrower than the present natural valley, will be created to accommodate the upper portion of the relocated Elk River.

- a significant narrowing of the lower reaches of the Weary Creek Valley.

- removal of a significant portion of the natural swamps and ponds on the valley floor and the introduction of more water surfaces in the man-made landscape.

- local steepening and widening of the east flank of the Elk Valley in the vicinity of Little Weary Ridge.

3.7.2 Mitigative Landscape Reconstruction Objectives

Landform alteration and land reclamation planning for this project has as an objective an unobtrusive landscape that compares with the existing conditions in terms of productivity and aesthetics.

The following specific landscape design concepts (Appendix A - Map 3) were identified for the preliminary concept of the mine and associated facilities to evolve a landscape as compatible as feasible with the existing terrain:

- the construction of sinuous ridges and a pond (13 ha) on the upper reaches of the west waste dump. These moraine-like ridges should blend with other features of the glaciated valley landscape. The lake will be designed to provide a boggy environment similar to existing muskeg swamps.
- the creation of a large lake (135 ha) in the southern portion of the pit on completion of the mining operation. The lake will submerge a large portion of the steep footwall slope. Natural seepage through the soil and rock horizons is expected to maintain the lake level. The shallow northern end of the lake will allow recreational use such as swimming in the summer. This environment might be enhanced with islands and waterfalls.
- the creation of a shallow clear water lake (47 ha) north of the plantsite. It will provide fish and waterfowl habitat. A small man-made island could be constructed near the centre of the lake to add to the overall aesthetics and to supplement waterflow habitat.
- suitable slope protection such as riprapping, ditch checks, berming and revegetation will be used to control erosion.

3.7.3 Slope Stability Concerns

Short- and long-term stability of man-made slopes and embankments has and will continue to receive substantial attention in the mine design to maximize the safety of men and equipment, project economics, the protection of the natural environment, and the enhancement of landscape aesthetics.

The selection of steeper pit slopes is desirable from the perspectives of cost, waste-to-coal ratio, and minimization of land disturbance for excavation and waste deposition. These desirable objectives need to be balanced with the costs of cleaning up slope failures, and of the disruption of the mining operation, which can negate the economic benefit gained from minimizing excavation requirements. Similarly, the environmental benefit of minimizing land disturbance can be negated by undesirable landscape modifications by natural forces, which might ultimately affect an area larger than that planned to be disturbed. The prime design consideration is the safety of personnel and equipment.

A major design concern is the stability of waste dumps, tailings ponds and settling ponds. The Company is sensitive to the degradation hazards for stream biota implied in inadequate design that does not guard against siltation of watercourses. It is recognized that a substantial geotechnical data collection effort will be required to establish the waste slope and footwall design parameters and to ensure the slope stability for various project components.

3.7.4 Mitigative Activities

The geotechnical and environmental studies that are in progress are integrated with mine planning components that investigate waste dump, tailings ponds and settling pond foundations. These studies include collection and analysis of climatic and hydrologic data, aerial photointerpretation, field reconnaissance and mapping, exploratory drilling, measurement of groundwater levels, groundwater pumping tests, and laboratory testing of soil and rock smmples. The extent of the several investigations varies depending on the size of the structure and the complexity of the foundation.

An early feasibility study of slope stability of the proposed pit and dump slopes was completed in September, 1971 (Golder, Brawner and Associates Ltd.). Additional detailed slope stability investigations are presently being carried out using information from ongoing exploration programs and other field activities, to allow the definition of slope safety concepts that include seepage control, surface drainage and controlled blasting.

Continued inspection of pit slopes, waste dumps, settling ponds and tailings ponds is envisaged for the mine operation. If deemed required, instrumentation to monitor groundwater pressure and slope movement will be utilized.

Additional information concerning the geologic structure and stratigraphy within the pit will become available as mining progresses and slope faces become exposed. This information will allow verification and refinement of the parameters adopted on the basis of geotechnical and associated studies undertaken to support the current mine planning effort.

3.8 Soil

3.8.1 Recognized Concerns

Elco recognizes that the ultimate assessment of the environmental success of the proposed mining project will, to a large extent, be based on the effective reclamation of disturbed land. It is sensitive to and acknowledges that mine and reclamation planning should give ample consideration to:

- the creation of a rooting medium on the reconstructed landscape that has a biological productivity potential comparable to that now existing in the natural environment;

- an inventory of the quantities and qualities of those components of the surficial deposits that offer the best prospects for utilization in the creation of a suitable growth medium, for the total area of planned land disturbance;

- the effective scheduling of overburden stripping operations, to the extent that successful reclamation depends on a properly scheduled sequential placement of rock waste, glacial and pro-glacial deposits, topsoil and salvaged soil amendment materials;

- the timely creation of stockpiles of reclamation materials for those phases of mine development for which a deficiency of reclamation materials derived from progressive overburden stripping relative to concurrent reclamation requirements is anticipated;

- the selective handling and stockpiling of topsoil, peat and soil amendment materials derived from stripped vegetation to enhance and preserve its biological activity with regard to plant growth;

- the formulation of landscape reconstruction plans, and surface redevelopment and land use objectives that are compatible with the character of the adjoining ecosystems;

- effective revegetation of all land disturbed by the construction of the transportation infrastructure for the mining project.

3.8.2 Mitigative Activities, Concepts and Options

Observations of reclaimed exploration areas that were seeded in 1971 and 1975 indicate mixtures of overburden and salvaged topsoil to be capable of sustaining plant growth for at least five growing seasons (Photos 12 and 14). Preliminary forage yield comparisons between a reclaimed site on Little Weary Ridge (Appendix A - Map 10, FY1) and a native grassland area (Appendix A - Map 10, FY2; Photo 15) indicate negligible differences in production: 2360 kg/ha and 2380 kg/ha respectively. The sown species are regenerating and remedial fertilizer treatment beyond the initial seeding effort has not been given, nor does it appear to be required.

Landscape reconstruction planning will give consideration to the use of:

- alternating slopes and benches where anticipated surface runoff conditions make induced infiltration of sheet drainage mandatory for erosion control;

- contour-berming of the surface of moderate slopes, where anticipated surface runoff conditions make induced infiltration desirable;

- contour plowing or tread-marking on gentle slopes where surface runoff conditions make induced infiltration undesirable, in the long-term;

- the salvage of topsoil and peat from areas that are proposed to be covered with dumps, tailings and settling ponds and the preparation plant complex;

- experimentation with the mining of topsoil, forest duff, herbaceous vegetation, logging slash, peat, and chipped or crushed woody vegetation to determine the pragmatically feasible blend of surface derived materials that optimizes:

    - seed germination
    - seed and rootstock sources of native vegetation
    - moisture supply to vegetation
    - fertility status
    - base exchange capacity
    - pH
    - root penetration
    - sheet erosion resistance
    - gully erosion retardation

Soil storage and development are regarded as essential to successful revegetation (Photo 14). Stephenson (1974) and others report that peat, because of its water holding capacity, is becoming a prominent

PHOTO 14:
Surface material stockpiling
October, 1974.

agent in recent and successful surface mine reclamation and soil development projects elsewhere in the Rocky Mountains. Peat will become available at the Elk River site (fen or meadow areas; Appendix A - Map 2) from selective overburden stripping and in stream diversion areas.

To the extent that site conditions indicate the necessity, the ability of reclaimed soils to support a native plant cover comparable to existing vegetation will be investigated. Initial "nurse crop" seeds will be selected to provide a short-term erosion control cover and to improve conditions for later establishment of native species of shrubs, trees and ground cover. Compilation of native flora now colonizing recently disturbed areas (Appendix C, Section 3.9 - Figure 2) is expected to provide adequate guidance for this aspect of reclamation and revegetation planning .

Elco also intends to address the question as to whether the establishment locally of tree nursery facilities is desirable from an economic as well as an employment opportunity diversification perspective, or that commercial nursery facilities elsewhere should be relied upon for the provision of planting stock.

3.9 Terrestrial Life

3.9.1 Vegetation Effects

The temporary loss of vegetative cover implied in the establishment of an open pit mining development and ancillary transport corridors, as described in Sections 1.2 - 1.6, entails the following environmental concerns:

- the loss of potential merchantable timber through premature removal of immature stands (± 40 years); mature stands are to be harvested as a matter of course;

- loss of a fraction of the habitat for resident and migratory wildlife, providing food and cover;

The habitat types and plant communities along road and rail line alternatives require further study in order to adequately assess the effects and identify mitigation options. Potential concerns are the removal of existing vegetation and replacement with a linear pattern of non-native cover, that is, those grasses and legumes best able to meet rapid establishment and erosion control requirements. Discouraging tree cover for fire control purposes enhances the discontinuity in the vegetation pattern.

The forest fire record of the Elk River Valley, together with the anticipated increase in human activity, suggest an attenuated fire hazard requiring increased prevention and control measures.

It is expected that hydroseeding will be effective on most cut-and-embankment slopes along the transportation corridors. Some more difficult surfaces may require fiber mulching in addition. Plant cover is not expected to become complete on some rocky cut slopes; this will be consistent with the regional landscape, which contains ample rock exposures.

3.9.2 Mitigative Activities and Options

Minimizing the amount of cleared surface exposed at any one time, which requires a continuous reclamation program, is receiving active consideration.

Figure 1 (Appendix C, Section 3.9) presents a sample of a revegetation concept for the minesite. Slope angle is viewed as the key variable.

A regional (Crowsnest Pass area of British Columbia) surface coal mine reclamation study (Berdusco, 1974) indicates that it may be desirable to plant deciduous trees and shrubs rather than coniferous trees because the pH range of soil materials of the study area was more suitable to the former.

Selectivity in materials handling for subsoil and topsoil development has not been a feature of most early reclamation projects. The Company considers using this approach, should improved growth be proven to result, as well as to be required by site conditions. Growth plot studies are envisaged for the development stage to assess the plant growth capabilities of local substrate materials.

Preliminary indications of wildlife acceptance of reclaimed exploration sites include elk grazing and droppings on Observation Line 6 (Appendix A - Map 10), elk and moose droppings, grazing and "beds" on observation Line 11, snowshoe hare droppings on Observation Line 11, and small rodent trapping returns and chaff piles from clover blossoms on Observation Line 6. The ungulate use pattern on these sites is generally concentrated on the fringes, based on pellet-group distribution observations.

Selectivity of ungulate foraging on these sites indicates an apparent preference for clover and low utilization of timothy, the most widely used reclamation grass. Improved species selection might optimize ungulate forage and encourage native species (for example, June grass, bluebunch wheatgrass, rough fescue, wild rye and hair grass). A significant environmental concern expressed frequently in public hearings and in environmental literature is the replacement of native plant species with introduced species. If natural species can be utilized to accomplish the erosion control requirements and range productivity objectives relative to wildlife needs, they appear preferable to introduced species. A list of plants colonizing disturbed sites within the study area is being compiled (Appendix C, Section 3.9 - Figure 2), as well as one for wildlife utilization value (Appendix C, Section 2.7 - Figure 2).

Linear habitats often provide corridors for animal movements between other habitats, and valuable "edge" characteristics. Substantial attention will be directed to the design of clearings to maximize their biological potential and enhance animal shelter capacity, food and nesting areas.

The Company recognizes the need for formulation of a comprehensive fire prevention and control program in accordance with B.C. Forest Service guidelines. It will consider the need for clearing around mining activity areas, fire hazard warnings, water storage, fire fighting equipment, maintenance of fire access, and the availability of men and equipment to assist Forest Service fire fighting crews. The Company is aware of Forest Service requirements with respect to slash and brush disposal following minesite clearing and road development.

3.9.3 Effects on Wildlife Resources

The Canada Land Inventory and more detailed field work by government and private sector biologists provide an adequate basis for assessment of regional habitat characteristics. More study is needed, however, of the animals themselves including: relative numbers and seasonal distribution of ungulates, presence of furbearers, small mammals and birds. Additional information is needed relative to habitat types and capability for and near the minesite. Pending the completion of follow-up studies, the following concerns were identified:

- habitat losses during construction and operation (land clearing), especially Forest and Shrub, and Open Forest (Appendix A - Map 8), of local significance to ungulates and bears;

- lack of knowledge respecting the capability of adjacent and regional ranges to absorb use by displaced animals (especially large mammals);

- possible disruption of ungulate migrations. Relationships between elk migrations, a possible mineral lick located on the Elk River floodplain (Appendix A - Map 10, Observation Line 5), and elk spring range immediately east on Mt. Loomis require investigation to determine potential effects, particularly on pregnant or lactating elk. Mining development may affect lower elevation winter range for white-tailed ptarmigan entering the Elk Valley from Weary Gap (Photo 13). Ptarmigan are known to descend far below the timberline if conditions are severe (Guiguet, 1973);

- the proposed road relocation west and north of the minesite (Appendix A - Map 12) requires consideration of effects on the Cadorna Creek drainage. The data base for this valley is insufficient for adequate effect assessment. Techman field studies (Appendix A - Map 10) and anecdotal evidence (Patterson, 1969) indicate this valley to be of importance for grizzly bear and mountain goat. Both species are vulnerable to increased recreational and hunter access. The highway relocation will improve access into the Cadorna Creek valley, particularly for those presently excluded by the nature of the terrain, such as "road hunters" and snowmobilers. Bears may emerge from their dens while snowmobile travel is still feasible, increasing the possibility of man-bear contacts;

- human perceptions of the upper Elk River Valley are varied. In Indian folklore, it is considered as a refuge for over-hunted elk from Alberta (Patterson, 1969). In hunting lore, it is regarded as a dispersal area from which elk re-entered Alberta. It is viewed as "wilderness", the varied predator community imparting a self-regulating wilderness character. These are recognized cultural considerations. For hunters who recall an earlier, and generally "undisturbed", environment in the Elk Valley, the question as to whether mining development and reclamation can maintain comparable wildlife resource capability is important;

- wildlife management problems attending mining and corridor disturbance and settlement are:

  - black and grizzly bears are attracted to settlements with poor garbage or sewerage disposal, becoming a nuisance and a danger as man-bear interaction increases;

  - winter use of the road and rail line will require snow clearing. Snow berms might present physical barriers to wildlife travel;

  - increased traffic and road salting will present road and railroad kill problems.

3.9.4 Mitigative Options and Effects

Should the loss of ungulate habitat within the licence area result in a decrease in total population numbers for the region, and should alternate habitat in the environs of the project area already support the maximum population possible, several options might be considered:

- assuming that the habitat loss is not critical to migrations and implies only a decrease in population proportionate to the loss of fully utilized ungulate habitat, no mitigative action would be required if the remaining habitat can accommodate the hunting pressures;

- wildlife management practices could include controls on hunting, if uncontrolled hunting pressure on the remaining habitat would result in over-kill and attendant declines in population;

- habitat improvement within or without the licence area could be considered, thus providing enough animals to satisfy uncontrolled hunting pressures by increasing the carrying capacity. Measures such as forest and deadfall clearing, limited burning to create temporary moose habitat, or fertilizer applications and/or seeding of native grasslands, could be considered.

Continuing wildlife habitat studies will evaluate habitat limitations and habitat improvement capability. Inventory studies will assist the formulation of a reclamation strategy (e.g. Appendix C, Section 3.9 - Figure 2; Appendix C, Section 2.7 - Figure 2). The tentative slope classification format for revegetation (Appendix C, Section 3.9 - Figure 1) is introduced here to indicate optimization of engineering requirements such as slope stability, and the interspersion of landform and vegetation types for wildlife habitat variety. The benched slope concept allows design of ungulate habitat features including shrub and grassland forage, forest cover, grassy and snow shedding slopes. Upon completion of the project, the environment could be more productive in terms of forage than the existing conifer-covered slopes. The preliminary observations of wildlife use of lands reclaimed to date indicate that reclamation of habitats is feasible. Reclaimed landscape features, such as lake and marsh development, will benefit animals requiring this kind of habitat.

Migration study subjects will include animal movement paralleling the Elk River, local vertical movements between upper slopes (Photo 15) and valley bottoms, and valley to valley movements. While hunting lore (Patterson, 1969) indicates the importance of Weary Gap as an interprovincial movement corridor for elk, this has not been borne out by field investigations to date. While the mine development will affect one particular access into Weary Gap, other alternatives for animal movement will remain available.

Field investigations support conservation officer assessments of the Aldridge Creek drainage as an important habitat and interprovincial movement possibility (Mr. L. Campbell, B.C. Fish and Wildlife, personal communication). This area will not be affected by mine or railroad disturbance (Appendix A - Map 12).

Other mitigative options relative to wildlife effects are:

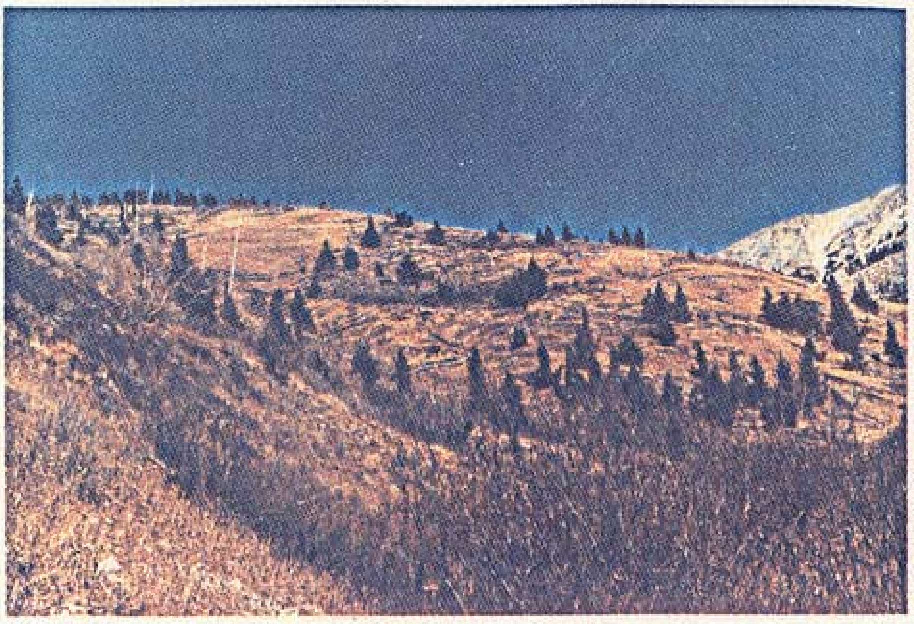


PHOTO 15:
South slope wildlife range east
of minesite - November, 1976.

- prompt garbage disposal to minimize wildlife - human conflicts, dependence and other problems associated with scavenger behaviour;

- once wildlife road and rail crossing areas are identified more precisely, snow removal equipment can be operated to ensure acceptable berm heights at critical locations;

- a critical wildlife management assignment for the minesite area is the control of human activity. Public access and hunting restrictions may be required to promote wildlife acceptance of habitat reclamation and trail development, and to encourage ungulates to fully utilize existing and improved habitats immediately adjacent to mining disturbance, much as they do in recreational areas and roadways in National Parks (Geist, 1970). The minesite location will effectively limit hunter and four-wheel drive access into the Weary Creek trail which presently leads to Weary Gap.

3.10 Aquatic Life

3.10.1 Recognized Effects

A commonly recognized strip mining hazard to aquatic life is the possibility of increase of the sediment load of the receiving waters. A high concentration of fines would fill in the pools and the interstices between the rocks of the riffles destroying fish eggs and insect larvae. If the sediment load is substantial it may also affect the aquatic plants (Herbert and Merkins, 1961). Furthermore, fine sediments which have an angular shape are abrasive to aquatic organisms, for example, they are known to damage the gills of fish (Klein, 1962). Increased sediment release to the Elk River would occur during the construction phase and involve mainly clay and silt which are not especially abrasive.

The proposed diversions of the Elk River (Appendix C, Section 1.4 - Figure 1; Appendix A - Map 5) could reduce the length of the stream and increase the gradient. The increased gradient would increase the flow velocity. The feasibility studies have several alternative designs under consideration.

The higher velocity may impede fish migration. Since the gradient of the existing channel is steep and contains waterfalls, it is doubtful that fish migration would be affected by a modest increase in gradient, provided that adequate resting places are available.

The interception of the Weary Creek drainage and the placement of overburden in part of this catchment (Appendix A - Maps 5 and 6) will remove the present aquatic habitat of the lower reaches of this stream. The natural stream contains log jams with very deep layers of fine sediment. This stream is not considered valuable to the Elk River fisheries, although fish have been sighted in this stream.

The proposed modifications of Gardner Creek (Appendix A - Map 6) would increase the impoundment area and the depth, thus making it more suitable for fish. Fish have been sighted in the existing ponds of this creek, but the fisheries value of these ponds has not yet been determined.

In cooperation with the B.C. Fish and Wildlife Branch fisheries studies will be undertaken during 1977. These will evaluate the fish habitat and utilization, the fish species, their relative abundance, and their migration patterns through the project area. Additional data on aquatic plants and macroinvertebrates will also be collected.

3.10.2 Mitigative Effects and Options

The creation of large ponds, the northwest dump beaver pond, "clear water lake" and the pit lake (Appendix A - Map 6) will increase the total aquatic habitat. In light of a B.C. Department of Environment report (1976) which points out the lack of lakes and developed shoreline in this area, the development of lakes would improve its recreation capabilities. The existing data (Section 2.2) indicate the flow of the Elk River to drop to less than 1 m^3/s in winter. The channel is constricted by ice build-up along the banks which causes an increase in the velocity, thereby rendering the stream unsuitable for overwintering fish. Therefore, the lakes would also provide overwintering habitat.

In order to reduce drainage flow through the mine and plantsite, the existing channels will be diverted around the project area by means of interceptor ditches. Although these diversions will eliminate aquatic life in the existing channels, similar communities would establish themselves in the new channels. The major change in the aquatic community in the upper reaches of the Weary Creek diversion would be the exclusion of fish. The dump slope extending across the channels, EL-T44.1 and EL-T43.7, will also eliminate the existing aquatic life in the affected reaches of these streams; displacement to the diversion channels is expected.

If studies currently in progress were to indicate that fish are migrating through the minesite area, and the velocity increase in the Elk River diversion channel (see Section 1.4 for Alternatives) would impede migration, several mitigative options will be considered:

- building a meandering channel and more or less maintaining the existing gradient. This would require moving a considerably greater volume of material, causing greater land disturbance;

- building a channel with riprap bars and pools, thus providing resting places for migrating fish.

The proposed ultimate rerouting of Weary Creek over the dump and into the final lake upon completion of mining will render the upper reaches of the stream inaccessible to migrating fish. From a fisheries perspective, it may be better to leave the creek in the initial diversion channel, since its lower reaches may provide suitable spawning habitat.

The construction of the clear water lake on the lower reaches of Gardner Creek, which increases the size and depth of existing impoundments, would be a fisheries asset.

After completion, the mined pit will be allowed to fill up resulting in a deep lake. It is recognized that a gently sloping shore at the north and south ends would improve the biological productivity of this lake.

4.0 SOCIO-ECONOMIC ASSESSMENTS

Tentative evaluations of primary social impacts have been made and are under continuing study. Employment, community development and resource use are addressed herein in a preliminary manner pending resolution of substantive matters such as community social requirements, townsite sizing and location.

4.1 Employment

It is estimated that the Elk Valley Coal Project will create approximately 1100 new jobs at the peak of construction, and approximately 1400 permanent positions upon start-up (Appendix C, Section 4.1 - Figure 1). Since the mine's production output is primarily dedicated to the consumption of the Owners in Canada and Europe, the labour status at the mine will not be greatly affected by the fluctuating Japanese demand for coking coal. The strength of the project lies in the diverse market conditions facing the Owners, which respond to different sets of circumstances in Canada and Europe. This tends to enhance a steady pace of production and thus to minimize the fluctuation of employment levels.

Coal shipped from the mine will eventually travel on oceans and possibly the Great Lakes system. Of the two, only the Great Lakes have a seasonality of operation. However, due to stockpiling capabilities in the transportation system, the project is not expected to create significant seasonality of local employment, except for student employment during the summer.

It is intended that British Columbia will be the primary recruiting area for all levels of professional and trade employees. There will also be some influx from other provinces in Canada. Recruitment from other countries will be minor since the open-pit mining techniques and the coal preparation process are relatively common in Canada. At all stages of the feasibility studies, design, construction and operation, the Company anticipates cooperation with the British Columbia

Department of Labour, and coordination of any required activities with that Department. At an early stage of employment policy formulation, the ratio of male to female workers will receive full consideration for both full and part-time employment. Elco Mining Ltd. plans to meet the established wage levels in the labour force of the East Kootenay Region.

Employment in support and service industries is estimated to be about 110 and 238 persons respectively. Where possible, Elco Mining Ltd. intends to purchase its goods and services from within the community.

4.2 Community Development

4.2.1 Introduction

Elco retained the Unecon Partnership to analyse the community development requirements of the proposed coal mining project, and to recommend a suitable location where residential facilities to house project personnel and employees of associated service and support industries could be established.

Elco recognizes that the present resurgence of interest in coal mining has made the labour market competitive for the employers. The attraction and stabilization of a high quality manpower force at acceptable cost is essential for the success of the project. The quality of the residential community in which project personnel will be housed is viewed as an important contributor to the viability of the project. Thus, the townsite selection cannot be made on the basis of strictly economic considerations only, but should be sensitive to all those social and socio-economic factors that influence the quality of life in a community.

This report summarizes the progress of the townsite selection program to date. A substantial program of socio-economic studies and physical site-evaluation must be completed before a definitive selection can be presented for review by government agencies and the public.

4.2.2 Community Development Requirements

The currently projected maximum manpower requirement to attain a yearly production of 3.6×10^6 tonnes of clean coal is 1200 persons; for the start-up period, an estimated 200 are required in addition. The production might be enlarged in later stages of the development, however, with a corresponding increase in manpower requirements. For the purpose of this report, the requirements were developed for a project work force of 1400 in a fully stabilized condition, i.e. the stage when the projected maximum manpower force contains 70% married persons, of whom a minimum of 17.5% are childless. To establish some guiding numbers relative to reserves of developable land for future expansion, this report assumed a doubling of the project work force during the first ten years of operation.

The factors used to project the number of working wives, family status of marrieds, family size, ratio of support and service employment to basic industry employment, and the filling of support/service industry job opportunities from within family groups, were established by direct analysis of survey statistics obtained from existing coal mining communities in Southeast British Columbia, as modified by experience in other resource extraction oriented communities.

The factors used to project the mix of housing preferences were developed from a real estate type appraisal that considered family size and income levels, weighted by experience of indicated preference for housing types in similar resource based communities (compare Appendix C, Section 4.2 - A).

The support industry category comprises those activities directly related to the support of the basic industry - e.g. equipment maintenance, tire supply, contract haulage, etc.

The service industry category contains those activities directly related to servicing the total community - e.g. education, professional (medical - legal), commercial, light industrial, utilities, etc.

The following summary of population projections and housing requirements was abstracted from the calculations presented in Section 4.2 (A) of Appendix C:

Population numbers:

Basic Industry	1,400	
Support Industry	112	
Service Industry	238	
Total Employees	1,760	1,760
Unemployed Dependents		2,715
Total Population		4,475

Residential requirements:

Hostel units	192	
Studio suites	356	
1 bedroom apartments	105	
2 bedroom apartments	85	
Total High Density	738	738
3 bedroom townhouse	66	
3 bedroom semi-attached	110	
4 bedroom semi-attached	41	
Total Medium Density	217	217
3 bedroom detached	167	
4 bedroom detached	165	
Total Low Density	332	332

Trailer units	83	
Mobile home units	269	
Total Mobile Units	352	352
Total Accommodations		1,639

Education and Religion

Elementary schools (18 classrooms)	2
Secondary schools (8 classrooms)	1
Churches	3

Commercial retail outlets

Food	10	
General Merchandise	4	
Automotive	4	
Apparel	8	
Hardware & Furniture	7	
Other	10	
Total Retail	43	43

Recreation

Community recreation facility containing hockey, skating, curling and swimming facilities, banquet/meeting hall, hobby rooms, etc; in-door hall-sport facility.	1
Auditorium	1
Outdoor sportfields, field-and-track sport facility	1
Golf course	1
Play-lots	to be determined
Neighbour parks with field house	to be determined
Major community park	1

Next to the commonly provided municipal services, there is a requirement for a public library, day-care centre, a diagnostic and treatment centre and a hospital; the establishment of a provincial highway maintenance depot is anticipated.

Supporting light industry:

Buildings and land to accommodate warehousing, yard storage, machine and repair shops will be required. The magnitude of the requirement has not been determined precisely, since it depends on the selected townsite location relative to existing settlements, mining and forestry projects and future industrial development potential.

Land requirements:

	Ha	Acres
Housing	88.1	220.5
Schools	10.0	25.0
Recreation	28.7	71.7
Commercial	3.0	7.4
Churches	1.4	3.6
Municipal	3.9	9.8
Health (Reserve)	1.0	2.5
Industrial Services	5.0	12.5
Roads	25.2	63.0
TOTAL LAND	166.3	416.0

The land requirement of 166.3 ha applies to a new town only. In the case of attachment to an existing community the requirement is estimated to be about 140 ha.

4.2.3 Location Alternatives

Basically, the three community development alternatives to house project personnel and associated service and support employees are:

1. Attach the community development to an existing town.

2. Attach the community development initially to an existing town, but plan for and gradually implement the development of a new town.

3. Establish a new town.

4.2.4 Alternative 1 - Attachment to Existing Town

The community development closest to the proposed project area is Elkford. The only transportation link between the minesite and Elkford is a gravel-surfaced road from the proposed plantsite to the south, past the confluence of Forsyth Creek and the Elk River, thence by way of a bench area known as Round Prairie to Elkford. The condition of this road is fair. Travel distance from Elkford to the proposed plantsite would be 46 km.

The closest existing community development encountered when travelling north from the proposed minesite is Kananaskis, located on Highway #1 in Alberta. It can be reached using an existing gravel road which runs past the confluence of Cadorna Creek and the Elk River, thence via East Elk Pass and the Kananaskis Lakes to Highway #1. The condition of this road is poor to the Kananaskis Lakes, and fair beyond. In Alberta, this road is being upgraded and paved from Highway #1 southward. There are no settlements along the road section in British Columbia. Travel distance from the proposed plantsite to Kananaskis is 145 km. At the time of writing, little information was available about this settlement. Its excessive distance from the project area as well as its location in Alberta makes it a very unlikely candidate for attachment as per Alternative 1.

Elkford: This existing town is the only feasible option for evaluation under Alternatives 1 and 2. This residential community is located at the confluence of Boivin Creek and the Elk River, to the west of the latter. Its approximate elevation is 1500 m above mean sea level.

The easterly exposure permits early enjoyment of the morning sun. The high mountain range to the west of the town causes early loss of the afternoon sunshine.

Elkford's population now stands at 2,353 on 277 ha of land (Municipal Statistics - Department Municipal Affairs, 1974). Economically, this population is dependent on the Fording Coal Ltd. mine, located on the Fording River, about 29 km from the town.

Schools, recreational, commercial, municipal and service facilities are only adequate to support the existing population. A Diagnostic and Treatment Centre is under construction scheduled for completion early 1977.

A recent study (Appendix C, Section 4.2 - B) examined potential areas for the expansion of the Village of Elkford. This study was based on aerial photography, preliminary topographic mapping and field inspection. It examined potential development areas having a slope of less than 12 percent and falling within a 4.8 km radius of the existing town centre, and clear of the floodplain. These areas are tabulated as follows:

Area Designation	Gross Size		Reserves (slope > 8%)		Net	
	ha	(acres)	ha	(acres)	ha	(acres)
A	115.2	(288)	19.2	(48)	96.0	(240)
B	45.6	(114)	11.2	(28)	34.4	(86)
C	154.0	(385)	49.6	(124)	104.4	(261)
D*	14.2	(38)	-		14.2	(38)
E*	20.0	(50)	-		20.0	(50)
F	10.8	(27)	-		10.8	(27)
TOTAL	359.8	(902)	80.0	(200)	279.8	(702)
Fording Coal Ltd. requirement (Appendix C, Section 4.2 - B)					82.0	(205)
Available for other developments					197.8	(497)

* These areas fall within the floodplain and one lies to the east of the Elk River. Development costs due to flood protection, high water table and bridge construction make both areas highly unattractive for cost-effective development.

The cited Elkford expansion study was undertaken to appraise the future development of Elkford to meet the community requirements, specifically relative to the expansion of the manpower force of Fording Coal Ltd. The net land requirement relative to the Fording project was assessed at 82 ha, and Area A to the south of the existing build-up area was selected for development.

Area B was identified in a government agency study as exposed to avalanche hazard. Moreover, the broken topography would make development costly. This area is estimated to yield about 34 ha for residential development.

Area C, the potential development area farthest removed from Elkford (5 km) lies astride a steep escarpment, which would add greatly to the cost of development as gaining access to the upper bench is expected to involve great expense. Moreover, the area would require a separate water supply and sewage disposal system. Finally, the geotechnical characteristics of the upper bench would add to the cost of development as the unit cost of buried services is estimated at well above average cost experience. Net residential acreage yield is estimated at 104 ha.

Area C lies approximately 5 km to the north of Elkford, and the intervening terrain is unlikely to be developed for a residential function, even in the distant future. It is unlikely that this area would ever become an identifiable part of Elkford, but would remain a separate community requiring its own social, health and recreational facilities. Thus, it is improbable that the principle attraction of attachment to an existing community, i.e. the economies of scale attainable in the case of areas A, B, D, E and F, could be realized in area C.

Areas D and E, together yielding 34 ha for residential development, are located on the floodplain of the Elk River. In Elco's view, residential development should not be undertaken on lands subject to flooding, particularly in mountainous terrain where flash-floods are likely to occur.

Area F, which could yield about 11 ha for residential redevelopment, is located close to the town "gate" and in suitable relationship to the existing commercial/municipal/institutional land uses, service industrial land, and medium/high density residential land. Elkford's present supply of developed lands in these categories does require recognition of the need of land reserves of this nature for a growing town.

In view of the above survey of Elkford's development capability, it is concluded that Elkford could accommodate in Area C about two-thirds of the requirement currently projected for the proposed Elco mining operation. All of the Elco related community development requirements could be met in Elkford if Areas B, D and E would be developed, with disregard for the cost and environmental factors that argue against this course of action.

If Elco were to select Elkford as a desirable development alternative, such a choice would imply the inherent acceptance of undesirable implications for its present and future personnel in terms of high cost residential lots, limited access to commercial, municipal and centralized recreation facilities, substantial environmental hazards and, moreover, excessive commuting distances. Being the last arriving in town, Elco employees would be relegated to accepting living in an area "down-the-road" (Area C), an area hazarded by avalanches (Area B), or by floods (Areas D and E).

In Elco's view, employees will accept commuting distances of up to 48 km on good roads for a limited period only. Commuting over such distances between Elkford and the proposed mine and the plantsite might make the venture liable to an unacceptable high staff turnover (with all the attendant replacement costs, i.e. recruiting, relocation, training) on the one hand, and to demands for reimbursement of travel cost and possibly portal-to-portal pay. It is likely that commuting over such distances will become an important issue in collective bargaining. Even with additional incentives, employees are not expected to accept, on a permanent basis, the drudgery of day-in, day-out travel over such distances. Their operating efficiency is impaired with the additional strain of commuting, particularly under winter ice and snow conditions. Employees will give preference to positions requiring the least commuting, all other conditions being equal.

Selection of Elkford as the site for community development for the Elco project implies the attending development of an all weather commuter transportation capability, as the mine is proposed to be operated on a year-round basis. Travel mode alternatives would be private cars, company operated buses or a public transport facility, all requiring a road of high standard, or by rail, implying a mandatory high standard for the track between the townsite and the project. Thus, there are considerable social, socio-economic and straight economic incentives to minimize the commuting distance to the proposed minesite.

Conclusion: While recognizing that some advantages are attainable by developing Elkford to accommodate project personnel, Elco Mining Ltd. considers this Alternative less suitable because:

- the aggregate of developable land is unattractive in comparison with the already settled or reserved areas in terms of location relative to the developed areas, environmental hazards, distance from centralized commercial, municipal and recreation facilities, and excessive development costs;

- the developable land available to Elco will be reduced if other resource developments such as the Line Creek Project were implemented;

- the broken topography of the Elkford site mitigates against the development of a much larger, coherent town with inherent effects on community spirit;

- Elco employees would be faced with the heaviest commuting liability relative to the rest of the town population, thus placing Elco at a severe disadvantage in the local labour market;

- the great distance to service and repair shops severely limits the benefits to the community of Elco's avowed policy to maximize local procurement of services, and induces development of light industrial support facilities near the project site, with attendant planning dilemmas of a regional nature;

- the great distance between community and project has substantial cost implications in terms of construction of roads and/or railroad to high standards, as well as social and socio-economic cost to the Company and the community;

- since about two-thirds of the Elco community development requirement would be located "down-the-road", virtually no economies of scale, otherwise derivable from attachment to an existing town, are attainable for Area C;

Thus, Elco Mining Ltd. has reluctantly concluded that Elkford might not meet the requirements for adequate residential community development.

4.2.5 Alternative 2 - Attachment with Subsequent Development of a New Town

The only existing residential settlement to which attachment might occur is Elkford. The sites on which subsequent establishment of a new town might prove feasible are reviewed in Section 4.2.6.

The essential assumption for Alternative 2 is that, as a townsite will be developed in closer proximity to the mining project, Elco personnel would tend to relocate to the new site, from the initially provided, rented or purchased acoommodation.

The general implications of this assumption are:

- its temporary nature, assuming a make-do, "muddling through" approach to accommodation provision;

- such accommodation facilities as are established would be vacated eventually and presumably occupied by persons migrating to Elkford to obtain employment in such other ventures as might develop subsequent to the Elco project and in closer proximity to Elkford than to the townsite eventually to be developed further north.

The advantages are:

- in view of the temporary nature of the attachment arrangements, investment by government, private enterprise, land developers and town residents could be limited to such items as are considered to be of permanent use; this relates to infrastructure as well as municipal and recreation facilities;

- no lands need to be developed and permanent housing built beyond the amount required in the foreseeable future by the growth of Elkford induced by other resource development projects, after the Elco employees have been relocated in the newly established town;

- portable housing units could be placed in medium density configuration, camp-type lodgements and mobile home units placed in high/medium density patterns would minimize need for piped and line services;

- rentals and leasing arrangements could be maximized;

- to the extent possible, particularly, single employees would be accommodated on or near the Elco project area, reducing the requirement for and the insistence on acceptable commuting capability;

- the decision respecting site selection for a new town can be postponed and adjusted to such other ventures as might be proposed in the near future. Necessary investments in survey, town planning and land development can also be postponed.

The disadvantages are:

- the town of Elkford would be subject to a boom-and-bust cycle that is expected to seriously affect its harmonious development;
- since the assumption was made that no permanent residential and other structures would be built beyond those required for growth after establishment of the new town, such piped and line services and temporary infrastructure as would be developed would require non-recoverable investment. Payout would have to be obtained otherwise over a short period, through rentals and leases paid by Elco employees, the Company or government agencies.
- substantial expanses of semi-developed land would surround Elkford, without utilization in the foreseeable future, after relocation of Elco employees;
- it is probable that Elco employees would be viewed as a disturbing element since they would have no stake in the community, nor its ultimate welfare. Such resentments might prove lasting, also, with due regard for the implications of the previous paragraph;
- the temporary nature of the offered accommodation discourages married potential employees in particular from accepting Elco jobs, thus mitigating against Elco's objective of early stabilization of its manpower force in a settled state;
- the circumstances that attract a labour force in which single, highly mobile and transient persons would likely dominate are also incentives towards inducing a social climate in the temporary residential community that is considered undesirable by many, i.e. an incompatible attitude towards alcohol, drugs, sex, sanitation, recreation, town aesthetics, work, driving habits, property etc.;
- the influx into Elkford of a manpower force that might be dominated by persons less well versed in the social graces discourages the

migration to that town of persons wishing to establish a specialty business, since there would be a smaller market than found in a town of similar size, but with a settled population consisting largely of married families;

- the temporary nature of the community development foreseen for Elkford discourages the influx of private venture capital to establish permanent retail and other commercial ventures; thus postponing the time that private forces and incentives take over the formative and leading role in community development from government and the Company;

- in order to attract a manpower force of the desired size, the Company would have to maximize the incentives towards accepting temporary residential accommodation. While minimizing its investment in community development, for which it will eventually realize an economic return, it must maximize subsidy arrangements for which there would be no realizable economic and socio-economic returns, particularly from the highly mobile, transient component of the labour force;

- investments into the development of a harmonious, prosperous and viable community would eventually have to be made, once the construction of the new town is taken in hand. Adverse experiences with life in temporary residential arrangements might induce a desire, if not a demand, for a greater measure of investment in infrastructure, municipal and community services and recreation facilities than would be considered reasonable without negative experiences.

Conclusion: Relative to Alternative 1, this option appears to be substantially less desirable.

4.2.6 Alternative 3 - Establishment of a New Town

Elco is presently evaluating whether the front end investment by various sectors of society to develop an adequate new town would be larger than required when attaching the community development to an existing town. It also has to be determined whether better utilization of existing facilities would actually occur by attachment to an existing community. This would only be the case if existing facilities and services are not yet fully utilized. Similar questions are being raised regarding operating costs.

An independent town will be lacking in commercial and recreational facilities until the population has grown to a size that makes somewhat specialized retail outlets economically feasible for potential entrepreneurs. Therefore, a properly sized facility has to be planned and developed right from the beginning.

Experience has shown that the highly visible role of the employer is necessary to develop the community desired; in the case of the Elco project, the visible presence of the employer in development matters is expected to disappear in about 5 years.

All of the above becomes inconsequential if employees will not accept commuting over large distances even with travelling costs paid. The commuting distance to Elkford, the lack of sufficient reserves of developable land, the circumstance that the "inexpensive" land has been either occupied or dedicated, the circumstance that a new mining project would locate in an established community serving an established mining project in closer proximity to the town, combine to warrant ample investigation of such potential new town sites as might be available closer to the proposed mining project.

Moreover, it might well be possible that development of the coal holdings to the north, presently controlled by the B.C. Hydro and Power Authority under Crown reserves, will generate a work force that might locate in a community development in the upper Elk River Valley.

Criteria for Townsite Selection: Elco's perspective on community development leads to the identification of the following site selection criteria:

- Travel Distance: No more than 32 km from the proposed minesite and no closer than 8 km to give adequate clearance from industrial operation.

- Adequate Land Area for Development and Reserves: A land requirement of approximately 170 developable ha for basic industry work force of 1400 is indicated by preliminary projections. Additional reserve developable area for possible community growth resulting from production expansion of this operation or other resource development suggest a minimum land requirement of 324 developable ha.

- Soils and Drainage: Clear of floodplain with preference to good-draining gravel terraces and slopes in the 0 - 12% range.

- Sun Orientation: Sloping toward south within ESE - WSW arc, and free of significant cut-off from nearby peaks and ridges.

- General Climate: Shielded from major prevailing winds (particularly storm), minimal snowfall and snow drifting, not subject to cold air drainage, and with minimal air pollution potential.

- Water Supply and Sewage and Waste Disposal: Within acceptable distance from an all-year creek supply or creek base aquifers for water supply; within reasonable distance from a creek or river with sufficient flow to receive sewage treatment effluents; adequate capability for solid waste disposal in environmentally acceptable manner, not attracting wildlife.

- Environmental Hazards: Not affected by avalanches, rock slides, 100 year floods.

- Environment: Not in critical wildlife habitats or across critical migration routes.

- Minerals, Oil and Gas: Not located over known occurrences of extractible resources implying unacceptable future land use conflicts.

Potential Townsites Identified To Date: Examination of aerial photography and topographic maps, and field inspection of the Elk River valley and adjacent areas, identified four possible townsite locations. Map 14 (Appendix A) shows the Elk River valley north from Elkford to the Kananaskis Lakes area and the identified townsite locations.

Site #1: Forsyth Creek - a gravel terrace of reasonable elevation lying to the north of the junction of Forsyth Creek and the Elk River.

Drainage appears to be moderate to good, with a low groundwater table. Orientation is good, sloping genlty to the east and south in a wider part of the Elk Valley (Photo 16).

Site #2: Cadorna Creek - a bench to the northwest of the junction of Cadorna Creek and the Elk River.

The site appear subject to early loss of afternoon sun. It seems exposed to cold air drainage. It is located over coal seams of unknown value.

Site #3: Kananaskis Lakes - an elongated bench to the east of the lower lake. It is subject to early morning sun interception by the Elk range. The higher elevation (approximately 366 m above Site #1) and pass access to the south might pose difficulties during winter months.

This site, while situated in an area with adjoining British Columbia and Alberta coal resource potential, lies in the Province of Alberta. The recently promulgated Alberta Coal Policy eliminates development of this resource in this area for the foreseeable future. Difficulties arising from the development of a community in one province to serve resource extraction in another are also anticipated.

With the limited knowledge available to date, it would appear that, among the three, Site #1 offers the best prospects for community development.

Appraisal Site #1 - Forsyth Creek

- Land Adequacy: The land area under consideration for a townsite comprises an area of approximately 310 ha in total. This provides a reserve for increase of the Elco work force if expanded for increased production or a reserve for attachment of community development for other projects.

  An earlier geotechnical study (Golder Brawner and Associates Ltd., 1969) identifies an area lying within the centre two thirds of the bench as the most suitable for townsite location. This area is approximately 202 ha in size and corresponds to the major portion of the terrace. While defining the preferred land area for residential development, this study confirms that the higher land rising gently to the north is also suitable for town development although with some additional servicing cost due to soils and watertable characteristics.

- Land Quality: Site #1 lies between the Elk River and Forsyth Creek and centers approximately opposite the mouth of Britt Creek. It was defined from air photo interpretation by Golder Brawner and Associates Ltd. in 1969.

  The lower granular terrace area rises from elevation 1417 m to 1463 m at a slope of about 3%. The upper bench of silty glacial till rises to an elevation of 1555 m at a slope of about 6.7%. The overall site slopes to southward with a drop of about 137.2 m in 3.35 km or just over a 4% average slope.

Much of this land area is covered with dense stands of small size lodgepole pine.

- Site Climate: Little site-specific information is available concerning climate, however, it is expected that this upper Elk River valley bottom site at 1463 m A.S.L. experiences a colder and drier climate than that of lower valley centres such as Fernie. This might translate into lower snowfall and snowpack, but greater vulnerability to frost penetration and heaving.

- Quality of the Environs: The upper Elk River valley contains considerable potential for outdoor recreation. High altitude lakes, the river, numerous creeks, waterfalls, and trails offer high potential for hiking, camping and enjoyment of scenery, particularly in the area on upper Forsyth Creek between the Connor and Abruzzi Lakes. Hunting and some fishing will be available, and the potential for quality skiing and related winter sports is considered high.

Desirable Planning Criteria: The physical aspects of this site suggest that the following planning criteria and constraints should be adopted:

- prohibit development on the floodplains of Forsyth Creek and the Elk River;

- construct a fire break system to protect the built-up area, possibly utilizing watercourses and a northside lateral break;

- locate the community and orient its layout to gain maximum sun penetration while minimizing exposure to high velocity prevailing winds;

- design streets and housing configurations to minimize snow drifting, facilitate easy snow removal;

- locate the highway and other major transportation corridors to by-pass the townsite area, including adequate land reserve for long range town expansions.

Conclusion: With due regard for the limited information about Sites #2 and #3, it is concluded that there is at least one site available on which a community development to accommodate Elco personnel could be established. Subject to more detailed study, it would appear that this site offers the desirable advantages that Elkford lacked when evaluated as Alternative 1.

From a perspective of maximizing the social and socio-economic benefits, Site #1 under Alternative 3 appears to be very attractive. Such an assessment cannot yet be made from a strictly economic point of view for lack of adequate data and analysis.

Analysis of the total cost of community development as per Alternatives 1 and 3 would determine whether Site #1 would in fact offer the prospect of being the more desirable location that, while minimizing the initial as well as the long-term investment, maximizes the return on that investment in social, socio-economic and strictly economic terms.

4.2.7 Further Studies and Public Impact

Many special interest groups at the local, regional, provincial and national levels become involved in a proposal such as the Elk River Coal Project. Elco recognizes that the maintenance of adequate channels of communication with such interest groups to obtain their input is essential to the success of the project, as has been demonstrated during Elco's first public meeting at Fernie in July 1975.

A number of items dealt with on a broad basis in the preceding text will require further detailed analysis and study before final solutions can be identified. These would comprise:

- Topographic mapping of the selected townsite.
- General and micro-climate data.
- Investigation of water supply sources.
- Geotechnical investigation.
- Location of aggregate borrow pits.
- Determination of transport and utility corridor impacts.
- Site-specific information on wildlife resources, fishery capabilities and vegetation characteristics.
- Effects of sanitary sewer effluent and solid waste disposal.
- Recreation potential and the impacts of "opening" the area.
- Manpower studies as to labour services, training and retraining.
- Effects on government facilities and services.
- Effects on regional transportation and utility networks.

With the available information, a meaningful socio-economic impact matrix cannot yet be prepared. It will be included in the Stage II Report.

PHOTO 16: Proposed townsite: Forsyth Creek - October, 1976.

4.3 Resource Utilization

4.3.1 Timber and Grazing

Recognized Effects: Forestry capability (Canada Land Inventory, 1970) forms the largest single resource block (58%) of the licence area. Both railway location alternatives will bisect areas of high and moderate yield forestry capability (Appendix A - Maps 4 and 7). The majority of stands are immature and may not realize commercial importance for another 40 years. The effect attending mining disturbance is the loss of potential timber production. A few stands of merchantable timber, missed by the 1936 fire, are located on the proposed minesite area (Appendix A - Map 8); these will not be affected significantly by mining development, although normal forestry practices may result in harvest during the mining period. An effect may result from improved access, especially rail, which could stimulate logging activity in the upper valley. Potential logging development in the Forest Reserves north of the minesite is presently under study by the Provincial Government.

Domestic grazing capabilities in the impact study areas have not been determined. Field evaluations at the minesite and along the road and rail corridors indicate grazing capability limitations because of dense forest cover, deadfall, muskeg and generally poor forage availability. At present, general agricultural activity in the Elk River basin is limited and confined to areas of the Elk Valley downstream from Elkford (B.C. Department of Environment, Water Resources Service, 1976).

Mitigative Considerations: In terms of natural resource utilization, loss of timberland and production time is a trade-off with coal resource development benefits, primarily a socio-economic consideration.

Post-mining lake development will eliminate approximately 183 ha of lands with potential forestry capability, although recreational and wildlife benefits are introduced as mitigative compensation.

Non-merchantable timber cleared by mining development will be used wherever possible to minimize waste. Logging slash could be incorporated into slope preparation for revegetation wherever fire hazards can be avoided. Assessment of the capability of reclaimed lands to support timber production is a revegetation study objective. A timber capability objective for reclamation remains a land use option that should be evaluated relative to and next to the forage yield potential of reclaimed lands.

4.3.2 Recreation and Aesthetic Resources

Recognized Effects: The existing recreation trends and values, as determined by British Columbia Fish and Wildlife (Bull, 1972), provide a preliminary basis for predictions of public concerns relative to mining development effects on recreation. These include:

- removal and alteration of mountain scenery;
- loss of fishing locations, and game fish productivity;
- noise pollution, both by the minesite and along the length of the valley (daily road and rail traffic);
- air pollution by coal dust and traffic dust;
- water pollution by seepage of mine and tailings water and by undesirable siltation;
- loss of big game capability;
- loss of winter recreation: snowshoeing, cross-country skiing, and snowmobiling;
- alteration or interruption of the proposed Great Divide Trail with attendant effects on hiking, camping and enjoyment;

- loss of non-game wildlife for bird watching and nature study;

- increased use of regional recreation areas by increased populations, with attendant increase of the forest fire hazard.

Mitigative Considerations: Preceding discussions of mitigation and reclamation can be interpreted in a recreation context. Revegetation and increased wildlife and fish productivity, coincidentally restoring traditional recreation uses and offering potential recreational alternatives, where feasible, are the ultimate aims of reclamation. The shallow lake below the northwest dump settling pond (Appendix A - Map 3) is a good example. It could be available early in project development as a recreation resource for picnicking, fishing and observation of mining activity. An information station can be established here as an education resource, providing interpretative material on energy resource development and local ecology.

Public and wildlife utilization of the ultimate landscape wil guide reclamation. Examples might be creation of waterfalls (aesthetic criteria), increased acreage of forage lands for elk production (hunting criteria), or return to climax conifer species (forestry criteria).

4.3.3 Heritage Resources

A reconnaissance survey for archaeological and historical resources has not been made previously in this remote, virtually unpopulated area. To ensure against the inadvertent destruction of such heritage resources, Elco has commissioned a survey for those areas that are liable to be disturbed during the life of the project.

5.0 ONGOING PROGRAMS AND CONTINGENCY PLANNING

Climate and Air Quality

Meteorological stations will be established at the top of Little Weary Ridge and on the valley floor near the 1975-76 exploration camp. Data collection will include maximum-minimum daily temperatures, wind direction and velocity, and precipitation. These weather data will supplement information presently being gathered in the vicinity by ELUC. A snow-course has been established and snow depths are being recorded at 18 stations across the floor and up both flanks of the valley (Appendix A - Map 10). These, along with one at each river gauging location, brings the total to 25 snow depth measuring locations which are monitored weekly. A dispersion climatology study is in the planning stage.

A dust monitoring program will be initiated prior to the start of construction to establish baseline conditions.

Noise

The establishment of a noise monitoring program is under study. Noise management planning in order to comply with Workers' Compensation Board, Mines Regulations Act, and other requirements, could be a component of this program.

The program content might include such items as:

- measurement of ambient and disturbance noise levels;
- preparation of a noise contour map;
- examination of wildlife responses in other regional coal mining and rail disturbance areas, as a basis for noise management.

Surface Water Flows

Water levels are presently being recorded by staff gauges installed at three locations in the Elk River and several of its tributaries within the licence area. Periodic flow meter readings will be obtained so that stage-discharge relationships can be developed to allow interpretation of staff gauge data.

Water Quality

Water samples will be collected from the Elk River, Weary Creek, Gardner Creek and other tributaries of the Elk River that might be affected by the project. Laboratory analysis of water samples will include determination of present base levels of various water quality parameters such as pH, conductivity, total solids, dissolved and suspended solids, organic carbon, turbidity, hardness, alkalinity, sulphates, acidity and heavy metals. Water sampling will be continued through the construction and mining phases to monitor the effects of the development on water quality. Water samples from natural seepages and springs will also be collected for laboratory analysis.

Groundwater

A more detailed assessment of present groundwater conditions in both the overburden and the bedrock will be developed as various geotechnical studies related to the design of pit slopes, waste dumps, tailings ponds, and plant are completed. Investigations of this type may include the installation of piezometers in drill holes, permeability tests, pumping tests and water level monitoring in open drill holes.

Slope Stability

Site specific geotechnical programs are presently evolving to further investigate the stability of the proposed pit and embankment slopes.

Parameters to be investigated in these studies will include existing geologic structure, physical properties of the rock, overburden and groundwater pressures and artesian flows.

Extensive geotechnical investigations related to the design of tailings ponds, waste dumps and plant foundations and other ancillary structures will be carried out during 1977 relative to final design, before commencement of construction.

Programs to monitor groundwater pressure and slope movement during the construction and mining phases of the operation will be set up where required. In addition, geologic information will be gathered on a continuing basis during the mining operation as slopes become exposed, to further refine the premises used in the initial slope design analysis.

Geology

The present 1976-77 exploration program will provide additional information regarding the stratigraphy and structural geology required to prepare the final mine design. Other infill drilling may also be carried out during 1977.

Soils

A soil and peat survey of the minesite and corridor study areas during the summer of 1977 will complete the inventory of materials available for soil reclamation. Guidelines for soil salvage operations will be developed from the results.

Ongoing reclamation planning will address construction, operation and post-operation phases of development and will also comprise:

- assessment of reconstituted rooting media as to plant growth capabilities through growth plot measurement and testing;

- development of an overall soil (and drainage) monitoring program relative to soil fertility and growth capability.

Vegetation

Continuing studies are:

- additional work to complete the plant species inventory, particularly for species sensitive to development;

- the development of species selection and planting programs;

- the development of a native species propagation program;

- the examination of the availability and condition of wildlife forage plants. This will be conducted concurrently with wildlife habitat studies.

Wildlife

Continuing field studies and monitoring programs will address data gaps discussed in this submission. Study emphasis for the 1977 field program in particular, will shift to the minesite-Elkford corridor area and alternative townsites.

The scope of ongoing studies includes:

- ungulate habitat capability and utilization assessments: snow depth monitoring, winter range utilization, spring surveys of utilization transects, mineral lick locations and identification of calving grounds;

- migration corridor investigations and relationships with high capability areas;
- identification of offsite habitat limitations;
- small mammal inventory;
- definition of environmentally sensitive areas;
- general wildlife observations and documentations.

Consultation between government agencies and the proponent might identify additional study needs.

Aquatic Life

During 1977, additional baseline data will be collected on the aquatic life in the vicinity of the minesite. These surveys will include the identification and relative abundance of algae and macroinvertebrates in those sections of the Elk River and its tributaries that may be affected by the project. In addition, all resident fish species within the minesite area, or migrating through the minesite, and the present utilization of the area will be determined. The fish habitat of the Elk River and its tributaries within the mining area will be further evaluated.

Public Consultation

The Company will develop programs for community interaction to ensure the involvement of citizen group and individual interests in project related environmental planning.

Recreation

Consultation with the Parks Branch and review of the Southeast Coal Study will determine how development alternatives relate to recreational reserves (Round Prairie, Boivin Creek, Weigert Creek, Connor Lakes and other sites; Andrusak, undated) and the needs for additional road and railroad corridor planning.

Community and socio-economic studies commissioned by the Company and regional studies (Southeast Coal Study) will allow the identification of the recreational needs of an increased urban population as well as effects on the capability of existing recreation areas in the Elk River Valley. Recreation will be an important parameter in the development of a reclamation plan.

Heritage Resources

An archaeological-historical reconnaissance has been commissioned for 1977.

6.0 IMPACT SUMMARY

6.1 Alternatives to be Further Defined in Stage II

Preliminary project planning has been based on economic criteria and the recognition of environmental effects associated with the current planning concept. This has resulted in the development of design and location alternatives which will be evaluated during subsequent design phases.

The formulation of alternatives was deemed desirable for:

- mine pit configuration;
- ancillary mine facilities layout:
  - waste dumps
  - tailings ponds
  - soil stockpiles
  - surface drainage modifications
  - roads
- plant layout;
- river diversions;
- powerline relocation;
- transportation corridor, including roads and railroads;
- community development.

Coal blending requirements, stripping ratios, coal reserves and other economic factors will define pit location and general development concepts, as discussed in Section 1.0. Additional information obtained from ongoing exploration programs will be incorporated into the final mine design. Alternatives under review at the present time include northward extension of the pit to allow the recovery of higher quality coals which may be required to obtain the needed blended coal quality during the early stages of mining; continuation of the pit southward; the development of an underground mining operation to recover additional reserves.

Waste dumps will have to be created outside the pit area during the early stages of pit development. Alternative dump locations are very limited and the preliminary mining plan recognizes the balance between environmental considerations and hauling costs. Backfilling will ensue once the initial pit has been sufficiently developed.

The location of soil stockpiles is relatively flexible. The stockpiles will be located within the disturbance area and be related to pit development. They will be removed as reclamation of various slopes proceeds during the mining phase.

Surface drainage modification is required to limit the amount of water flow through the minesite and promote stability of adjacent embankment slopes. Alternatives will be developed and assessed in Stage II. However, the general location of drainage interceptor ditches is governed by the location of roads, waste dumps, pit and other structures and by the existing terrain.

There does not appear to be an economically feasible method for backfilling of the final mine pit. Therefore, the development of this segment of the pit as a lake is probably the most satisfactory means of reclamation and may be viewed as a recreation resource development opportunity.

At completion, Weary Creek could be rerouted over the dump and into the final lake, or maintained in the diversion ditch. The latter would require considerable maintenance.

Ongoing hydrological, ecological and geotechnical studies will provide additional data that will allow better definition of the river diversion. The valley configuration limits the number of Elk River diversion alternatives that would be feasible. Several alternative methods of diverting the Elk River were considered relative to river gradient, area of disturbance, safety, and locations of mine facilities such as the plant, pit waste dumps and water retention ponds. The Alternative presented in this report is considered to cause the least disturbance; however, as indicated in Section 1.4, a rethinking of diversion alternatives may become necessary. Were the mine to extend further northward for resource conservation purposes, an additional alternative i.e., diversion of the Elk River and Cadorna Creek above their confluence would have to be evaluated.

Plant location alternatives are few in view of constraints imposed by the location of the mine and the valley floor conditions. The indicated plantsite (Appendix A - Map 3) is near the centre of the mining activity and on the valley floor. If the mine is extended southward, the proposed plantsite will still be favourable. Location at higher elevations would seriously affect the layout of ancillary features such as the blending bed and the tailings ponds.

The development of the pit on the east flank of the valley will require relocation of the powerline. The most suitable route is considered to be along the west flank of the valley, around the minesite, joining up with the existing line south of the mine (Appendix A - Map 12).

Preliminary railway alignment studies investigated seven possible routings. Of these, two were considered in greater detail. At this stage, assessments of these two alternatives, (Appendix A - Map 12 and 12a) including further investigations relating to technical feasibility and environmental effects are in progress.

No additional access roads are being considered. The existing forestry road can be upgraded to handle the increased volume of traffic. The forestry road relocation above the plant along the western flank is considered to be the most suitable for the purpose of keeping traffic away from the mining and plant activity. North of the mine, the road could be routed via switchbacks to cross the Elk River downstream from the Cadorna confluence. A fairly straight road without switchbacks crossing both the Cadorna Creek and Elk River, upstream from the Cadorna confluence would be the alternative. Road locations within the mining development are determined by mine and plant layout.

Unecon Project Consultants have evaluated four alternative community development sites. These include expanding the existing townsite of Elkford, a gravel terrace near the Forsyth Creek confluence, the bench south and east of the Cadorna Creek confluence, and the Kananaskis Lakes area.

6.2 Biophysical Impact Matrix

The preliminary matrix analysis presented considers proposed minesite activities only. Offsite impact assessments are not provided at this time, pending completion of the data base and better definition of alternatives.

The assessments relate to successive stages of development identified in the matrix. For example, "Operation" phase judgments for any one "environmental factor" presuppose the previous "Construction" phase conditions. The approach will assist in identifying the needs and staging of mitigation and reclamation measures.

In general, the matrix design and coding format is derived from that provided by the B.C. Guidelines for Coal Development. Additional site-specific and minesite operation factors recognized in this report have been added. The basic assumptions and coding description are contained in the attached "Explanatory Notes", cross-referenced to matrix footnotes.

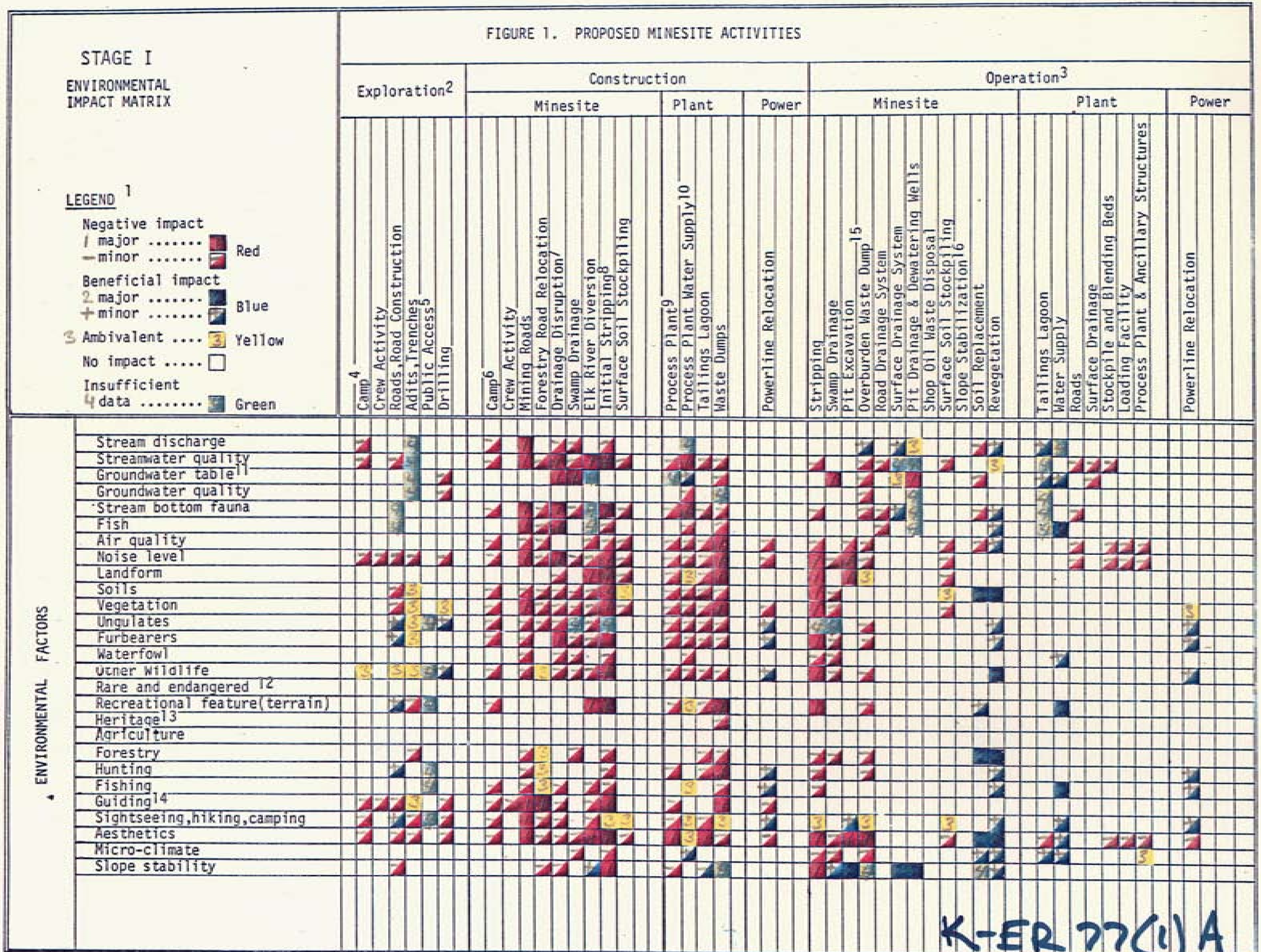


FIGURE 1. PROPOSED MINESITE ACTIVITIES
STAGE I
ENVIRONMENTAL IMPACT MATRIX
LEGEND 1
Negative impact
major .... Red
minor ....
Beneficial impact
major .... Blue
minor ....
Ambivalent .... 3 Yellow
No impact .....
Insufficient data .... Green
Exploration2
Construction
Minesite
Plant
Power
Operation3
Minesite
Plant
Power
Camp4
Crew Activity
Roads,Road Construction
Adits,Trenches
Public Access5
Drilling
Camp6
Crew Activity
Mining Roads
Forestry Road Relocation
Drainage Disruption7
Swamp Drainage
Elk River Diversion
Initial Stripping8
Surface Soil Stockpiling
Process Plant9
Process Plant Water Supply10
Tailings Lagoon
Waste Dumps
Powerline Relocation
Stripping
Swamp Drainage
Pit Excavation
Overburden Waste Dump15
Road Drainage System
Surface Drainage System
Pit Drainage & Dewatering Wells
Shop Oil Waste Disposal
Surface Soil Stockpiling
Slope Stabilization16
Soil Replacement
Revegetation
Tailings Lagoon
Water Supply
Roads
Surface Drainage
Stockpile and Blending Beds
Loading Facility
Process Plant & Ancillary Structures
Powerline Relocation
ENVIRONMENTAL FACTORS
Stream discharge
Streamwater quality
Groundwater table11
Groundwater quality
Stream bottom fauna
Fish
Air quality
Noise level
Landform
Soils
Vegetation
Ungulates
Furbearers
Waterfowl
Other Wildlife
Rare and endangered 12
Recreational feature(terrain)
Heritage13
Agriculture
Forestry
Hunting
Fishing
Guiding14
Sightseeing,hiking,camping
Aesthetics
Micro-climate
Slope stability

6-5

K-ER 77(1) A

EXPLANATORY NOTES

1. Impact = Change
   - ☐ No noticeable or "significant" change.
   - ◪ Degree of change minor - confined to licence area.
   - ■ Degree of change major - extending beyond licence area (sub-region, i.e., Upper Elk River Valley, above Elkford) and/or substantial long-term change within licence area.

   Ambivalent = balance between negative and beneficial results.

   Impact judgments are relative to the specified time block.

   Impact assessments relative to Environmental Factors have considered historic use(s) and resource capability.

   Proposed minesite activities consider individual impact relationships only, not collective effects, on individual Environmental Factors.

2. Elco Project began with 1975 exploration.

3. Post-operation has not been evaluated pending completion of feasibility studies.

4. Evaluations concern this project only; hence, previous clearing of campsite not considered.

5. Public access depends on reclamation planning, i.e., whether or not roads are closed, and government direction.

6. Includes consideration of camp water, sewage and runoff from campsite.

7. Drainage disruption includes minor interception ditches as well as Weary Creek diversion.

8. Initial stripping includes Little Weary Ridge and Valley bottom.

9. Includes blending beds, stockpile and loading areas.

10. Includes Clear Water Lake.

11. Groundwater table includes piezometric levels in aquifer.

12. "Rare and Endangered" wildlife category assumes none present.

13. "Heritage" category assumes no artifact sites.

14. Guiding facilities will be eliminated by pit construction phase.

15. Includes pit backfill.

16. Not evaluated pending design.

ACKNOWLEDGEMENTS

This report is based on office studies and field and laboratory observations that were initiated in 1974 and concluded in January 1977. During this period valuable assistance and worthwhile advice was received from many government agencies.

Elco Mining Limited would like to acknowledge the contributions made in particular by:

The British Columbia Department of Mines and Petroleum Resources;
The British Columbia Forest Service;
The British Columbia Fish and Wildlife Branch;
The British Columbia Environment and Land Use Committee;
The Northern Forest Research Centre, Canadian Forestry Service;
Environment Canada;
The Water Survey of Canada;
The Canadian Wildlife Service;
The Department of Regional and Economic Expansion, Canada.

Substantial segments of this report are either based on reports by, or were prepared by consultants retained by Elco Mining Limited. The Company acknowledges the contributions made by:

Exploration und Bergbau GmbH;
Emkay Canada Natural Resources Ltd;
Techman Ltd.;
Unecon Project Consultants Limited.

K-ELK RIVER 77(8)A

ELK RIVER COAL PROJECT

STAGE I REPORT

APPENDICES

ELCO MINING LIMITED

January, 1977

COPY NO. 14

ELK RIVER COAL PROJECT
STAGE I REPORT
APPENDICES

prepared for the

ENVIRONMENT AND LAND USE COMMITTEE
as prescribed by the
GUIDELINES FOR COAL DEVELOPMENT
BRITISH COLUMBIA

by

ELCO MINING LIMITED

January - 1977

APPENDIX C - SUPPORT MATERIAL

SUPPORT MATERIAL APPENDIX C

1.3 COAL QUALITY AND BLENDING REQUIREMENTS

1.4 MINING PLANS

1.5 COAL PREPARATION PLANT

2.1 CLIMATE

2.2 SURFACE WATER

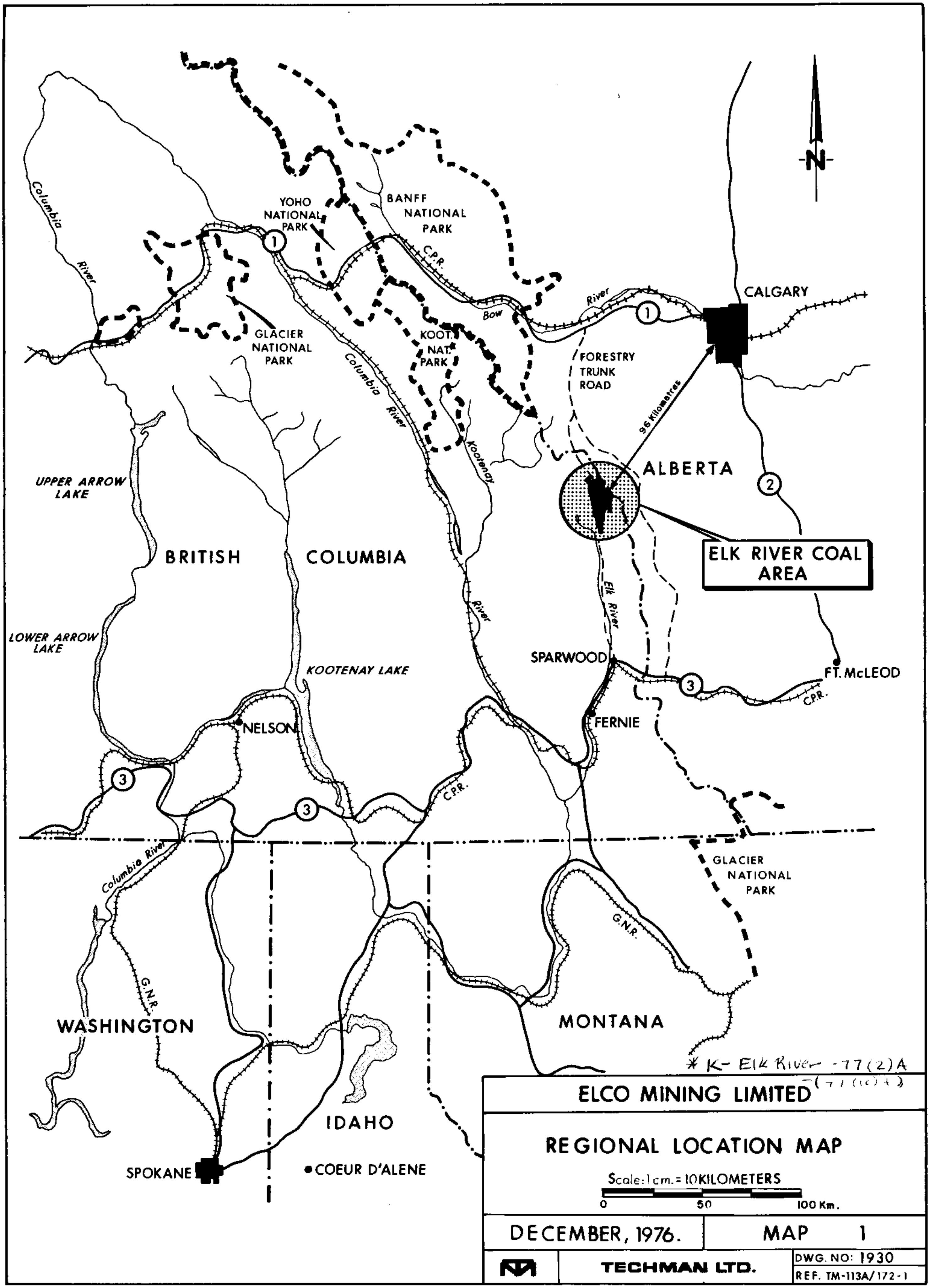
APPENDIX A

APPENDICES

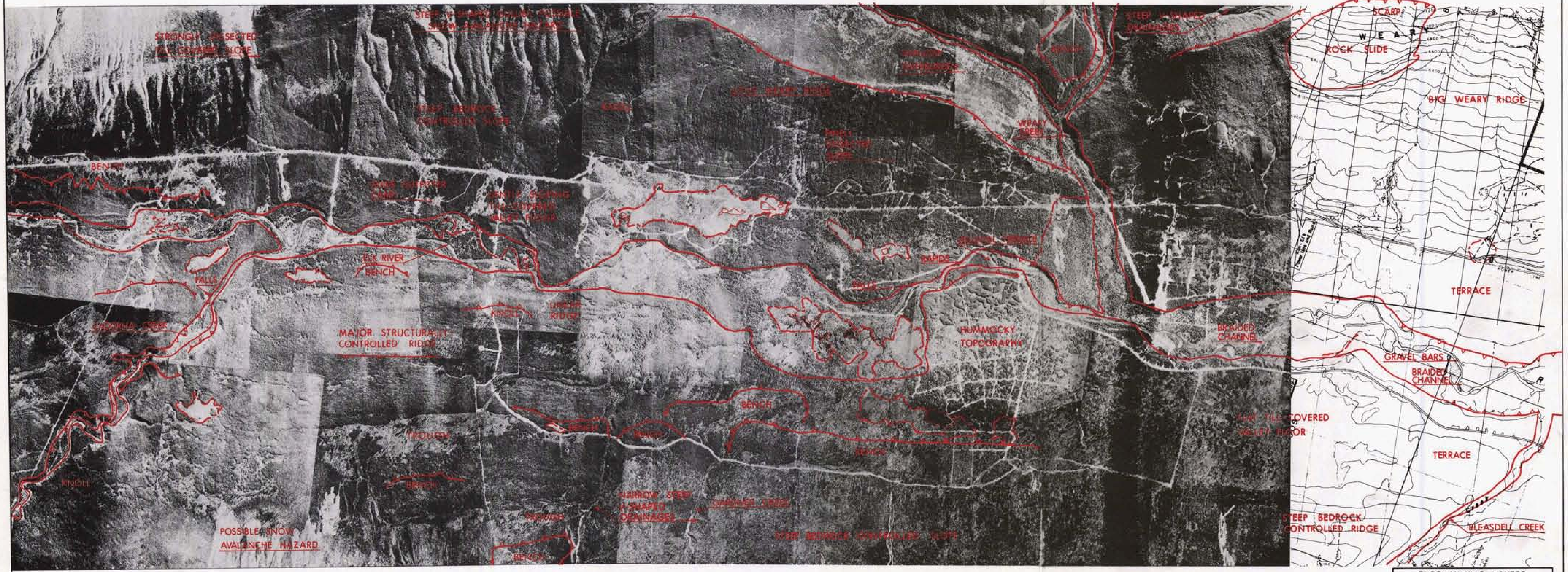
APPENDIX A - MAPS

MAPS

APPENDIX B - GLOSSARY OF ENVIRONMENTAL AND SCIENTIFIC TERMS



N
YOHO NATIONAL PARK
BANFF NATIONAL PARK
C.P.R.
Columbia River
Bow River
CALGARY
GLACIER NATIONAL PARK
KOOT. NAT. PARK
Columbia River
FORESTRY TRUNK ROAD
96 Kilometres
Kootenay
ALBERTA
UPPER ARROW LAKE
BRITISH COLUMBIA
ELK RIVER COAL AREA
Elk River
River
LOWER ARROW LAKE
KOOTENAY LAKE
SPARWOOD
FT. McLEOD
C.P.R.
NELSON
FERNIE
C.P.R.
Columbia River
GLACIER NATIONAL PARK
G.N.R.
G.N.R.
WASHINGTON
MONTANA
IDAHO
SPOKANE
COEUR D'ALENE
* K- Elk River -77(2)A
ELCO MINING LIMITED
REGIONAL LOCATION MAP
Scale: 1 cm. = 10 KILOMETERS
0
50
100 Km.
DECEMBER, 1976.
MAP 1
TECHMAN LTD.
DWG. NO: 1930
REF. TM-113A/172-1



LEGEND

FLOOD PLAIN	ALLUVIAL FAN
BREAK IN SLOPE	MEANDER SCAR
RIDGE	FEN OR MEADOW
	LAKE

ELCO MINING LIMITED

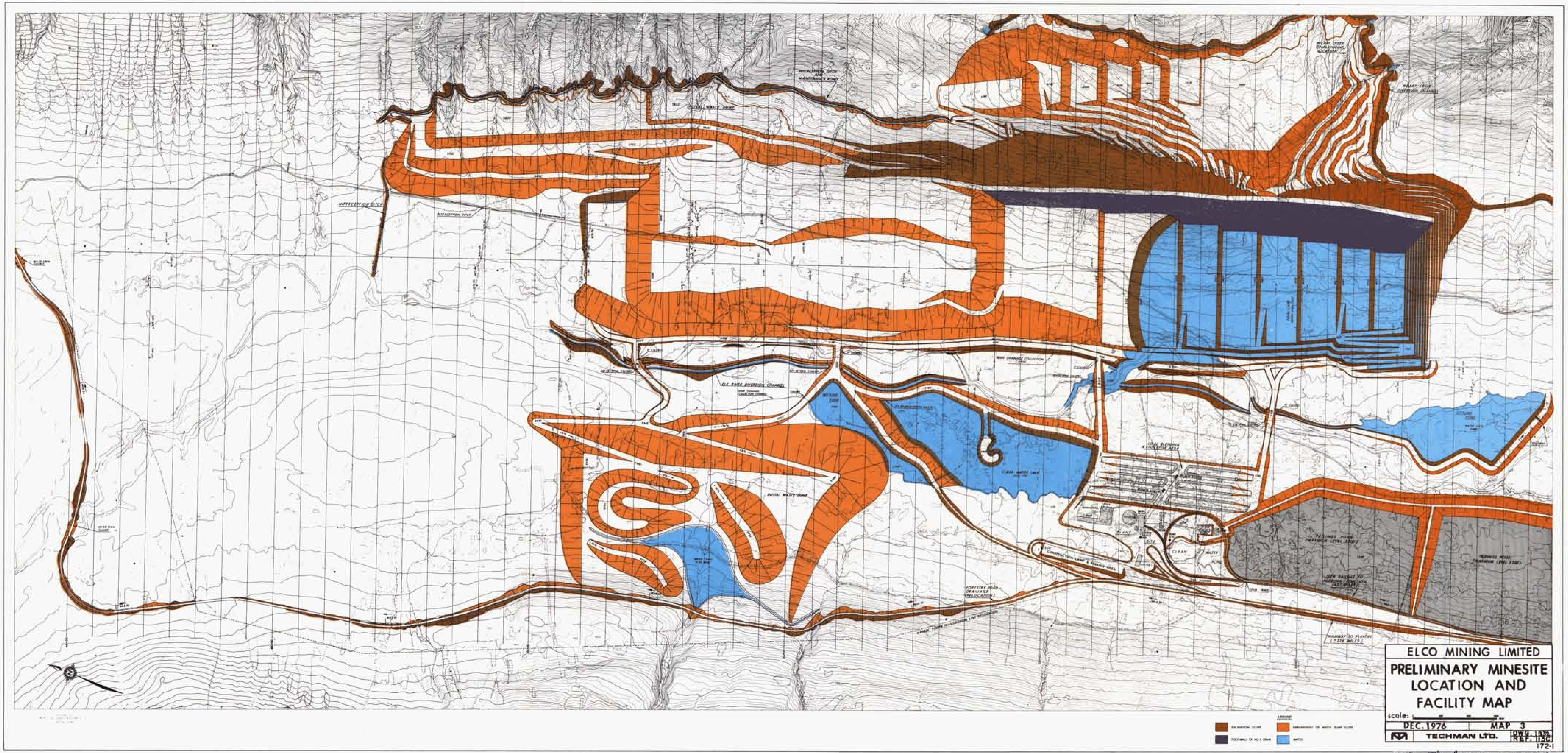
LANDFORM FEATURES

Scale: 0 0.5 KILOMETER

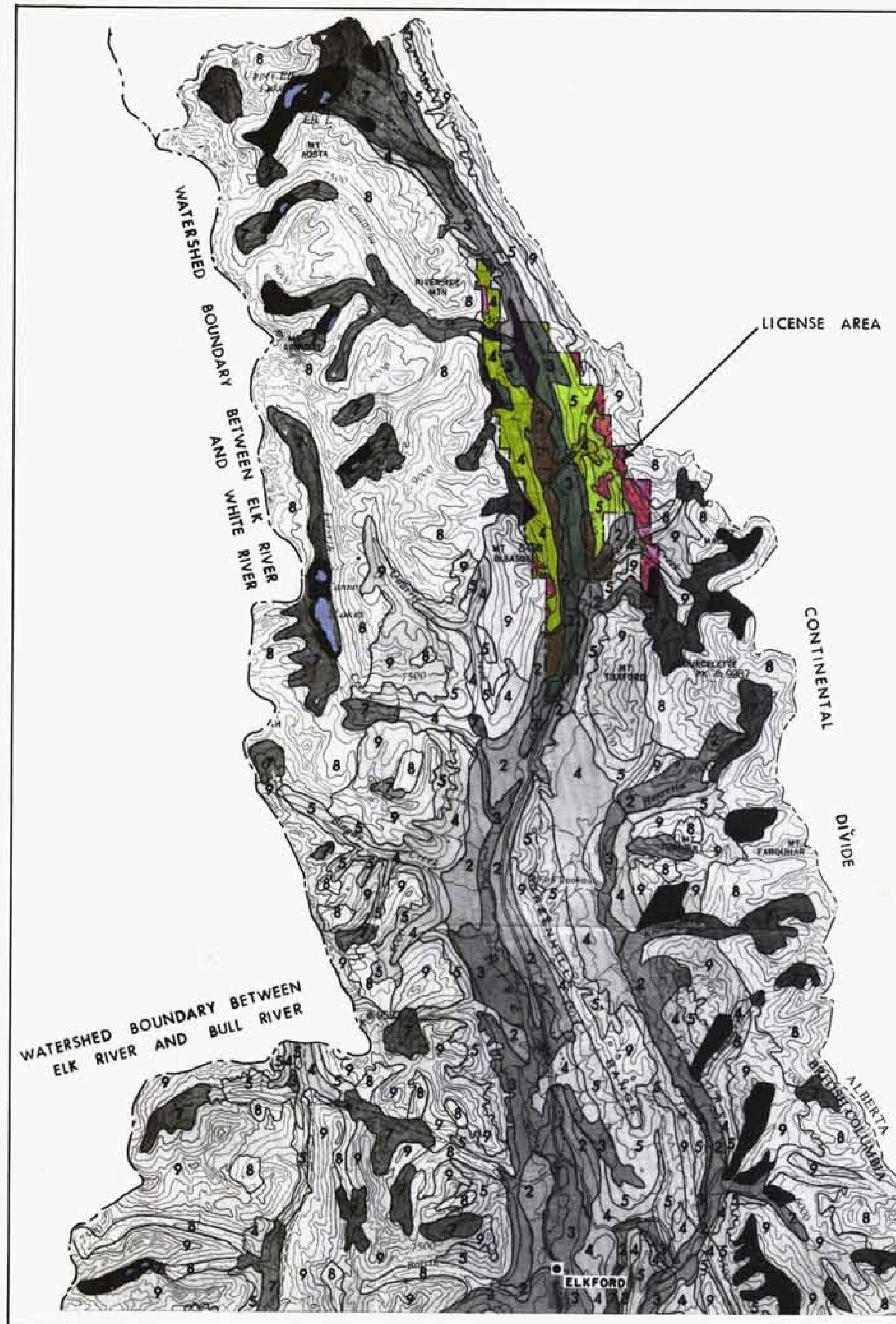
DEC. 1976 MAP 2

TECHMAN LTD.

* K- Elk River -77 (2) A.



* K-Elk River-77 (2) A.



LEGEND

BIG GAME

1 — PRIME BIG GAME RANGE
These lands are important winter concentration ranges for ungulates (deer, moose, sheep and goat) that summer over a widespread area. These wintering areas also have capabilities for summer production.

2 — MODERATE BIG GAME RANGE
These lands have slight limitations to the production of ungulates but are important year-round or seasonal use areas.

FORESTRY

3 — HIGH YIELD FOREST
Productivity ranges from 71 to 130 cubic feet per acre per year for main commercial species.

4 — MODERATE YIELD FOREST
Productivity ranges from 51 to 70 cubic feet per acre per year for main commercial species.

5 — LIMITED YIELD FOREST
Productivity ranges from 31 to 50 cubic feet per acre per year for main commercial species. Large units of this class would be required to sustain a viable industry.

RECREATION

6 — QUALITY RECREATION
Sites and units with capability for intensive recreation use. Includes historic and view sites, natural phenomena, ski areas and man-made attractions of National or Provincial significance as well as shoreline features of regional significance for bathing, camping, boating and cottaging.

7 — MODERATE RECREATION
Important upland areas containing streamside camping sites or units offering a full range of extensive recreation activities of high quality. These areas may be used casually or intermittently for important single activities.

8 — EXTENSIVE RECREATION
Generally large units with capability for a limited range of extensive recreation pursuits and small site specific attractions with limitations of climate or topography.

SPECIAL CATEGORY

9 — HIGHLAND
This is high elevation land with capabilities for both Big Game and Recreation. For Big Game it contains excellent summering areas for many species as well as escape terrain and wintering ranges for mountain goat and sheep. Capabilities for Recreation are of the *Extensive Recreation* type such as hiking and riding, mountain climbing, wildlife viewing and hunting.

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* K-Elk River-77(2)A

CANADA LAND INVENTORY SYNOPTIC LAND CAPABILITY

Scale : 0 5 10 15 KILOMETERS

DECEMBER, 1976. | MAP 4

TECHMAN LTD. DWG. NO: 1933 REF. TM-113A/172-1

275

1.3

FIGURE 1

MINING PLAN C
QUALITY COMPARISON SHEET*

SEAM NUMBER	% COAL (RESERVES)	% WT. ROM COAL	% ASH (DRY BASIS) 2" x 1/2"	1/2" x 28M	28M x 65M	65M x 0	HEAD ASH % (DRY BASIS) 2" x 0
2	10.29	9.58	57.03 (17.9)	35.53 (50.0)	23.25 (4.9)	20.0 (27.2)	34.55
3	4.25	4.37	67.39 (13.6)	12.93 (48.7)	11.06 (22.3)	11.0 (15.4)	19.62
4	18.56	17.78	34.92 (17.9)	26.62 (58.3)	18.13 (11.3)	16.2 (12.5)	25.84
5	1.11	1.52	34.92 (17.9)	26.62 (58.3)	18.13 (11.3)	16.2 (12.5)	25.84
6	3.38	4.15	45.95 (20.0)	22.81 (46.8)	15.05 (11.1)	13.1 (22.1)	24.39
7	2.87	2.83	56.65 (13.4)	38.53 (44.7)	28.86 (15.1)	19.9 (26.8)	34.50
8	10.63	10.47	53.86 (26.7)	28.82 (50.3)	15.57 (18.9)	13.7 (4.1)	32.38
9	8.45	7.71	34.45 (24.2)	21.91 (57.0)	10.10 (10.3)	11.4 (8.5)	22.83
10	12.48	11.32	46.89 (16.2)	19.67 (50.9)	10.79 (9.4)	11.8 (23.5)	21.39
11	2.63	2.63	63.44 (28.3)	37.18 (51.1)	20.49 (8.7)	17.9 (11.9)	40.86
12	7.40	7.48	63.44 (28.3)	37.18 (51.1)	20.49 (8.7)	17.9 (11.9)	40.86
13	7.77	8.64	82.38 (19.3)	60.48 (63.7)	34.08 (7.4)	33.0 (9.6)	60.11
14	4.92	5.41	68.1 (30.6)	41.6 (51.8)	27.58 (7.0)	26.1 (10.6)	46.78
15	3.30	3.57	62.03 (34.1)	42.60 (47.9)	20.98 (11.9)	21.9 (6.1)	45.39

*Fall 1975 Birtley data

Note: () denotes percent by weight of specified size fraction.

FIGURE 1 Cont'd

MINING PLAN C
QUALITY COMPARISON SHEET*

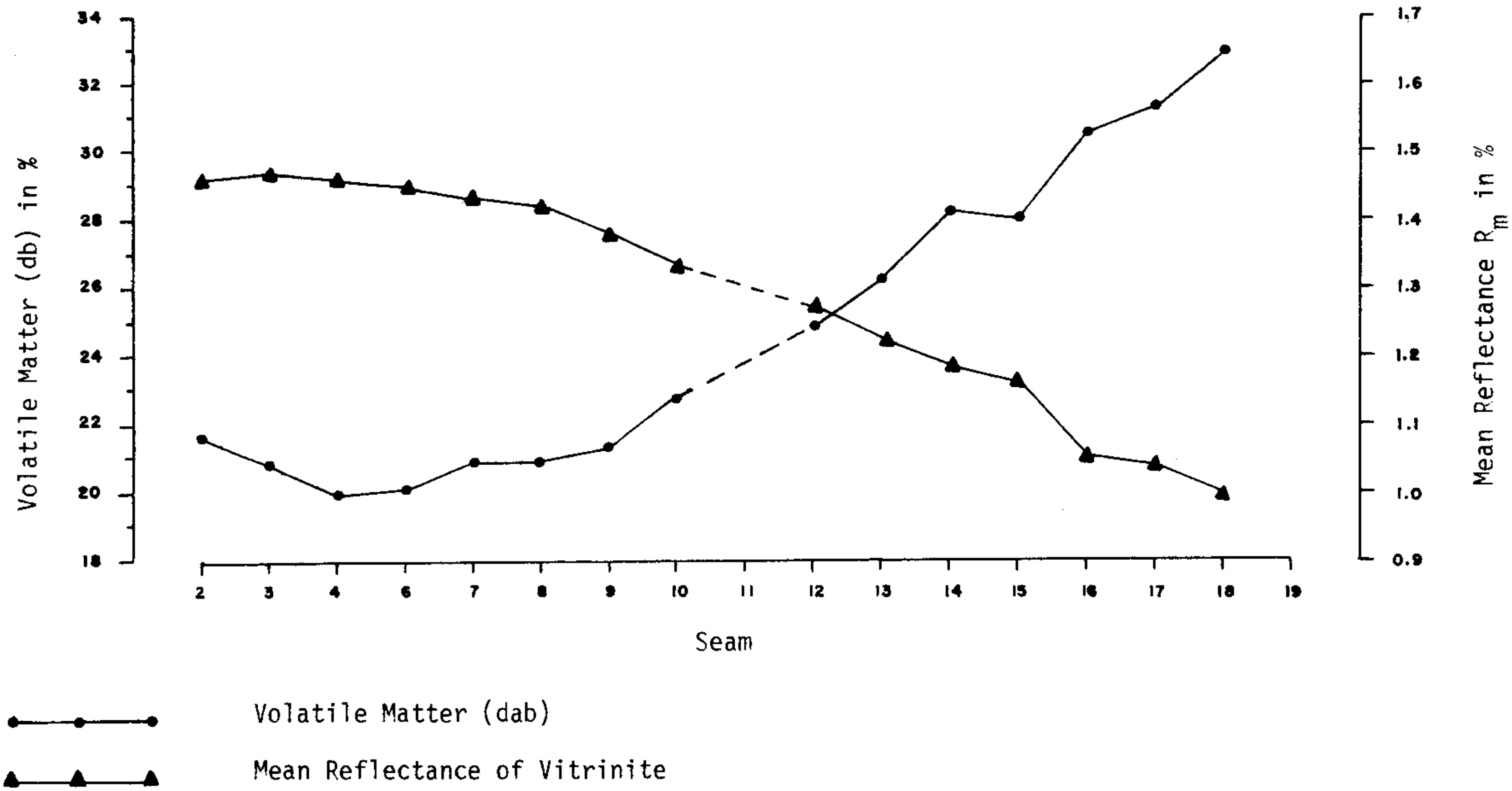
SEAM NUMBER	% COAL (RESERVES)	% WT. ROM COAL	% ASH (DRY BASIS) 2" x 1/2"	1/2" x 28M	28M x 65M	65M x 0	HEAD ASH % (DRY BASIS) 2" x 0
16	1.12	1.56	69.73 (28.9)	33.87 (47.5)	23.07 (11.3)	20.9 (12.3)	41.41
17	0.79	0.91	60.38 (28.6)	23.04 (56.6)	16.92 (9.6)	19.9 (5.2)	32.96
18	0.05	0.07	52.65 (18.0)	35.29 (62.4)	16.73 (8.0)	16.2 (11.6)	34.71

*Fall 1975 Birtley data

Note: () denotes percent by weight of specified size fraction.

FIGURE 2

VOLATILE MATTER AND RANK OF ELK RIVER SEAM COALS



EXPLORATION UND
BERGBAU G.m.b.H.

VOLATILE MATTER AND MEAN REFLECTANCE OF VITRINITE OF
ELK RIVER SEAM COALS

Partnership Coal
1976

FIGURE 3

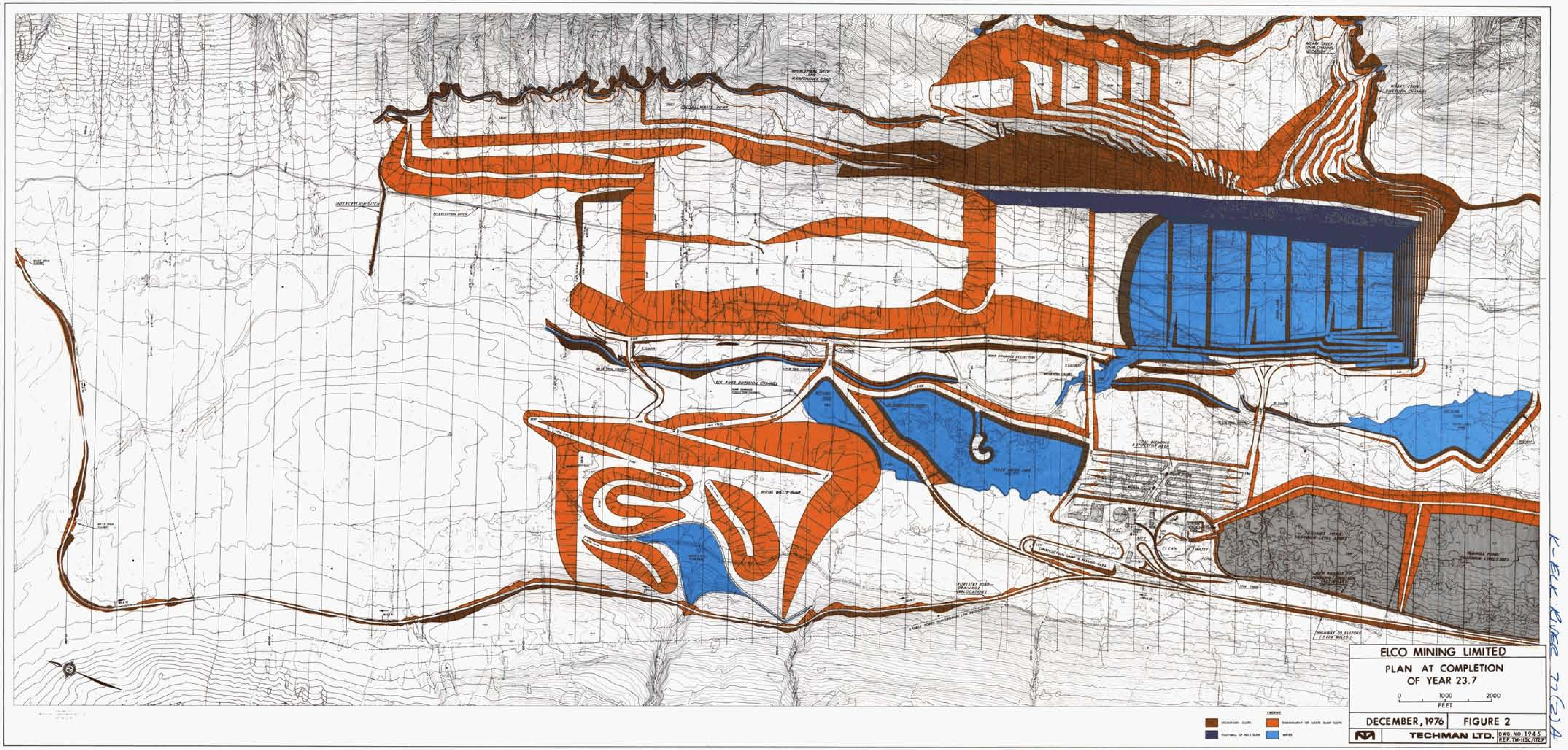
CLEAN COAL CHARACTERISTICS

Seam	Percentage Recovery Composite A	Percentage Recovery Composite C	Mean Seam Thickness m	Volatile Matter (db) %	Volatile Matter (dab) %	Content Ash %	Content Sulphur %	Content Phosphorus %	Swelling Index	G-Value	Max. Fluidity DDPM
2	8,0	8,8	4,6	19,9	21,7	9,5	0,54	0,018	8	1,022	119
3	5,0	6,1	2,2	19,1	20,8	9,1	0,55	0,127	7½	0,955	21
4	8,8	21,3	9,3	18,2	19,9	8,5	0,39	0,024	4	0	2
6	3,6	5,1	2,1	18,3	20,1	9,9	0,69	0,119	2½	0	1
7	2,1	2,6	1,9	18,8	20,9	10,7	0,61	0,043	5	0	1
8	8,9	10,7	6,7	19,2	20,9	8,7	0,48	0,055	5	0,384	3
9	8,5	9,5	5,1	18,5	21,3	8,3	0,45	0,027	4½	0,250	2
10	15,0	17,0	8,5	21,0	22,8	8,6	0,44	0,026	6	0,718	2
11	1,6	1,8	5,0	22,7	24,8	9,1	0,71	0,048	8½	1,038	132
12	4,1	4,5	5,9	22,7	24,8	9,1	0,71	0,048	8½	1,038	132
13	2,6	3,4	6,8	23,4	26,2	10,5	1,01	0,060	8½	1,054	284
14	4,1	3,9	6,3	26,0	28,2	8,1	0,84	0,052	8½	1,083	1004
15	4,2	2,6	6,2	25,8	28,0	8,2	0,80	0,047	8	1,052	280
16	4,1	1,5	5,0	27,6	30,6	10,4	0,78	0,096	8	1,067	1090
17	4,6	1,1	5,4	29,2	31,3	7,1	0,76	0,065	8	1,069	1146
18	3,7	0,0	4,3	30,6	33,0	7,4	0,76	0,048	8	1,080	2220
19	1,1	0,0	2,4	30,6	33,0	7,4	0,76	0,048	8	1,080	2220
A	100,0		85,9	21,3	23,3	8,8	0,58	0,051	7½	0,952	17
C		100,0	83,5	20,1	22,2	9,4	0,51	0,050	6½	0,850	5

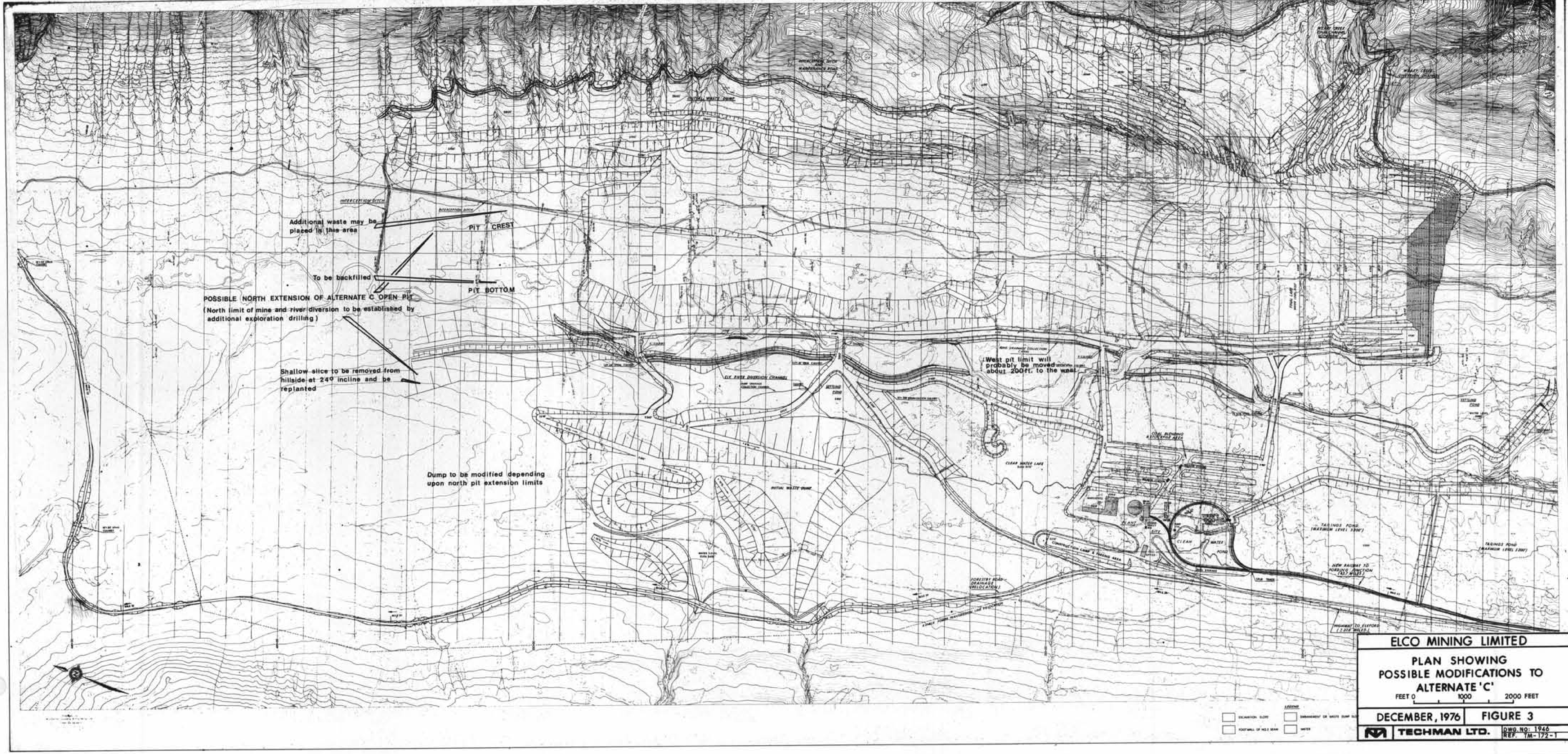
K-ELK RIVER 77(8)A

1.4

K-Elk River 77(2)A



K-ELK RIVER 77(2)A



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PLAN SHOWING POSSIBLE MODIFICATIONS TO ALTERNATE 'C'

FEET 0 1000 2000 FEET

DECEMBER, 1976 FIGURE 3

TECHMAN LTD. DWG. NO: 1946 REF. TM-172-1

K-Elk River 77(2)A

ELCO MINING LIMITED

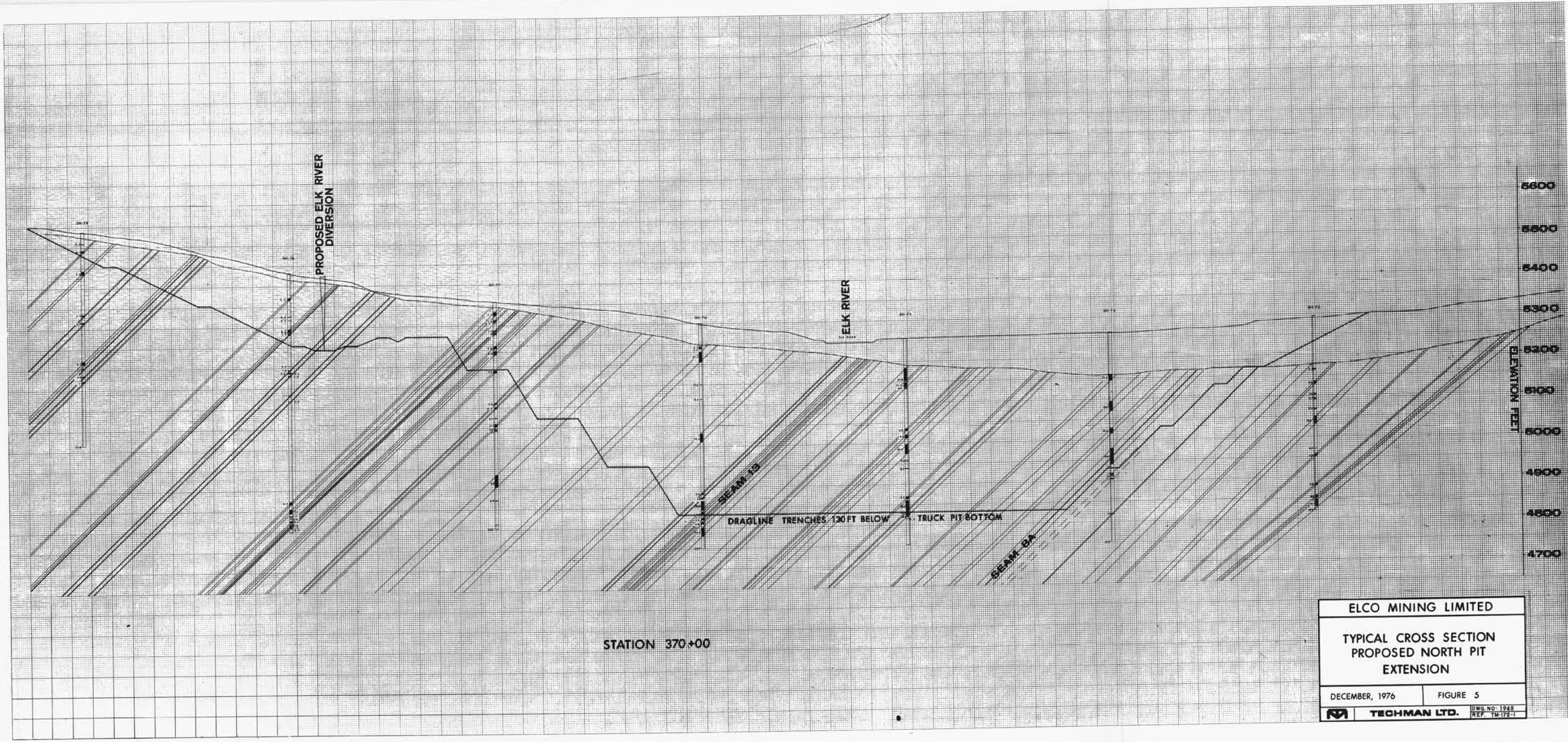
TYPICAL CROSS SECTION

STATION 260+00

100 0 100 FT.

DECEMBER, 1976 | FIGURE 4

TECHMAN LTD. DWG. NO: 1947 REF. TM-113C/ 172-1



K-ELK RIVER 77(2)A.

Figure 6

Mining Alternate C

ANNUAL COAL & OVERBURDEN VOLUMES

Year	Recovered Raw Coal Thousands S.T.	Recovered Raw Coal Thousands c.yds.	Recovered Dilution Rock to Plant Thousands c.y.	Glacial Till Overburden Thousands c.y.	Rock Overburden to Waste Dump Thousands c.y.	Annual Total Overburden Dilution Rock and Coal Thousands c.y.	Annual Overburden Ratio cu. yds/ Short Ton
P.P.	500	409	50	3,000	3,000	6,459	12.10
1	4,138	3,392	448	4,500	22,200	30,540	6.56
2	4,138	3,392	459	15,600	22,200	41,651	9.25
3	4,827	3,957	543	2,500	26,600	33,600	6.14
4	5,518	4,523	227	800	29,000	34,550	5.44
5	5,517	4,522	878	1,100	32,700	39,200	6.29
6	5,517	4,522	578	1,200	28,800	35,100	5.54
7	5,517	4,522	427	1,300	29,000	35,249	5.57
8	5,518	4,523	478	1,400	27,500	33,901	5.32
9	5,517	4,522	428	1,500	27,000	33,450	5.24
10	5,517	4,522	477	1,200	26,800	32,999	5.15
11	5,517	4,522	428	1,000	27,000	32,950	5.15
12	5,518	4,523	348	1,020	26,400	32,291	5.03
13	5,517	4,522	407	830	27,200	32,959	5.15
14	5,517	4,522	378	570	27,100	32,570	5.03
15	5,517	4,522	427	660	28,100	33,709	5.29
16	5,518	4,523	428	660	28,400	34,011	5.24
17	5,517	4,522	528	660	28,500	34,210	5.38
18	5,517	4,522	328	820	28,200	33,869	5.32
19	5,517	4,522	828	800	27,800	33,950	5.33
20	5,518	4,523	678	660	26,580	32,441	5.06
21	5,517	4,522	628	400	28,220	33,770	5.30
22	5,517	4,522	577	133	26,750	31,982	4.98
23	5,518	4,523	928	0	28,950	34,401	5.42
23.7	3,858	3,163	458	0	18,167	21,778	4.83
	127,807	104,759	12,362	42,313	652,167	811,600	

Note; Fleet capability is designed so that year 2 peak is averaged back to 1 and year 5 peak is averaged back over years 3 & 4.

ORIGINAL RIVER CHANNEL
NEW DIVERSION CHANNEL
ORIGINAL RIVER CHANNEL
NEW DIVERSION CHANNEL
0.70%
0.78%
1.16%
ORIGINAL RIVER CHANNEL
NEW DIVERSION CHANNEL
0.50%
2.00%
ORIGINAL RIVER CHANNEL
5200
5100
5050
0+00
ELCO MINING LIMITED
PROFILE OF ELK RIVER DIVERSION CHANNEL
DEC. 1976
FIGURE 7
TECHMAN LTD.
DWG. 1949

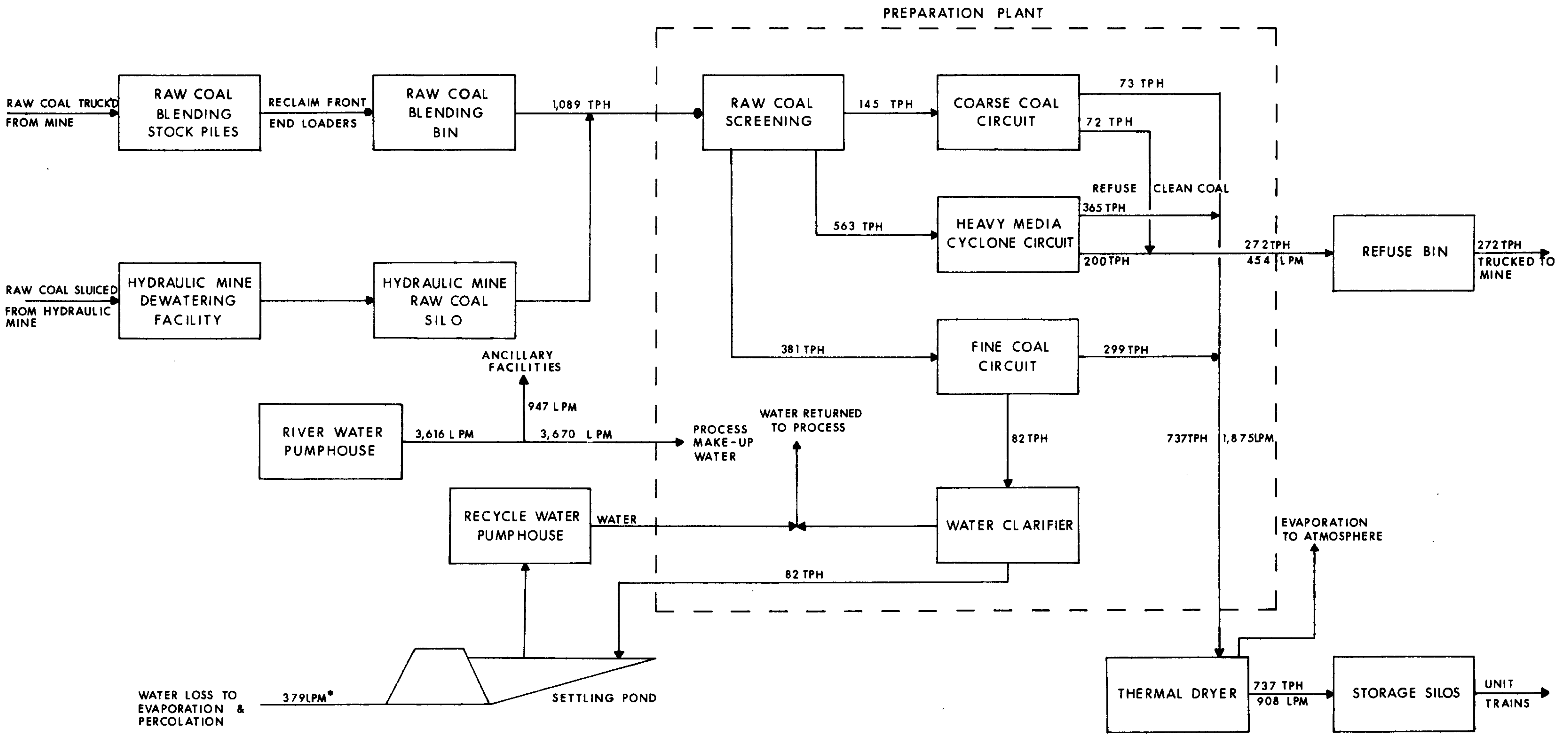
ELCO MINING LIMITED

LONGITUDINAL SECTION SHOWING
MINING & BACKFILLING SEQUENCE
PLACEMENT BY LIFTS

JANUARY, 1977 | FIGURE No. 8

TECHMAN LTD. | DWG. No. 1956 | REF. TM 172-1

1.5



*TO BE CALCULATED DURING DESIGN
ALL UNITS CALCULATED IN METRIC

ELCO MINING LIMITED

SCHEMATIC COAL PREPARATION

DEC. 1976 | CHART 1

TECHMAN LTD. DWG. No. 1950 REF. TM-172-1

APPENDIX B

GLOSSARY OF ENVIRONMENTAL AND SCIENTIFIC TERMS

ADAPTABILITY: the ability of an organism or a population to respond to changes in its environment so as to continue living and reproducing.

AGGRADING: building up the grade or slope of a stream by deposition of sediment.

AIRSHED: a local drainage basin with regard to airflow.

ALGAE: chlorophyll-bearing aquatic plants with no true leaves, stems or roots.

ALLUVIUM: stream deposits of comparatively recent geologic age.

AQUIFER: a water-bearing stratum of permeable rock or soil material.

ARCHAEOLOGY: the scientific study of any prehistoric culture by excavation and description of its remains.

ARTESIAN: groundwater under sufficient hydrostatic head to rise above the aquifer containing it.

ATMOSPHERIC INVERSION: a condition in which cooler surface air is trapped under an upper layer of warmer air, preventing vertical circulation.

BEDLOAD: soil, rock particles or other debris rolled along the bottom of a stream by moving water.

BIOLOGICAL DIVERSITY: the number of kinds of organisms per unit area or volume; the richness of species in a given area.

BIOMASS: the total weight of matter incorporated into (living and dead) organisms.

BIOTA: all of the named or unnamed organisms of an area; flora and fauna.

BRAIDED STREAM: a stream flowing into several dividing and reuniting channels, the cause of diversion being the obstruction by sediment deposited by the stream.

BROWSE: shoots, twigs and leaves of trees and shrubs eaten by large herbivores.

BRUNISOLS: brown forest soils, characteristically well-drained.

CARRYING CAPACITY: the maximum level to which the resources of a habitat can be used by organisms without inducing instability.

CLIMAX: the final or ultimate community in a plant succession.

COLONIZING: relating to organisms which occupy areas previously barren.

COMMUNITY: all of the plants and animals in an area or volume.

CONFLUENCE: the point where two streams meet.

CONIFER: trees having cones as reproductive structures.

COVER TYPE: vegetation mapping unit based on dominant overstory species, composition and maturity.

CREEL CENSUS: survey of fish catches.

CUTBANK: a condition which exists where the river current has undermined a section of the bank creating a steep unvegetated slope.

DEADFALL: dead trees on a forest floor.

DECIDUOUS: refers to plants which lose their leaves regularly each year.

DEGRADING: removal of material through erosion and transportation by flowing water.

<u>DIP</u>: the angle at which a stratum or any planar feature is inclined from the horizontal.

<u>DIP SLOPE</u>: a slope of land surface which conforms approximately to the dip of the underlying strata.

<u>DISCHARGE ZONE</u>: an area in which groundwater issues from a surfacing aquifer.

<u>DISPERSION CLIMATOLOGY</u>: study of climate as it relates to the dispersion or scattering of particulates.

<u>DISSOLVED SOLIDS</u>: soluble salts found in streams and in discharges to streams.

<u>DISTURBANCE</u>: any disruption of environmental conditions, usually unanticipated by wildlife and usually related to human activity, which threatens the ability of a particular animal to survive.

<u>ECOLOGY</u>: the study of relationships between organisms and their environment.

<u>ECOSYSTEM</u>: a complex of interrelated organisms and non-living environmental elements, which interact to form identifiable patterns.

<u>EFFLUENT</u>: the outflow of a sewer, septic tank, or industrial facility.

<u>ENERGY DISSIPATORS</u>: activities or devices which disperse energy.

<u>EUTRIC BRUNISOL</u>: Brunisolic soils that, under virgin conditions, have organic surface horizons over Bm horizons in which the base saturation (NaCl) is 100% and the pH ($CaCl_2$) is usually 5.5 or higher (Canada Department of Agriculture, 1974).

<u>FAUNA</u>: the animals of a given region taken collectively.

<u>FEN</u>: an area of peat accumulation overlain by sedges (and frequently, shrubs) wherein the water table is at the surface.

FISHERY: a population of a fish species, and its habitat, of commercial or recreational value.

FLASH PEAKS: a condition typical of areas which are well drained; these tend to retain very little water thus causing the levels of discharge rates of watercourses to oscillate. Watercourses which receive runoff from such well drained areas reach peak discharge rates shortly after periods of precipitation; this is a flash peak.

FLOCCULANT: a substance that induces or promotes aggregation, and subsequently settling out of materials suspended in water (flocculation).

FLOODPLAIN: the portion of a river valley, adjacent to the river channel, which is built of sediments during the present regime of the stream and which is covered with water when the river overflows its banks at flood stages.

FORAGE: all vegetation that is available and acceptable to animals for consumption.

FORB: any herb that is not a grass or grasslike; for example, legume plants.

FOREST DUFF: a thick organic layer on the surface of forest soils.

FROST FREE DAY: a day on which the daily minimum temperature recorded is above $0^{o}C$.

GABION: wire mesh basket filled with rock.

GLEYSOLS: grey and/or yellow-grey coloured soils usually resulting from water-logging and lack of aeration.

GROUNDWATER: water found below the surface in porous rock or soil strata.

GULLY: a small depression worn out by running water.

HABITAT: the place where an organism (or a community of organisms) lives or regularly appears; it is commonly defined with respect to the type of soil, topography, and vegetation which occupy the area.

HABITUATION: diminishing response by an animal to a stimulus (or disturbance) as a result of its repetition.

HEAVY METAL: a metal which has a specific gravity greater than 4.

HERBIVORE: an organism which eats plants or plant parts.

HUMIC: relating to soil or water borne substances resulting from the partial decay of leaves and other plant material.

HWF: high water flow in cubic meters per second.

HYDROCARBONS: commonly considered, substances that are based in a carbon-hydrogen molecule.

HYDROSEEDING: application of a solution of seeds, water, various nutrients, and binders or mulches by spraying.

INDIGENOUS: implying a plant or animal that is native to a particular region.

IN SITU: in its natural position or place.

INVERTEBRATE: any animal lacking a backbone.

LACTATION: period during which milk is secreted; the suckling of young.

LEACHING: the process by which soluble compounds or elements are dissolved by water percolating through soil.

LIMITING FACTOR: any condition which approaches or exceeds an organism's limits of physiological or behavioural tolerance.

LUVISOLS (Gray-Wooded): soils which have developed from high base materials under forests and characterized by an impoverished gray layer near or at the surface of the mineral soil.

LWF: low water flow in cubic meters per second.

MACROINVERTEBRATES: those aquatic invertebrates (mainly insect larvae) which are visible without the aid of a microscope.

MACROPHYTES: vascular aquatic plants, such as bulrushes.

MEAN ANNUAL TEMPERATURE: the average of all daily temperatures for the year for the period of record.

MEAN DAILY TEMPERATURE: the average of the maximum and minimum daily temperatures.

MEANDER: one of a series of somewhat regular and looplike bends in the course of a stream developed when the stream is flowing, through lateral shifting of its course towards the convex sides of the original curves.

MELANIC BRUNISOL: Brunisolic soils that, under virgin conditions, generally lack F and H horizons (i.e., those with partly decomposed or decomposed organic matter). They have mineral-organic (Ah) surface horizons thicker than 5 cm which have developed primarily from the incorporation of plant residues into the soil through the action of soil fauna (Canada Department of Agriculture, 1974).

MESISOL: a type of organic soil with a dominantly mesic middle tier, i.e. in an intermediate stage of decomposition, as defined by Canada Department of Agriculture (1974).

MESOCLIMATE: that component of climate for a gross physiographic unit, for example a mountain valley, controlled by regional climatological factors, for example, regional variability in topography and wind patterns; weather conditions at a subregional (county or municipal, for example) level.

MICROHABITAT: a small unit of space which can support a particular species or community.

MIGRATION: a regular movement of animals from one region to another.

MINERAL LICK: muck (wet) or mineral (dry) areas kept bare through constant use (or licking) by animals (usually ungulates).

MULCH: leaves, straw, peat moss or other materials spread on the ground around plants to prevent evaporation of water from soil and to stabilize soil.

MUSKEG (bog): area of insufficient drainage over which organic material has accumulated to considerable depth.

NURSE CROP: plants seeded to improve the conditions of spoil piles and overburden dumps and which enhance the seedbed for native species plantings and/or colonization.

ORTHIC REGOSOL: Regosol soils lacking soluble salts, and with organic matter content decreasing regularly with depth (Canada Department of Agriculture, 1974).

OVERBURDEN: unconsolidated material overlying a deposit of useful materials.

OVERSTORY: those plants whose canopies occupy the greatest heights.

PEAT: a highly organic soil of partially decomposed vegetable matter.

PELLET-GROUP: a unit of animal feces, particularly those of ungulates, used for population index or distribution measures in pellet-group count survey techniques.

PHENOLS: a hydroxyl derivative of benzene which is distasteful to humans and is toxic to fish.

PHOTOSYNTHESIS: in green plants, synthesis of organic compounds from water and carbon dioxide using energy absorbed by chlorophyll.

PIEZOMETER: an instrument used for measuring water pressure in drill holes.

POIKILOTHERMS: animals, such as fish or insects, which are cold-blooded, that is, their body temperature is dependent upon external temperatures and varies with them.

POOL: that stretch of a watercourse where the water is calm and deep.

POPULATION: an interbreeding group within a species, isolated to some degree from other such groups in the species.

PREDATOR: an organism which kills and consumes another organism in whole or in part.

PRIMARY CONSUMER: an organism which consumes green plants.

PRODUCTIVITY: rate of energy storage, or rate of biomass formation in a community; commonly, the productivity of an ecosystem refer to its "richness". The productivity of each trophic level (that is, each group of organisms which feed on smaller organisms or plants) is limited by primary productivity (plant life), which in turn is limited by the photosynthetic process of the plants.

RAPTORS: any of several birds of prey (hawks, falcons, eagles, owls).

RECHARGE ZONE: an area in which groundwater seeps into an aquifer.

REGOSOLS: well and imperfectly drained mineral soils with good to moderate oxidizing conditions having horizon development too weak to meet the requirements of scils in any other order (Canada Department of Agriculture, 1974).

RIFFLE: the rocky area of a watercourse where the water is shallow and the current swift.

<u>RILL</u>: a very small trickling stream of water.

<u>RIPARIAN</u>: pertaining to the banks of a body of water.

<u>RIPRAP</u>: broken rock used for revetment.

<u>RUBBLE</u>: all accumulations of loose angular fragments not waterworn or rounded like gravel.

<u>SALMONID</u>: a member of the salmon family used in this presentation as a reference to trout and char.

<u>SEDGE</u>: any of the various rush-like or grass-like plants growing in wet places such as ponds.

<u>SERE (Seral)</u>: a series of communities which develop in a given physical environment; the relatively transitory communities are called seral stages.

<u>SHOT ROCK</u>: blasted rock.

<u>SILTATION</u>: the deposition of water-borne particles along stream beds.

<u>SLUDGE</u>: the residue resulting from separation processes employed to remove dissolved or suspended solids from waste water.

<u>SOIL PROFILE</u>: the physical and chemical features of the soil seen in vertical sections from its surface to the point at which the characteristics of the parent material are not modified by surface weathering or soil processes.

<u>SPAWNING REDDS</u>: small depressions, dug by the female of salmonid fishes, into the gravel substrate of riffles into which the eggs are released and fertilized, and then covered with gravel.

<u>STRATIFICATION</u>: the layering which occurs in impounded water bodies due to differing densities.

<u>STRIKE</u>: the course or bearing of an inclined bed or structure on a level surface or bearing of a horizontal line in the plane of an inclined stratum, joint, fault, cleavage plane or other structural plane.

<u>SUBSTRATE</u>: the river bottom material.

<u>SUSPENDED SEDIMENT</u>: sediment which remains in suspension in water for a considerable period of time without contact with the bottom.

<u>SYNCLINE</u>: a fold in rocks in which the strata dip inward from both sides of the axis.

<u>TERRIC MESISOL</u>: Mesisol soils with a terric layer (i.e., an unconsolidated mineral substratum not underlain by organic matter) beneath the surface tier (Canada Department of Agriculture, 1974).

<u>TRANSECT</u>: a line through a community or study area on which important characteristics of the environment are monitored and recorded.

<u>TROPHIC LEVEL</u>: all organisms which secure their food from plants by the same number of steps, i.e., green plants, first trophic level; herbivores, second trophic level; carnivores, third trophic level.

<u>TURBIDITY</u>: a condition of water resulting from suspended matter.

<u>UNDERSTORY</u>: vegetation zone lying between the forest canopy (overstory) layer and the vegetation covering the ground.

<u>UNGULATE</u>: any hoofed animal, such as elk, deer, moose, and bighorn sheep.

<u>WILDLIFE SIGN</u>: animal observation data including actual sightings, tracks, trails, forage utilization, beds, shed antlers and calls.

GLOSSARY OF SCIENTIFIC AND COMMON NAMES

COMMON NAME	SCIENTIFIC NAME
Trees and Shrubs	
Douglas-fir	*Pseudotsuga menziesii*
lodgepole pine	*Pinus contorta*
white spruce	*Picea glauca*
aspen poplar	*Populus tremuloides*
scrub birch	*Betula glandulosa*
willow species	*Salix* spp.
alder species	*Alnus* spp.
buffalo-berry	*Shepherdia canadensis*
Forbs and Grasses	
fireweed species	*Epilobium* spp.
white clover	*Trifolium repens*
sedge species	*Carex* spp.
bluebunch wheatgrass	*Agropyron spicatum*
bearded wheatgrass	*Agropyron subsecundum*
hair grass species	*Deschampsia* spp.
wild rye species	*Deschampsia* spp.
rough fescue	*Festuca scabrella*
fescue species	*Festuca* spp.
june grass	*Koeleria cristata*
timothy	*Phleum pratense*
inland bluegrass	*Poa interior*
Mammals	
moose	*Alces alces*
Rocky Mountain elk	*Cervus canadensis nelsoni*
mule deer	*Odocoileus hemionus hemionus*
white-tailed deer	*Odocoileus virginianus*

bighorn sheep	*Ovis canadensis*
mountain goat	*Oreamnos americanus*
cougar	*Felis concolor*
grizzly bear	*Ursus arctos*
black bear	*Ursus americanus*
coyote	*Canis latrans*
lynx	*Lynx rufus*
wolverine	*Gulo luscus*
mink	*Mustela vison*
beaver	*Castor canadensis*
muskrat	*Ondatra zibethica*
red squirrel	*Tamiasciurus hudsonicus*
white-footed mouse	*Peromyscus maniculatus*
redback vole	*Clethrionomys gapperi*
long-tailed vole	*Microtus longicaudus*
snowshoe hare	*Lepus americanus*

Birds

blue grouse	*Dendragapus obsurus*
spruce grouse	*Canachites canadensis*
ruffed grouse	*Bonasa umbellus*
white-taïled ptarmigan	*Lagopus leucurus*

Fishes

mountain whitefish	*Prosopium williamsoni*
cutthroat trout	*Salmo clarki*
Dolly Varden	*Salvelinus malma*
brook trout	*Salvelinus fortinalis*

Algae

blue green algae (Division)	Cyanophyta
green algae (Division)	Chlorophyta

member of Division Chlorophyta	*Stigeoclonium* sp.
yellow brown algae (Division)	Chrysophyta
brown algae (Class of Chrysophyta)	Chrysophyceae
member of Chrysophyceae	*Hydrusus foetidus*
diatoms (Class of Chrysophyta)	Bacillariophyceae

Aquatic Invertebrates

mayflies	Ephemeroptera
stoneflies	Plecoptera
true flies	Diptera
caddisflies	Trichoptera

Others

filamentous bacteria	*Sphaerotilus* sp.

2.1

FIGURE I

ACCUMULATED SNOW DEPTH AND WATER EQUIVALENT

SNOW COURSE	STATION NUMBER	LOCATION	ELEVATION (METERS)	LATITUDE	LONGITUDE	WATER EQUIVALENT (MM) MAX.	MIN.	AVERAGE	NUMBER OF YEARS RECORDED (PRIOR to 1976)
Fernie	10	Within the Town of Fernie (90 km SSW of licence area)	1070	49° 30'	115° 03'	386	51	212	35
New Fernie	10A	East of the Town of Fernie,(90 km SSW of licence area)	1250	49° 30'	115° 02'	584	206	372	25
Morrissey Ridge	10B	Ten km South of Fernie 4 km East of Highway No.3 (100 km SSW of licence area)	1860	49° 27'	114° 58'	1006	447	697	12
Upper Elk River	41	Within the Town of Elkford (43 km South of licence area)	1340	50°01'	114° 56'	330	69	193	27
Mount Assiniboine	199	Within Mount Assiniboine Provincial Park 4 km NE of Mt. Assiniboine (70 km NW of licence area)	2230	50° 54'	115° 37'	645	389	494	7
Mount Joffre	200	2½ km SW of the Upper Elk Lake 14 km NW of licence area	1750	50° 32'	115° 07'	551	246	365	6

NOTE: Although water equivalent varies with the amount, density and age of the snow pack, it can be assumed to be one-tenth that of snowfall with longterm records as above. (i.e. water equivalent x 10 = snowfall)

All readings were taken in March, the month of maximum snow depth.

Source: *Water Investigation Branch*
Department of Lands, Forests and Water Resources
Victoria, British Columbia

2.2

K-ELK RIVER 77(Z)A.

ELCO MINING LIMITED

PROFILE OF ELK RIVER AND TRIBUTARIES

DEC. 1976 | FIGURE 1

TECHMAN LTD. DWG. NO. 1951 REF. TM-172-1

FIGURE 2

HYDROLOGICAL DATA: ELK RIVER AND TRIBUTARIES
1972

Site	Date	Gradient (%)	Depth (m)	Width (m)	Velocity m/s	Discharge m^3/s	Degree of Fluctuation HWF:LWF	% Bank Stability	Bedload Discharge (gms/sec)	Suspended Sediment Discharge (gms/sec)	Total Sediment Discharge (gms/sec)
ELK RIVER	07-05-72		0.76	11.28	0.91	8.75			1.7	11.6	15.6
Upper Bridge	08-10-72		0.70	10.06	0.85	8.30			2.1	11.6	13.7
	09-24-72	.8	0.37	7.32	0.49	1.61	5.4:1	63	0.1	2.2	2.3
Forestry Br.	07-06-72		1.01	11.28	1.95	30.72					
	08-11-72		0.82	0.67	1.58	16.99					
	09-25-72	.8	0.61	9.45	1.07	8.50	3.6:1	65	0.1	10.1	10.2
TRIBUTARIES											
Cadorna Cr.	07-06-72		0.61	14.94	1.55	11.86					
	08-11-72		0.46	19.20	1.73	10.48			17.5	9.4	26.9
	09-24-72	1.7	0.24	13.72	1.13	4.30	2.7:1	93	0.1	4.3	4.4
Gardner Cr.	07-12-72		0.24	3.05	0.40	0.79					
	08-13-72		0.46	2.13	0.20	0.28					
	09-25-72	11.4	0.15	3.05	0.30	0.14	5.6:1				
Bleasdell Cr.	07-11-72		0.24	6.10	0.76						
	08-14-72		0.21	5.49	0.76	0.65					
	09-30-72	10.7	0.18	2.74	0.55	0.25	5.1:1	100			
Weary Cr.	07-11-72		0.34	3.66	0.43	0.54					
	08-13-72		0.18	3.05	0.73	40					
	09-29-72	10.9	0.15	3.05	0.24	0.11	4.8:1	100			
Aldridge Cr.	07-13-72		0.27	7.01	0.82	1.61					
	08-13-72		0.55	3.66	0.39	0.79					
	08-29-72	7.1	0.40	2.44	0.37	0.39	4.4:1	75			
Creek A	07----72	35.3			0.18	.01					
WS-15	08----72										
	09----72										
WS-15A	07----72				0.24	0.03					
	08----72										
	09----72				0.15	0.03					
Creek B	07----72				1.16	0.06					
	08----72				0.79	0.01					
	09----72	30.6			dry	dry	6.6:1				
Creek C	07----72				0.34	0.01					
	08----72				dry	dry					
	09----72	17.8			dry	dry					
Creek D	07----72				0.73	0.02					
	08----72				0.82	0.02					
	09----72	20.4			0.46	0.02	1.1:1				

Raw data obtained from B.C. Research, 1974b

FIGURE 3
DISCHARGE RATES,ELK RIVER, 1976

STREAM NAME	STATION NUMBER	LOCATION DESCRIPTION	DATE OF MEASUREMENT	CHANNEL WIDTH	AVERAGE DEPTH	MEAN VELOCITY	DISCHARGE	COMMENTS AND/OR OBSERVATIONS
Elk River	EL 47.5	Most northerly station on Elk River, upstream from Cadorna Creek confluence.	May 26, 1976	12.00m	0.70m	0.60m/s	5.04 m^3/s	
			October 5, 1976	15.85m	0.22m	0.85m/s	3.08 m^3/s	
			December 3, 1976	3.05m	0.35m	0.47m/s	.69 m^3/s	one half of channel frozen.
Elk River	EL 46.5	Downstream from the Cadorna Creek confluence.	May 25, 1976	16.00m	0.75m	1.08m/s	12.96 m^3/s	
			October 5, 1976	23.47m	0.37m	0.61m/s	6.17 m^3/s	
			December 3, 1976	15.70m	0.20m	0.57m/s	1.41 m^3/s	
Elk River	EL 43.0	At Forestry Bridge	May 26, 1976	12.20m	0.92m	2.05m/s	23.00 m^3/s	
			October 5, 1976	17.98m	0.49m	1.07m/s	10.94 m^3/s	
			November 4, 1976	14.94m	0.43m	0.61m/s	3.89 m^3/s	
			December 3, 1976	0.91m	0.76m	1.22m/s	0.85 m^3/s	Due to large amounts of ice, measurement made in small channel.
Elk River	EL 40.0	Upstream of the Aldridge Creek confluence.	December 4, 1976	13.72m	0.18m	0.56m/s	1.54 m^3/s	

Velocity measurements were made using an AA Price type current meter.

FIGURE 4

DISCHARGE RATES OF THE ELK RIVER TRIBUTARIES, 1976

STREAM NAME	STATION NUMBER	LOCATION DESCRIPTION	DATE OF DISCHARGE MEASUREMENT	CHANNEL WIDTH	AVERAGE DEPTH	MEAN VELOCITY	DISCHARGE	COMMENTS AND/OR OBSERVATIONS
Cadorna Creek	CA 1.1		May 27, 1976	10.00m	0.58m	1.20m/s	6.96 m^3/s	
Tributary to Elk River	EL-T44.1 - 1.0	West side of Elk Valley.	October 6, 1976	1.00m	0.09m	0.46m/s	0.04 m^3/s	
Tributary of Elk River	T 43.7 0 - 0.9	West side of Elk Valley.	May 26, 1976	3.50m	0.31m	0.54m/s	0.58 m^3/s	
			October 6, 1976	1.80m	0.13m	0.64m/s	0.11 m^3/s	
Gardner Creek	GA 0.1	Above Gardner-Elk confluence	May 26, 1976	3.80m	0.23m	0.71m/s	0.62 m^3/s	
			October 8, 1976				0.01 m^3/s	
			December 3, 1976	0.07m	0.18m	0.39m/s	0.39 m^3/s	Discharge measurement taken at culvert inlet
Gardner Creek	GA 1.2	Upstream end of Gardner Creek.	May 26, 1976	4.50m	0.23m	0.61m/s	0.63 m^3/s	
			October 6, 1976	2.35m	0.15m	0.74m/s	0.08 m^3/s	
Tributary of Gardner Creek	GA T0.2 T0.4	West side of Elk Valley.	May 26, 1976				0.03 m^3/s	
Tributary of Gardner Creek	GA T0.2 T0.8	West side of Elk Valley	May 26, 1976	0.53m	0.152m	0.62m/s	0.05 m^3/s	
			October 5, 1976				.003 m^3/s	
Tributary of Gardner Creek	GA T0.2 T0.3-0.7	West side of Elk Valley	May 26, 1976	0.20m			0.004 m^3/s	
			October 6, 1976				0.009 m^3/s	Bucket method.
Bleasdell Creek	BL 0.4	Where main road crosses creek	May 27, 1976	2.13m	0.30m	0.91m/s	1.89 m^3/s	
			October 7, 1976	1.98m	0.15m	0.73m/s	0.31 m^3/s	
			November 4, 1976	2.99m	0.16m	0.45m/s	0.20 m^3/s	
			December 3, 1976	2.74m	0.12m	0.36m/s	0.11 m^3/s	
Weary Creek	WE 0.5	Where bridge crosses river near drill campsite.	October 7, 1976	1.98m	0.27m	0.36m/s	0.15 m^3/s	
			November 4, 1976	2.70m	0.11m	0.25m/s	0.08 m^3/s	
			December 3, 1976	2.80m	0.13m	0.22m/s	0.08 m^3/s	
Tributary of Weary Creek	WE-T1.1 - 0.1	First tributary to Weary Creek flowing south.	December 4, 1976	2.44m	0.14m	0.18m/s	0.04 m^3/s	
Aldridge Creek	AL 0.5		October 6, 1976	4.27m	0.33m	0.64m/s	0.97 m^3/s	
			November 4, 1976	1.86m	0.25m	0.62m/s	0.25 m^3/s	
			December 3, 1976	3.60m	0.18m	0.14m/s	0.10 m^3/s	

FIGURE 5
SUMMARY OF 1972 WATER QUALITY DATA: ELK RIVER
(from B.C. Research, 1974)

STATIONS	WS-1			WS-2			WS-3			WS-4			WS-5			WS-7		
Parameter	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F
Temperature(^{o}C)	7-6	2.0-11.1	3	6-4	2.5-11.1	3	6-2	3-8.9	3	6-9	4.5-10.0	3	6.3	2.0-10.0	3	6.7	4.5-7.8	3
Conductivity (micro MHO_5/Cm)	229	200-247	3	232	206-247	3	201	214-247	3	273	219-252	3	243	225-252	3	246	227-258	3
pH - Field	7.7	7.0-8.3	3	8.0	7.6-8.4	3	8.0	7.7-8.5	3	8.3	7.7-8.7	3	8.0	7.5-8.3	3	8.2	7.6-8.5	3
- Lab	7.8	7.4-8.1	2	8.0	8.0-8.1	2	8.2	8.0-8.5	3	8.0	8.0-8.1	2	8	8.0-8.1	2	7.9	7.8-8.1	2
Dissolved Oxygen																		
Surface	11.9	11.0-12.3	3	12.3	11.4-13.4	3	12.5	12.0-13.1	3	12.5	12.1-13.2	3	12-8	12.0-13.7	3	12.5	12.2-12.6	3
Intergravel	8.6	8.0-9.5	3	9.1	8.4-9.9	2	9.4	8.0-10.4	3	10.4	9.7-11.5	3	10.9	9.1-12.7	3	10.7	9.8-10.8	3
Solids - Total	113	102-130	3	112	99-127	3	116	106-129	3	121	111-137	3	113	104-119	3	126	117-137	3
- Dissolved	111	99-128	3	110	97-125	3	115	105-126	3	120	110-135	3	113	104-117	3	124	115-137	3
- Suspended	2	2-3	3	2	1-2	3	1	1-3	3	1	1-2	3	1	1-2	3	1	1-2	3
Turbidity (or SiO_2)	0-3	0.14-0.5	3	0.5	-	2	0.3	0-0.5	3	0.2	0.1-0.5	3	0.7	0.1-0.8	3	0.1	0-0.3	3
Hardness (or $CaCO_3$)	99	85-112	3	103	89-118	3	106	93-122	3	239	219-252	3	109	98-122	3	111	102-127	3
Alkalinity (or $CaCO_3$)	88	70-101	3	93	78-106	3	95	83-108	3	96	93-108	3	97	87-110	3	101	90-115	3
Carbon - Total	23	19-25	3	23	19-26	3	24	20-26	3	23	20-26	3	24	21-26	3	26	23-27	3
- Organic	1	1-3	3	1	1-4	3	1	1-1	3	1	1-1	3	1	1-2	3	1	1-2	3
Color (APHA Units)	3	5-5	3	3	5-5	3	3	5-5	3	3	5-5	3	3	5-5	3	3	5-5	3
Coliforms (MPN) - Presumtive	23	-	2	-	-	-	-	-	-	-	-	-	-	-	-	23	-	2
- Recal	1	1-2	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2

All Parameters except pH expressed in PPM unless indicated otherwise

M - Mean
R - Range
F - Frequency
- is considered to be negligible

Sampling Station Locations are marked on Map 5 (Appendix A)

FIGURE 6
SUMMARY OF 1972 WATER QUALITY DATA: ELK RIVER TRIBUTARIES
(From B.C. Research, 1974)

	CADORNA CREEK			GARDNER CREEK						WEARY CREEK			BLEASDELL CREEK			ALDRIDGE CREEK					
	WS-13			WS-14			WS-18			WS-10			WS-9			WS-8			WS-19		
	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F
Temperature (^{o}C)	6.5	3.0-5.6	3	5.6	2.0-8.9	3	7.8	-	1	4.2	2.5-6.1	3	5.6	4.0-8.3	3	5.7	1.0-10.6	3	-	-	-
Conductivity (Micro HHOS/cm)	25	206-236	3	290	274-296	3	386	-	1	270	255-282	3	275	263-294	3	298	280-318	3	-	-	-
pH - Field	8	7.6-8.4	3	7.5	7.1-7.9	3	7.8	-	1	8.1	7.9-8.4	3	7.8	7.3-8.3	2	7.9	7.4-8.2	3	-	-	-
- Lab	8	7.7-8.0	2	7.8	7.6-8.0	2	-	-	-	7.9	7.8-8.1	2	8.0	7.9-8.1	2	8	7.9-8.1	2	-	-	-
Dissolved Oxygen																					
- Suface	12.9	12.8-13.2	3	10.9	10.3-11.2	3	9.0	-	1	13.1	12.3-13.7	3	12.7	12.4-13.0	3	13.0	12.5-14.0	3	-	-	-
- Intergravel	10.8	9.9-11.8	2	5.9	4.0-8.8	3	-	-	-	10.9	10.2-11.5	3	10.3	10.1-10.6	3	10.8	8.3-12.1	3	-	-	-
Solids - Total	95	90-106	3	166	128-166	3	176	-	1	139	121-160	3	140	122-158	3	157	130-183	3	-	-	-
- Dissolved	94	87-105	3	165	127-166	3	176	-	1	139	121-159	3	139	122-156	3	157	130-182	3	-	-	-
- Suspended	2	1-3	3	1	1-2	3	0	-	1	0.2	0-0.4	3	0.1	0-0.3	3	0.1	0-0.2	3	-	-	-
Turbidity (AS SiO_2)	0.1	0-0.2	3	0.3	0.1-0.8	3	0	-	1	0.2	0-0.4	3	0.1	0-0.3	3	0.1	0-0.2	3	-	-	-
Hardness (AS $CaCO_3$)	104	91-124	3	133	122-155	3	174	-	1	128	110-148	3	128	111-150	3	134	117-155	3	-	-	-
Alkalinity (AS $CaCO_3$)	88	77-99	3	119	110-135	3	170	-	1	101	95-113	3	107	99-124	3	114	102-129	3	-	-	-
Carbon - Total	22	20-24	2	29	28-31	2	45	-	1	26	24-27	3	29	24-27	3	24	26-30	3	-	-	-
- Organic	1	1-3	3	2.2	1-4.5	3	1	-	1	1	1-2	3	1	1-2	3	1	1-2	3	-	-	-
Color (APHA Units)	3	5-5	3	8	5-10	3	10	-	1	3	5-5	3	2	5-5	3	3	5-5	3	-	-	-
Coliforms (MPN) - Presumptive																12	2-23	21	43	8-79	2
- Fecal																2	-	2	2	-	2

All Parameters except pH are expressed in PPM unless indicated otherwise.
M - mean
R - Range
F - Frequency
\- Is considered to be negligible

Sampling stations locations are marked on Map II.

FIGURE 7

B.C. POLLUTION CONTROL BRANCH
1972-1974 WATER QUALITY DATA

SITE	SITE 41 Upstream from Elco Mining Co. Exploration Area		SITE 43 Downstream from Elco Mining Co. Exploration Area and Upstream from Elkford							
Sampling Date	July 1972	August 1972	May 1972	June 1972	July 1972	August 1972	April 1973	June 1973	August 1973	April 1974
Alkalinity, total - mg/l	94	100				120				
Solids, dissolved - mg/l	100	104				138				
Solids, suspended - mg/l			124	144	30		12	10	4	82
Solids, total - mg/l	108	110				150				
Turbidity J.T.U.	4.2	3.5	20	32	5.9	3.0	0.2	29	0.7	32

Sampling Station locations are marked on Map 9 (Appendix A)

Figure 8

FIGURE 8

SUMMARY OF 1976 WATER QUALITY DATA
ELK RIVER AND CADORNA CREEK

STATIONS		CA 1.1			EL 47.5 M			EL 46.5 W			EL 46.5 M			EL 46.5 E			EL 43.0 W			EL 43.0 M			EL 40.0 W			EL 40.0 M			EL 40.0 E	
PARAMETERS	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F
pH	7.7	7.7-7.8	2	7.6	7.6-7.7	2	7.7	-	1	7.5	-	1				7.7	7.6-7.8	2	7.4	-	1	7.6	7.5-7.7	2	7.8	-	1	7.7	-	1
CONDUCTIVITY(micro MHOS/cm)	210	-	1	350	230-473	2	195	-	1	210	-	1				200	-	2				199	198-200	2	210	-	1	218	-	1
TURBIDITY (TU)	0.32	0.4-0.25	2	4	-	1	0.6	-	1	0.4	-	1	0.4	-	1	0.5	0.4-0.6	2	0.6	-	1	0.5	0.4-0.6	2	0.7	-	1	0.6	-	1
TOTAL SOLIDS	231	208-253	2	210	190-234	2				203	-	1				232	222-243	2	179	-	1	238	235-242	2	248	-	1	246	-	1
SUSPENDED SOLIDS	3.5	1-7	2	6.5	5-8	2				8	-	1				3.5	1-7	2	2	-	1	4	1-7*	3	9	-	1	10	-	1
TOTAL DISSOLVED SOLIDS	208	-	1	-	-	-										168	-	1	177	-	1	169	-	1						
OIL & GREASE																5	-	1				7	-	1						
TOTAL ORGANIC CARBON	3	-	1	4	3-5	2				4	-	1				3.5	3-4	2				2.5	2-3	2	1	-	1	3	-	1
AMMONIA																2.9	-	1				0.7	-	1						
NITRATE																0.44	-	1				2.4	-	1						
PHOSPHATE																0.002	-	1				0.03	-	1						
SULPHATES	15	11-18	2	7	0-13	2	10	-	1	13	-	1	12	-	1	10	-	2	9	-	1	14	12-16	2	14	-	1	12	-	1
HYDROGEN SULFIDE	ND	-	1	ND	-	1				ND	-	1				ND	-	2				ND	-	1	ND	-	1	ND	-	1
SODIUM AND POTASSIUM	2.0	-	1	1.5	2.0-1.0	2	2.0	-	1	5.0	-	1				3.0	2.0-5.4	2				4.2	2.5-6.0	2	1.0	-	1	2.0	-	1
POTASSIUM																0.4	-	1				0.5	-	1						
CHLORIDES	4	-	1	6	4-8	2	4	-	1	11	-	1				6	-	2				5	-	1	4	-	1	4	-	1
CALCIUM	36	-	1	37	-	2	34	-	1	40	-	1	43	-	1	37	37-38	2				38	-	2	37	-	1	40	-	1
MAGNESIUM	10.0	-	1	7.0	6.0-8.0	2	9	-	1	10	-	1	8	-	1	7.5	7.0-8	2				7.0	6.0-8	2	9.0	-	1	8.0	-	1
CARBONATES	0	-	1	0	-	2	0	-	1	0	-	1				0	-	2				0	-	2	0	-	1	0	-	1
BI-CARBONATES	146	-	1	127	-	2	137	-	1	146	-	1				138	136-142	2				135	127-142	2	142	-	1	142	-	1
HYDROXIDE	0	-	1	0	-	2	0	-	1	0	-	1				0	-	2				0	-	2		0		0	-	1
TOTAL ALKALINITY	146	-	1	127	-	2	137	-	1	146	-	1				139	136-142	2				142	127-142	2	142	-	1	142	-	1
ALKALINITY AS $CaCO_3$	120	-	1	94	-	2	112	-	1	120	-	1				114	112-116	2				110	106-116	2	116	-	1	116	-	1
IRON	0.05	-	2	0.05	-	2				0.05	-	1				0.05	-	3	0.05	-	1	0.05	-	3	0.05	-	1	0.05	-	1
ARSENIC																0.01	-	2				0.01	-	2						
ALUMINUM																1.0	-	1				1.0	-	1						
BARIUM																0.2	-	1				0.2	-	1						
CADMIUM	0.01	-	1													0.02	-	1	0.02	-	1	0.02	-	1						
LEAD																0.01	0.01-0.02	2				0.01	0.01-0.02	2						
MERCURY	0.002	-	1													0.007	0.0002-0.0013	2	0.0002	-	1	0.0008	0.0002-0.0014	2						
COPPER																0.05	-	2												
NICKEL																0.05	-	2												
VANADIUM																														
ZINC																														

All Parameters expressed in PPM unless indicated otherwise.
Analyses conducted by Core Laboratories According to Standard methods.

M - mean
R - Range
F - Frequency
\- is considered to be negligible

Sampling station locations are marked on Map 9 (Appendix A).

ND-Not detected

FIGURE 9

SUMMARY OF 1976 WATER QUALITY DATA:
ELK RIVER TRIBUTARIES

	TRIBUTARY EL T43.7			TRIBUTARY EL T44.1			GARDNER CREEK						WEARY CREEK			BLEASDELL CREEK			ALDRIDGE CREEK			FORSYTH CREEK		
STATIONS	EL T43.7-0.9			EL T44.1-1.0			GA 1.2			GA 0.1			WE 0.5			BL 0.4			AL 0.5			FO 0.5		
PARAMETERS	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F	M	R	F
pH Laboratory	7.5	-	1	7.7	-	1	7.5	-	2							7.3	6.8-7.8	2	7.5	7.5-7.6	2	7.6	-	1
CONDUCTIVITY(micro MHOS/cm)	200	-	1	310	-	1	235	230-240	2							200	-	1	270	-	1	250	-	1
TURBIDITY (TU)	0.4	-	1	0.4	-	1	0.4	-	1							0.7	0.7	2	o.5	0.4-0.5	2	0.4	-	1
TOTAL SOLIDS																267	292-442	2	246	188-303	2			
SUSPENDED SOLIDS										1	-	1				14.5	9-20	2	5	1-11	2	6	-	1
TOTAL DISSOLVED SOLIDS										1182	-	1				422	-	1	188	-	1			
OIL & GREASE																								
TOTAL ORGANIC CARBON																2	-	1	2	-	1	2	-	1
AMMONIA																								
NITRATE																								
PHOSPHATE																								
CALCIUM																								
MAGNESIUM																								
CHLORIDES																								
SULPHATES	23	-	1	8	-	1	25	-	2							18.5	18-19	2	27	26-29	2	20	-	1
HYDROGEN SULFIDE	ND	-	1	ND	-	1	ND	-	1							ND	-	1	ND	-	1	ND	-	1
SODIUM AND POTASSIUM	2	-	1	39	-	1	4.3	1-7.6	2							2	-	1	28	-	1	1	-	1
POTASSIUM							0.6	-	1															
CHLORIDES	11	-	1	8	-	1	15	-	2							30	-	1	15	-	1	11	-	1
CALCIUM	38	-	1	33	-	1	41.5	40-43	2							51	-	1	25	-	1	49	-	1
MAGNESIUM	10	-	1	6	-	1	13.5	12-15	2							9	-	1	9	-	1	9	-	1
CARBONATES	0	-	1				0	-	2							0	-	1	0	-	1	0	-	1
BI-CARBONATES	122	-	1	210	-	1	141	132-151	2							137	-	1	156	-	1	156	-	1
HYDROXIDE	0	-	1	0	-	1	0	-	2							0	-	1	0	-	1	0	-	1
TOTAL ALKALINITY	122	-	1	210	-	1	141	132-151	2							137	-	1	156	-	1	156	-	1
ALKALINITY AS $CaCO_3$	100	-	1	172	-	1	116	108-124	2							112	-	1	128	-	1	129	-	1
IRON	ND	-	1	ND	-	1	0.05	-	1	0.05	-	1	0.05	-	1	0.05	-	2	0.05	-	1	0.05	-	1
ARSENIC							0.01	-	1	0.01	-	1	0.01	-	1									
ALUMINUM										1.0	-	1	1.0	-	1									
BARIUM							0.2	-	1															
CADMIUM							0.02	-	1							0.01	-	1	0.01	-	1			
LEAD							0.01	-	1	0.03	-	1	0.03	-	1									
MERCURY							0.0011	-	1	0.0002	-	1	0.0002	-	1	0.0002	-	1	0.0002	-	1			
COPPER							0.05	-	1	0.05	-	1	0.05	-	1									
NICKEL							0.05	-	1	0.05	-	1	0.05	-	1									
VANADIUM							1.0	-	1	1.0	-	1	1.0	-	1									
ZINC							0.01	-	1	0.01	-	1	0.01	-	1									
CHROMIUM										0.01	-	1	0.01	-	1									

All Parameters expressed in PPM unless indicated otherwise.
Analyses conducted by Core Laboratories According to Standard methods.

M - mean
R - Range
F - Frequency
\- is considered to be negligible

Sampling station locations are marked on Map 9 (Appendix A).

ND-Not detected

FIGURE 10

ANALYSES OF SEDIMENT SAMPLES
COLLECTED AT STATION EL 42.0 E - OCTOBER 6, 1976

Trace Metals Analysis in ppm

Iron	0.81
Mercury	0.0413
Cadmium	0.4
Zinc	77.0
Nickel	19.4
Copper	16.3
Lead	13.7

Particle Size Distribution in Percent

+100 mesh	11% (Sand)
+230 mesh	26% (Fine Sand)
+325 mesh	5% (Silt)
-325 mesh	58% (Clay)

Samples collected using an Ekman Dredge, from backwater pool.

2.5

SECTION 250+00

NOTE

1. GENERALIZED GEOLOGIC SECTION BASED ON PRE-1975 EXPLORATION INFORMATION.

K- ELK RIVER 77(2)A.

ELCO MINING LIMITED

DIAGRAMMATIC GEOLOGIC CROSS SECTION

SCALE: 0 0·05 0·1 KILOMETER

DEC. 1976 | FIGURE 1

TECHMAN LTD. DWG. NO: 1952 REF. TM-113C/178

2.6

FIGURE 1

DESCRIPTION OF SOIL PROFILES FROM VEGETATION MACROPLOTS IN THE UPPER ELK RIVER VALLEY, 1972
(from B.C. Research Report No. 1, 1974a)

PROFILE 1: Soil subgroup - Degraded Eutric Brunisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Immature pine forest, with a sparse forb and shrub dominated ground cover in the coniferous forest type.
		Parent material - glacial till derived from weathered shale.	
L-H	1.3-0	Organic litter.	
Ahe-Ae	0-16.5	Fine granular structure to slightly platy; some shale particles, gray brown to gray in color; pH greater than 6.0.	
Bm_1	16.5-35.6	Coarser material with 1.0-1.3 cm. sand and shale particles, angular blocky to granular structure; pH 6.5.	
Bm_2	35.6-43.2	Fine material, like weathered shale; clayey, orange color probably result of red colored shale; pH 6.9.	
C	43.2+	Soft shale, carbonaceous material pH 6.7.	

FIGURE 1, continued

PROFILE 2: Soil subgroup - Degraded Eutric Brunisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Open buffalo-berry-wildrye community in the open forest cover type.
		Parent material-loess over till.	
L-H	1.3-0	Organic litter.	
Ahe	0-6.4	Silty material, probably loess.	
Bm_1	6.4-15.2	Silty material, reddish brown, pH 6.	
Bm_2	15.2-33.0	Silty material, probably loess, yellowish brown, pH 6.	
C	33.0-91.4	Dark greyish brown till, sandy texture, pH 5.7.	

FIGURE 1, continued

PROFILE 3: Soil subgroup - Terric Mesisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Willow-sedge and grass dominated community in the forest and shrub cover type.
		Parent material - glacial till sandstone and shale present.	
Surface	0-7.6	Fibric, dark brown, organic material.	
Tier	7.6-10.2	Intermittent zone of volcanic ash deposition.	
	10.2-50.8	Mesic to humic black organic material.	
Middle	50.8-61.0	Mineral soil contact, Cg horizon.	
Tier	61.0+	Till, clayey texture, Cg horizon continued.	

FIGURE 1, continued

PROFILE 4: Soil subgroup - Terric Mesisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Sedge and willow dominated community within the forest and shrub cover type.
		Parent material - glacial till.	
Surface	3.8-0	Moss other than *Sphagnum*.	
Tier	0-1.3	Fibric organic material.	
	1.3-3.8	Mesic organic material, black.	
	3.8-34.3	Humic organic material, black.	
Middle	34.3-43.2	Mineral soil, appears to be volcanic ash, reddish brown.	
Tier	43.2-50.8+	Grey glacial till, clayey texture; free water at till layer.	

FIGURE 1, continued

PROFILE 5: Soil subgroup - Melanic Brunisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Immature pine-spruce forest with a shrub and forb dominated ground cover in the open forest cover type.
		Parent material - lacustrine, this soil appears to have undergone some mixing possibly by soil creep.	
F	7.1-6.4	Organic litter.	
H	6.4-0	Decomposed organic litter.	
Ah	0-19.1	Black loamy material (O.M. content about 9%).	
Bm_1	19.1-38.1	Brown, fine silty material of probably lacustrine origin (O.M. content about 4.5%, pH 6.8).	
Bm_2	38.1-43.2	Yellowish brown color, lacustrine (O.M. content about 4.5%, pH 6.8).	
C1	43.2-45.7	Black carbonaceous material (O.M. content about 19%, pH 7.0).	
C2	45.7-50.8	Brown material (O.M. content about 6%, pH 7.4).	
IIC	50.8-66.0+	Grey colored clay mixture of lacustrine and till.	

FIGURE 1, continued

PROFILE 6: Soil subgroup - Terric Mesisol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Willow-birch-side fen community in the forest and shrub cover type.
		Parent material - glacial till with sandstone present.	
Surface	0-8.9	Fibric, dark brown, organic material.	
Tier	8.9-24.1	Fibric, brown, organic material.	
Middle	24.1-45.7	Mesic to humic, black organic material.	
Tier	45.7+	Till, clayey texture.	

FIGURE 1, continued

PROFILE 7: Soil subgroup - Orthic Regosol

Horizon	Depth in Centimeters	Soil Description	Vegetation
			Mature spruce and cottonwood community with a forb dominated ground cover in the deciduous and coniferous cover type.
		Parent material - alluvial.	
LF	3.3-0.8	Organic litter, primarily spruce needles.	
H	0.8-0	Decomposed organic litter.	
Ahej	0-16.5	Sand and silt material, platy structure, grey black.	
C	16.5-99.1	Sand, silt and clay material, slight banding due to alluvial deposition.	

2.7

FIGURE 1 - SUMMARY OF
PRELIMINARY HABITAT ASSESSMENTS

OBSERVATION LINE	DATE (S) EXAMINED	COVER TYPES TRANSECTED[1]	LARGE MAMMAL USE[2]	OTHER WILDLIFE	UNGULATE FORAGE AVAILABILITY & KEY SPECIES[3]	UNGULATE HABITAT UTILIZATION	GAME TRAIL DEVELOPMENT & USE	HABITAT OPPORTUNITIES AND LIMITATIONS
1	05-25-76	Open Forest (1) Aspen-Pine (2)	Elk, Moose, Deer, Black Bear: all in both habitat types.	Blue Grouse, Coyote: in both cover types.	Limited (Aspen, Willow)	Light Winter Use	Deadfall slight factor limiting natural trail development; coal exploration has provided movement possibilities.	South and west slopes of Little Weary considered potential winter range. Limitations include forage deficiencies (native grassland development poor relative to reclaimed and seeded areas) and possible deep snow (under investigation).
2	05-25-76	Open Forest	Moose, Elk	Beaver	Scattered Willow	Light Winter Utilization	Limited by deadfall except in floodplain area; outfitter horse trail used by game.	Poor interspersion of vegetation types; forested areas limited by dense tree cover and deadfall.
3	05-26-76	Pine (1) Open Forest (2)	Moose (Open Forest), Elk (Pine)	-	Negligible	Transitional Use	Negligible	Limitations include deadfall, forest encroachment and forage plant deficiencies.
4	05-27-76	Pine (1) Forest & Shrub (2)	Grizzly Bear, Moose, Elk: all in both habitat types.	Coyote: in both habitat types.	Willow in Forest & Shrub	Transitional Use	Negligible (Forestry road as movement corridor).	Limitations include deadfall and forest encroachment.
5	09-27-76	Pine (1) Forest & Shrub (2) Open Forest (3)	Grizzly Bear, Black Bear, Moose: in all cover types	Beaver, Mink, Coyote: all in Open Forest	Limited primarily to Floodplain Areas	Limited to Elk River Flood-Plain Area.	Natural development limited by deadfall. Game utilization of manmade trails.	Ungulate habitat limitations (lack of forage and vegetation type interspersion in pine forest) are balanced by bear habitat capability. Forest and shrub area along Elk River may contain lick site. (under investigation).

1. Relative occurrence of Cover Types (according to BCR inventory, 1974a) encountered.
2. As determined by sign: Pellet-groups, tracks, foraging and sightings, in relation to cover type use where applicable
3. Key forage sources considered for utilization measurement.

Figure 1 Cont'd

OBSERVATION LINE	DATE (S) EXAMINED	COVER TYPES TRANSECTED[1]	LARGE MAMMAL USE[2]	OTHER WILDLIFE	UNGULATE FORAGE AVAILABILITY & KEY SPECIES[3]	UNGULATE HABITAT UTILIZATION	GAME TRAIL DEVELOPMENT & USE	HABITAT OPPORTUNITIES AND LIMITATIONS
6	05-27-76	Reclaimed Exploration Site, Little Weary Ridge	Elk	Small Rodent	Seeded Clover and Grasses	Heavy transitional use by elk.	Negligible	Seeded species selection requires wildlife forage use consideration; wildlife cover limitations.
7	10-01-76 10-06-76	Reclaimed Exploration Site, Little Weary Ridge	Elk, Deer, Moose	Small Rodent	Seeded Clover and Grasses	Transitional use by elk; Light winter use by moose in reclaimed road area.	Use of exploration trails into reclaimed sites.	Seeded species selection requires wildlife forage use consideration; wildlife cover limitations.
8	10-01-76	Fen and meadow	Moose	-	Browse plant limitations: abundance of scrub birch relative to willow. Variety of sedges and grasses.	Generally light utilization, but grass/sedge utilization remains to be evaluated.	N/A	Browse plant limitations.
9	10-05-76 10-06-76	Open Forest	Moose, Elk	Golden Eagles, Bald Eagle, Other Raptors	Willow and general forage variety in riparian areas; native grass availability on upper slopes (1980-2290 m).	Only apparent in pine-grassland ecotone areas; overall, a light transitional use pattern.	Distinct lack of game trail development. No terracing on upper slopes (above 1980 m).	Deadfall in lower forested areas and cover deficiencies on grass slopes. Aspen is missing as a cover and forage component.
10	10-09-76	Open Forest	Moose, Elk, Grizzly Bear	Beaver, Mink	Willow is abundant.	Willow shows little utilization.	Negligible	Deadfall is a factor limiting ungulate capability.

1. Relative occurrence of Cover Types (according to BCR inventory, 1974a) encountered.
2. As determined by sign: Pellet-groups, tracks, foraging and sightings, in relation to cover type use where applicable
3. Key forage sources considered for utilization measurement.

Figure 1 Cont'd

OBSERVATION LINE	DATE (S) EXAMINED	COVER TYPES TRANSECTED[1]	LARGE MAMMAL USE[2]	OTHER WILDLIFE	UNGULATE FORAGE AVAILABILITY & KEY SPECIES[3]	UNGULATE HABITAT UTILIZATION	GAME TRAIL DEVELOPMENT & USE	HABITAT OPPORTUNITIES AND LIMITATIONS
11	10-09-76	Forest & Shrub	Moose, Elk, Deer	-	Willow is abundant, some aspen.	Winter range use and transitional use.	Limited by deadfall; use of manmade roads.	Deadfall is a factor limiting ungulate capability. Snow depths under investigation.
12	10-18-76	Reclaimed exploration sites (1), Open Forest (2)	Moose, Elk: in both cover types	Snowshoe Hare (reclaimed exploration site).	Limited	Moose account for the major winter browsing observations; elk use is light and/or transitional.	Some natural game trail development; exploration trail use is evident.	Improved seed selection is required on reclaimed areas. Browse plant deficiency.
13	11-05-76	Open Forest	Elk, Deer, Moose	Beaver	Undetermined	Undetermined	Undetermined	Probably an important range and migration corridor area.
14	11-05-76	Alpine	Elk, Grizzly Bear, Cougar	Wolverine, Weasel, White-Tailed Ptarmigan	Native Bluegrass Meadow.	Negligible	Negligible	Input

1. Relative occurrence of Cover Types (according to BCR inventory, 1974a) encountered.
2. As determined by sign: Pellet-groups, tracks, foraging and sightings, in relation to cover type use where applicable
3. Key forage sources considered for utilization measurement.

FIGURE 2

LIST OF PLANT SPECIES UTILIZED BY UNGULATES IN THE MINESITE AREA

1. TREES

Subalpine fir (*Abies lasiocarpa*)[2]
Aspen (*Populus tremuloides*)[1,2]
Balsam poplar (*Populus balsamifera*)[1]

2. SHRUBS

Saskatoon-berry (*Amelanchier alnifolia*)[1,2]
Black twinberry (*Lonicera involucrata*)[1,2]
Gooseberry (*Ribes* spp.)[2]
Rose (*Rosa* spp.)[2]
Salmonberry (*Rubus leucodermis*)[1]
Willow (*Salix* spp.)[1,2]
Elderberry (*Sambucus racemosa*)[1,2]

3. FORBS

Nodding onion (*Allium cernuum*)[1]
Pearly everlasting (*Anaphylis margaritacea*)[1]
Large purple aster (*Aster conspicuus*)[1]
Indian paintbrush (*Castilleja miniata*)[1]
Fireweed (*Epilobium angustifolium*)[1,2]
Varied - leaf phacelia (*Phacelia heterophylla*)[1]
White clover, seeded (*Trifolium repens*)[2]

4. GRASSES

Blue wild rye (*Elymus glaucus*)[2]
Hairy wild rye (*Elymus innovatus*)[1]

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1 B.C. Research, 1972 Wildlife Observations, Report No. 4 (1975a)
2 Techman Ltd. Field Investigations, 1976

2.8

FIGURE 1

ALGAE COLLECTED FROM ELK RIVER

AND TRIBUTARIES - OCTOBER, 1976

	ELK RIVER								TRIBUTARIES		
OBSERVED RELATIVE DENSITY OF PERIPHYTON	EL 46.5 East O	EL 46.5 West O	EL 43.6 West A	EL 43.0 East A	EL 43.0 West A	EL 42.0 East O	EL 42.0 West O	EL 38.9 Mid. C	GA 1.2 C	WE 0.5 O	BL 0.4 C
Species Present											
Chlorophyta											
Cladophora sp.											
Closterium sp.											
Merospora sp.											
Spirogyra sp.	A										
Stigeoclonium nanum						C					
Stigeoclonium spp.	C	C			O	A	O	C			
Ulothrix zonata	C						O	A			
Zygnema spp.	A										
Cyanophyta											
Calothrix spp.	C					O					
Gleocapsa spp.											
Merismopedia glauca		O									
M. convoluta											
Nostoc verrucosum			A		O					C	
Oscillatoria agarhii		A		A		O			A		
Oscillatoria spp.	C						O				
Phormidium spp.	C					C		O		O	A
Rivularia cf. borealis			C								
Rivularia spp.					O						
Chrysophyta											
Class Chrysophyceae											
Hydrurus foetidus		A		C			A		C		A
Class Bacillariophyceae											
Achnanthes minutissima	C	C				C	A			A	C
Achnanthes spp.	A	A			A		A				
Amphipleura pellucida	O	O									
Cocconeis pediculus	O	O					O				
Cocconeis placentula	O	O			O		O		C		
Cymbella microcephala	R	R					R				
Cymbella minuta	O	O					O			O	
Cymbella spp.	C	C		C		C	C		C	O	C
Diatoma hiemale var mesodon									C	R	
Diatoma vulgare									C		
Didymosphenia geminata	C	C		O	O	O	O		O		
Fragilaria construens											
Fragilaria spp.				C						O	
Frustulia rhoniboides				O	R						
Gomphonema spp.	C	C		C	O	C	C		C	O	C
Hanraea arcus var amphioxys	R	R					R			R	
Hannaea arcus	O	O		C			O		A	C	
Meridion circulare									C	R	
Navicula cryptocephala	O	O					O				
Navicula radiosa	O	O					O				
Naricula spp.				C					C		
Nitzschia dissipata											
Nitzschia spp.	O	O					O		C		
Surirella spp.											
Synedra spp.											
Number of Species Present	22	19	2	9	8	9	18	3	12	11	5

A = Abundant; C = Common; O = Ocassional; R = Rare

Identification and relative abundance determined by Aquatic Environments Ltd.

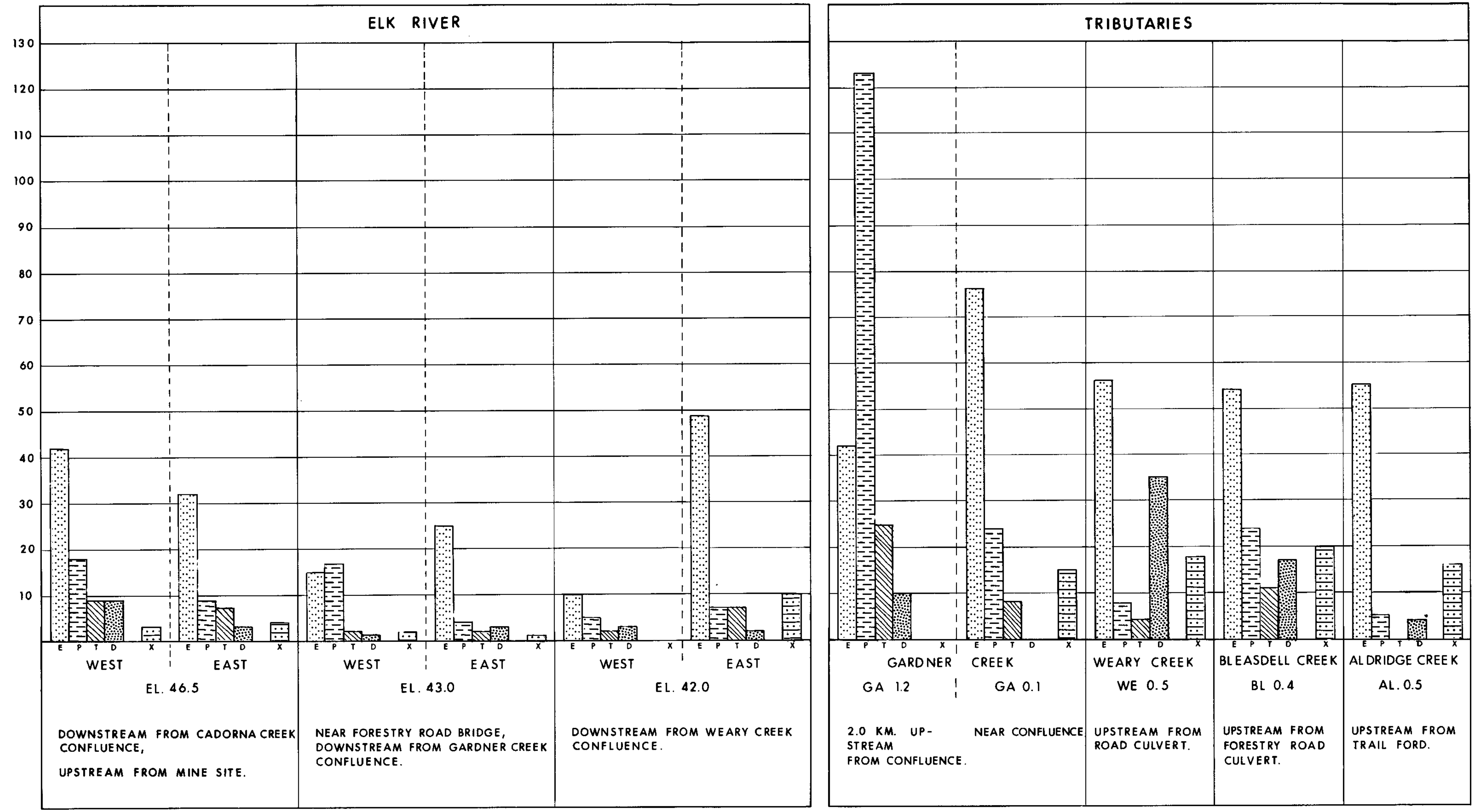
FIGURE 4

FISH OF THE UPPER ELK RIVER WATERSHED

SPECIES[1]	RELATIVE ABUNDANCE[1]	HABITAT	FOOD	SPAWNING SEASON	SPAWNING HABITAT
Yellowstone Cutthroat Trout (*Salmo clarki lewisi*)	Abundant	Lakes & rocky pools & back eddies of streams.[2,3]	Primary - aquatic and terrestrial invertebrates. Secondary - fish.[2,3]	Spring and eary summer.[2,3]	Migrate short distances. Spawn in redds dug on upstream end of riffles.[2,3]
Doly Varden (*Salvelinus malma*)	Common	Probably live in lakes & migrate into stream to spawn.[2,3]	Primary - fish. Benthic organisms - molluscs, insect larvae and fish eggs.[2,3]	Fall (mid-August to early November).[2,3]	May migrate long distances; spawn in streams.[2]
Eastern Brook Trout (*Salvelinus fontinalis*)	Occasional	Thrives best in cold, clear streams.[2,3]	Primary - insects; Secondary - fish.[2,3]	Spawn in fall; hatch in spring.[2,3]	Constructs redds in gravel beds of streams (and possibly lake shoals).[2]
Mountain Whitefish (*Prosopium williamsoni*)	Abundant	Lakes & streams (often found in swift flowing streams).[2,3]	Chiefly a bottom feeder, mainly on insect larvae.[2,3]	Spawn in late October or early November. Eggs hatch in March.[2,3]	Release eggs on gravel in shallow water. Spawn in lakes.[2,3]
Bridgelip Suckers (*Catestomus columbianus*)	Rare	Running water and occasionally lakes.[2]	Probably eat algae off rocks.[2]	Late spring.[2]	Probably spawn in streams.[2]

1. Clark, updated
2. Carl et. al., 1959
3. Paetz and Nelson, 1970

3.7



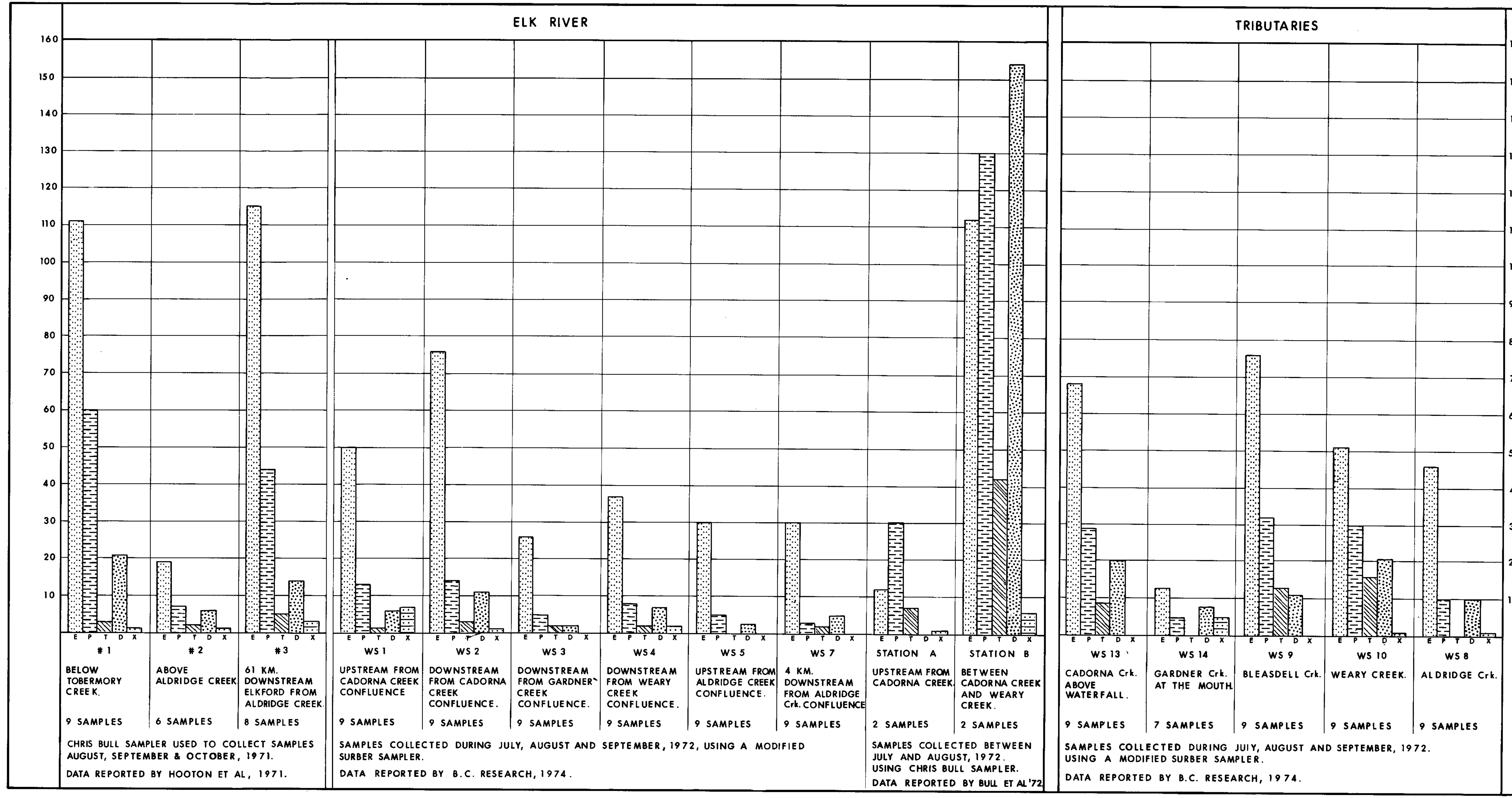
SAMPLES COLLECTED OCTOBER 5-7, 1976, USING STANDARD SURBER SAMPLER.

EACH SAMPLE WAS A COMPOSITE OF THREE SAMPLES, AS RECOMMENDED BY B.C. DEPARTMENT ENVIRONMENT, 1976.

E - EPHEMEROPTERA (MAYFLIES)
P - PLECOPTERA (STONEFLIES)
T - TRICHOPTERA (CADDISFLIES)
D - DIPTERA (TRUE FLIES)
X - OTHERS

K - ELK RIVER 77(10)A.

ELCO MINING LIMITED	
MACROINVERTEBRATES COLLECTED FROM ELK RIVER AND TRIBUTARIES OCTOBER 5-8, 1976. MEAN NUMBER OF TYPES PER SAMPLE.	
DEC. 1976	FIG. 2
TECHMAN LTD.	DWG. NO. 1953 REF. TM-172-1



LEGEND

E - EPHEMEROPTERA (MAYFLIES)
P - PLECOPTERA (STONEFLIES)
T - TRICHOPTERA (CADDISFLIES)
D - DIPTERA (TRUE FLIES)
X - OTHERS

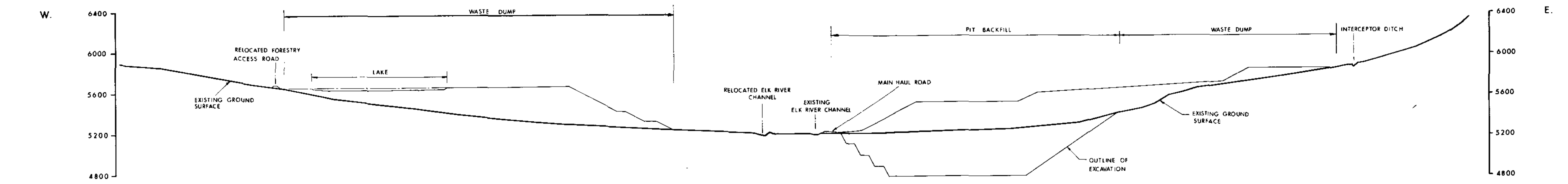
K - ELK RIVER 77(10)A.

ELCO MINING LIMITED

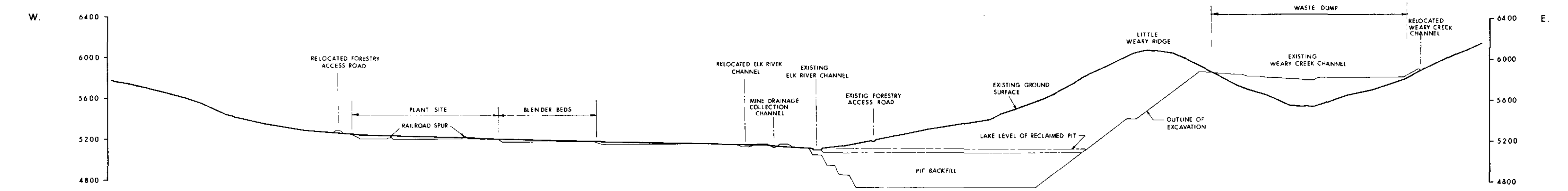
MACROINVERTEBRATES COLLECTED FROM ELK RIVER AND TRIBUTARIES 1971-1972.
MEAN NUMBER OF TYPES PER SAMPLE.

DEC. 1976 | FIG. 3

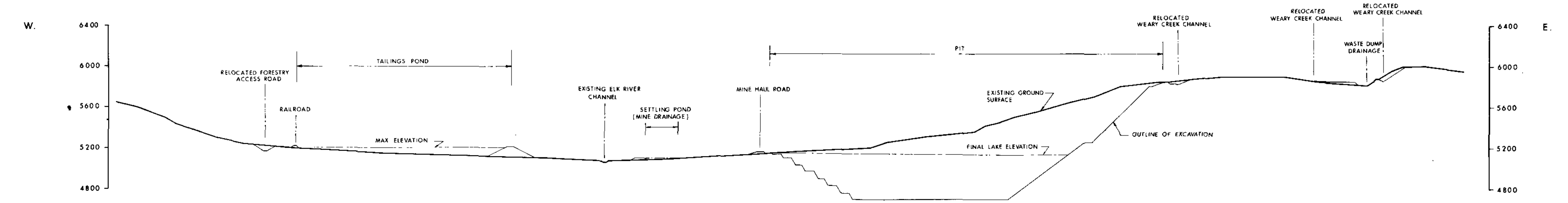
TECHMAN LTD. | DWG NO: 1954 | REF. TM-172-1



SECTION 315+00



SECTION 225+00



SECTION 185+00

ELCO MINING LIMITED

VALLEY CROSS SECTIONS

DEC. 1976	FIGURE 1
TECHMAN LTD.	DWG 1955 REF. T-0173

3.9

FIGURE 1

SLOPE CLASSIFICATION FOR REVEGETATION AND MITIGATIVE ENHANCEMENT OF OFFSITE UNGULATE RANGES

TYPE	CHARACTERISTICS	RELATIVE MINESITE OCCURRENCE AND TREATMENT SUMMARY
A. HIGH CAPABILITY	Low relief (0^{o} to 17^{o})	60 percent.
Natural Soil	Offsite* wildlife habitat improvement areas.	Fertilized and seeded where appropriate with preferred forage species.
Reclaimed Soil	Bench slopes on dumps and other level disturbance areas.	Fertilized and seeded with preferred forage species. Tree plantings.
B. MODERATE CAPABILITY	Moderate relief (17^{o} to 26^{o}).	18 percent.
Natural Soil	Offsite* wildlife habitat improvement areas.	Fertilized and seeded where appropriate with preferred forage species.
Reclaimed Soil	Most dump slopes; some exploration trenches, road cuts and fills.	Fertilized and seeded with initial cover crop and/or conifers. Planted where appropriate with trees and shrubs.
C. LOW CAPABILITY	High relief (26^{o} to 34^{o})	3 percent.
Reclaimed Soil	Some exploration trenches, most roadway cut and fill slopes.	Fertilized, mulched and seeded with initial cover crop. Planted where appropriate with trees and shrubs.
D. PARTIALLY RECLAIMABLE	34^{o} + slopes	5 percent.
Predominantly Rock Some Reclaimed Soil	Vegetated pockets on excavated rock faces.	Utilize benches for seeding or plantings.

*Offsite: Key wildlife areas, outside the mining site with potential for forage improvement to offset temporary range losses resulting from mining.

TYPE	CHARACTERISTICS	RELATIVE MINESITE OCCURRENCE AND TREATMENT SUMMARY
E. LAKE OR POND		13 percent.
Landscaped Shoreline	Final pit and specially designed recreational lakes and wildlife ponds	Utilize landform modification to produce desirable water resource features.

FIGURE 2

LIST OF NATIVE PLANT SPECIES COLONIZING DISTURBED SITES

(LITTLE WEARY AND WEARY RIDGES)

A. Reclaimed Exploration Sites

1. TREES

Balsam poplar (*Populus balsamifera*)
Lodgepole pine (*Pinus contorta*)

2. SHRUBS

Green alder (*Alnus crispa*)
Rose (*Rosa* sp.)
Red raspberry (*Rubus idaeus*)
Thimbleberry (*Rubus parviflorus*)
Willow (*Salix* spp.)
Elderberry (*Sambucus racemosa*)
Shiny-leaf spiraea (*Spiraea betulifolia*)

3. FORBS

Pearly everlasting (*Anaphalis margaritacea*)
Arnica (*Arnica* sp.)
Aster (*Aster* sp.)
Fireweed (*Epilobium angustifolium*)

B. Roadways and Cutlines

1. TREES

Balsam poplar (*Populus balsamifera*)
Lodgepole pine (*Pinus contorta*)

2. SHRUBS

Willow (*Salix* spp.)
Buffalo-berry (*Shepherdia canadensis*)
Rose (*Rosa* sp.)
Red raspberry (*Rubus idaeus*)
Grouse-berry (*Vaccinium scoparium*)

3. FORBS

Pearly everlasting (*Anaphalis margaritacea*)
Wild vetch (*Vicia americana*)

4.1

FIGURE 1

LABOUR REQUIREMENTS FOR MINE SITE, ROAD AND RAILWAY

TRADE	Approximate No. of Employees/Year				
	1979	1980	1981	1982-90	1991-2006
Construction Supervision	14	94	97		
Mine Supervision		6	27	27	27
Engineering	52	68	32	26	26
Maintenance Supervision	12	15	34	34	34
Office, Administration/Clerical	23	29	44	44	44
Warehouse	12	10	8	8	8
Security & First Aid	8	8	13	13	13
Services & Transportation	58	55	165	135	135
Equipment Operators & Helpers	129	96	390	390	373
Mechanics, Electricians & Servicemen	95	189	277	277	260
Blasting Crew			27	27	28
Preparation Plant Supervision				24	24
Preparation Plant Operating Labour				88	88
preparation Plant Mainten. Labour				100	100
Carpenters	30	6	6		
Iron Workers	25	92	101		
Pipe Fitters		122	135		
Instrumentation		61	67		
Millwrights		92	101		
Boilerworkers		31	34		
Miscellaneous Labour	21	92	101		
<u>Underground Mining Operation</u>					
Wage Earners					176
Mining Operators					21
TOTAL LABOUR FORCE*	479	1066	1659	1179	1343

*The townsite construction labour force has not been analysed and is not included. However, depending on the rate at which family housing is provided, the work force in the building and construction trades required to build a small city in three years could be 2000 to 3000 men. Depending upon the rate of initial startups an additional 200 men could be employed at this time.

K-ELK RIVER 77 (4) A

APPENDIX C

4.2

APPENDIX C, SECTION 4.2

A. FACTORS AND CALCULATIONS FOR COMMUNITY REQUIREMENTS

APPENDIX C - SECTION 4.2 - A

A. FACTORS AND CALCULATIONS FOR COMMUNITY REQUIREMENTS

POPULATION:

1. Assumptions

a. Basic Industry

Employee status - 30% single, 70% married as target, but depending on employment policy and good town amenity.

Family Status of Marrieds - 25% childless, 75% with children.

2.5% of wives are employed by Industry (assumed from childless married).

Children average 2.25/family with children.

b. Support Industry

Job opportunities = 8% of basic industry employment.

Employee status - 62.5% single, 37.5% married.

Family members fill job opportunities @ 1.25 persons/family.

Family Status of Marrieds - 60% childless, 40% with children.

Children average 2.1/family with children.

NOTE: Employment highly variable depending on basic industry policy as to degree of maintenance and auxiliary services to be provided within the Company.

NOTE: It must be noted that forecasts developed are only for that segment NOT covered within basic industry population.

c. Service Industry

Job opportunities = 17% of basic industry employment.

Employee status - 36.5% single; 63.5% married.

Family members fill job opportunities @ 1.85 persons/family.

Family Status of Marrieds - 70% childless, 30% with children.

Children average 2.1/family with children.

NOTE: Government policy on locating government departments in the town can be a varying contributor.

NOTE: It must be noted that forecasts developed are only for that segment NOT covered within basic industry population. Total Service Industry employment will be increased by wives and children of basic industry employees filling full or part-time job opportunities.

d. Translation of Assumptions

	Basic Industry	Support Industry	Service Industry	Total
Employment Level	1400	112	238	1760
Mix Breakdown - Singles	420	70	87	577
- Married	980	42	151	1173
- Childless	245	25	106	376
- Familied	735	17	45	797
Population Breakdown				
- Singles - Male	395	65	43	503*
- Female	25	5	44	74
- Childless Married:				
Male	229	20	60	309*
Employed Wives	16	5	46	67
Non-Employed Wives	213	15	14	242
- Familied Married:				
Male	727	15	40	782*
Employed Wives	8	2	5	15
Non-Employed Wives	719	13	35	767
- Children	1636	32	48	1716
TOTAL ESTIMATED POPULATION				4475

* Carried forward to housing projections..

HOUSING PROJECTIONS:

1. Translation of Assumptions

a. Household Status

From the foregoing population projections, the housing requirements may be tabulated as follows:

Single Persons	577
Childless Married	309
Families	782

b. Household Groups

The household grouping from the basic status may be tabulated as follows:

Single		577	
Childless Married - 2 person		309	
Families - 3 person (32%)	250		
- 4 person (35%)	274		
- 5 person (21%)	164		
- 6+ person (12%)	94	782	
			1668

c. Housing Preferences

1 Person - Hostels	(35%)	192		
- Studio Suites	(65%)	356		
- Boarders	(5%)		(29)*	548
2 Person - 1 Bedroom Apartment	(34%)	100		
- Trailer	(27%)	83		
- Mobile Home	(39%)	121		309
3 Person - 2 Bedroom Apartment	(34%)	85		
- 3 Bedroom Duplex	(25%)	63		
- Mobile Home	(41%)	102		250

4 Person	- 3 Bedroom Townhouse	(24%)	66	
	- 3 Bedroom Duplex	(17%)	47	
	- Mobile Home	(17%)	46	
	- Detached House - 3 Bedroom	(42%)	115	274
5 Person	- Duplex - 4 Bedroom	(25%)	41	
	- Detached House - 3 Bedroom	(32%)	52	
	- Detached House - 4 Bedroom	(43%)	71	164
6+ Person	- Detached House - 4 Bedroom	(100%)	94	94
TOTAL ACCOMMODATIONS				1639
* Boarders				(29)*

SCHOOLS:

1. Child Population & School Requirement Forecast

a. Child Population - Breakdown

	Basic Industry	Support Industry	Service Industry	Total
Preschool (0-5)	851	17	25	893
Elementary (6-12)	597	12	18	627
Junior Secondary (13-15)	172	3	5	180
Senior Secondary (16-18)	16	-	-	16
TOTAL				1716

Projected requirement is for:

2 elementary schools providing 18 classrooms.
1 secondary school providing 8 classrooms.

RECREATION:

Provision of play-lots, neighbourhood parks and major community parks.

A recreation facility including a figure skating - hockey arena, curling ice, banquet - meeting hall, hobby rooms all with associated storage, viewing and washrooms.

Auditorium, playing fields and track facilities in conjunction with the school development.

Golf course and skiing facilities as suggested by the local environment and community demand.

COMMERCIAL:

Projections have been developed from analysis in like communities.

Centre	Pop.	Total Outlets	Food	Gen. Mdse.	Auto	Apparel	Hdw. Furn.	Other
Sidney	3160	55	12	1	6	8	5	23*
Hinton, Alta.	4307	51	7	5	10	6	5	8
Merritt	4500	61	11	4	18	9	9	10
Mission	5351	61	10	4	18	8	8	13
Average of above	4330	55	10	4	13**	8	7	10

* Non-Typical Weighting - Heavy tourist orientation related to ferry service.

** Requirements of a new town would reflect the proximity of Elkford, Sparwood, and Alberta communities as competitors, particularly for the Automobile related outlets.

Proposed requirements:

Total Outlets	Food	Gen. Mdse.	Auto	Apparel	Hdw. Furn.	Other
43	10	4	4	8	7	10

GENERAL:

From the foregoing population projections, related general requirements are as follows:

1. Religious

Provision for three churches, recognizing Roman Catholic, Protestant and other persuasions.

2. Municipal/Public Safety/Utilities

A municipal administration facility and library with related works yard; Public Safety facility for a five man police detachment and related Fire and Provincial agencies (Social & Judicial); Provincial Highways depot; utilities and municipal services (Hydro, Telephone, T.V., water supply and sanitary sewage treatment).

3. Health

A Diagnostic & Treatment Centre with Ambulance facility. Health agency recommendations suggest a town cannot support a hospital until the population exceeds 6,000; land should be reserved for expansion of this facility to a 25 bed hospital.

4. Service Industrial

A Light Industrial area allowing warehousing, Building Supplies, Machine Shops, etc. and sites for service stations.

LAND:

The projected land requirements for the Settled Condition - i.e. basic industry labour force of 1400 with a Singles-Married ratio of 30%-70% may be tabulated as follows:

A. Housing	Number	Yield/Ac.	Acres
Hostel Units	192	30	6.5
Walk up apts. area	461	20	23.
Garden apts. area	85	18	4.75
Townhouse lots	66	12	5.5
Duplexes lots	151	7	21.5
Trailer park	83	10	10.25
Mobile home plots	269	7	38.5
Detached house lots	332	4.5	73.75
Total net residential acreage			183.75
Add 20% for road allowances			36.75
Gross residential land:			220.50

B. Schools	Number	Unit	Acres
Elementary School/s	2	7.5	15.
Secondary School	1	10	10.
			25.

C. Recreation	Number	Unit	Acres
Playlots @ .057 acres/1000 persons.			.25
Neighborhood parks @ 1 acre/ 1000 persons			4.5
Major park area @ 2.5 acres/ 1000 persons			11.25
Recreation centre building area allowance			6.
Playfields @ 1.25 acres/ 1000 persons			5.75
Residential green belts & Land loss @ 20% residential gross areas			44.
			71.75

D. Commercial

Commercial	Number	Area	Acres
Hotel (incl. parking)	1		2
Motel (incl. parking)	1		1.5
Shopping retail		30,000 s.f.	
Personal Services		10,000 s.f.	
Professional offices		8,000 s.f.	
Commercial recreation & Entertainment		2,000 s.f.	
		55,000 s.f.	1.3
Parking and landscaping for shopping centre @ 2 x gross area		110,000 s.f.	2.6
			7.4

E. Religious

Religious	Number	Unit	Acres
Church parcels	3	1.2	3.6

F. Municipal - Public Safety and Utilities

Municipal - Public Safety and Utilities	Number	Unit Yield	Acres
Municipal offices & departments			.5
Public Safety Building			2.
Public Works Yard			2.
Water Supply			1.
Treatment Plant (Including screening)			1.5
Sub-Station (including screening)			1.
Telephone Equip. Building			.25
Municipal Library			.5
Dept. Highways Work Yard			1.
			9.75

G. Health	Number	Unit/Yield	Acres
Diagnostic Centre			2.00
Reserve to increase to 25 bed Hospital status			(2.50)

H. Service Industrial	Number	Unit	Acres
Service stations	3	.5	1.5
Repair & machine shops	2	.5	1.
Fuel dealer	1	.5	.5
Auto dealer, etc.	2	.5	1.
Bldg. supplies, etc.	3	.5	1.5
Equipt. sales	2	.5	1.
Misc. outlets	12	.5	6.
			12.5

I. Industrial Buffer Allowance	Number	Unit	Acres
Roads @ 25% - net 131.90			33
- Highway bi-pass			30
			63

Total Land Requirement Projection:	415.50
Hospital Reserve	2.50
	418.00
SAY:	420.00 ACRE

APPENDIX C, SECTION 4.2

B. ELKFORD 1976

" ELKFORD 76 → "

THE UNECON PARTNERSHIP
Project Consultants

McCARTER, NAIRNE & PARTNERS
Planning Consultant

ASSOCIATED ENGINEERING SERVICES LIMITED
Municipal Engineering Consultant

McELHANNEY ASSOCIATES
Survey Consultant

December 1976

I N D E X

ASSIGNMENT

To appraise future development of the Village of Elkford to meet the community requirements specifically for the expanding labour force of Fording Coal Limited, and in general for potential resource industry development in the area.

Requirements for housing, servicing, educational, recreational, and institutional facilities will be developed for the projected population generated by the Fording Coal Limited anticipated labour force increase.

Potential areas for expansion will be examined including required "off site" servicing and cost estimates to meet the projected development capability.

CHAPTER I

FORDING GENERATED DEVELOPMENT

A. PREAMBLE

Fording Coal Limited have projected their maximum labour force as 1223 employees for the production of 3,500,000 tons of clean coal annually. Employment levels have gone far beyond the original work force of 350 given by the Company in 1969 (and subsequently increased to 610) as part of the terms of reference for the original townsite planning. The Company has also stated that if markets expand, then production could be increased with a resultant growth in the labour force. The requirements of a 1500 labour force have been examined for this contingency.

This report analyzes the existing (1975) status of the Village of Elkford and projects the requirements for the proposed Fording Coal Limited labour force stages of 1223 and 1500 employees.

B. POPULATION

1. Existing

a. Fording Employment Data (from Company statistics for October 1975)

Single men/women	415	(45.6%)
Married women	20	(2.2%)
Married men (495-20)	475	(52.2%)
TOTAL	910 employees	

b. Population Generated from Fording Employment (Company statistics ref.)

Total number of families	475	
Less married with children	271	(57.0%)
Net childless married	204	(43.0%)

i)	single male/female employees	415
ii)	childless male employees	204
iii)	assumed childless female employees	20
iv)	non-employed childless females (204-20)	184
v)	male employees w/children	271
vi)	non-employed females w/children	271
vii)	total children	775
	Fording-generated population	2,140 persons

c. Support and Service Industry Data (from field survey)

Single	- male	52
	- female	39
Childless married	- male	26
	- female	26
Married with children	- male	17
	- female	17
	- children	36
Support and Service population		213 persons

d. General Observations

i) High Percentage of Single Status Employees

A maximum of 30-35% single employees in a mining labour force has been equated with reasonable stabilization. The present level of 45% of total work force is seen as excessive and a review of proportions at previous lower employment levels suggests that this present proportion could be the highest to date. The following reasons are contemplated:

a. deliberate plan to extend fullest utilization of camp while gradually and conservatively providing alternatives,

b. present labour market deficient in potential married employees,

c. deterring lack of suitable housing for married employees in Elkford.

It is assumed that the Company wishes to improve stability and that lack of suitable housing for married employees is the primary reason for present high levels of single employees.

ii) <u>High Percentage of Childless Married Status Employees</u>

While it is recognized that current economic climate, trend to postpone child raising, career aspirations of young married women & birth control methods of today are contributors to an increase in childless couples in today's labour force, the present proportion of 43% childless in the total married force is twice the proportion which would normally be expected.

While childless couples offer improved stability over single employees, they are more mobile than families with children. Some surveys suggest that they are only 1/3 - 1/2 as stable as families with children.

The following reasons for the present high proportion are contemplated:

a. hiring policy aimed at reducing land development, dwelling unit, and school load costs,

b. high proportion of childless married in present labour market,

c. attraction of high wages and highly subsidized housing to a potentially mobile force of young couples,

d. lack of larger family housing units as deterrent to families with children.

Lack of familied housing in Elkford does not appear to be a reason for the high number of childless couples. A detached housing and mobile home family accommodation inventory of 226 + 183 = 409 net available family units, compared to a projected requirement of 271 + 51 = 322 units, indicates a surplus of 87 family accommodations. If no recognizable surplus exists it is because childless married couples are occupying family units (non-Fording occupancies have been subtracted). Indeed, all indications are that the childless married employees are the specific category for which little housing has been provided.

Because of the theoretical surplus of larger family units and the deficiency of couples accommodation, ranging from 1 bedroom apartments to mobile homes, it is recommended that a serious review be made of the entire aspect of childless couple numbers, housing needs, and present occupancies.

Implications are that if the present childless married proportion holds or increases, there will be a danger of overbuilding detached housing, overdeveloping land, and encouraging excessive development of mobile homes because of lack of provision of smaller family accommodation alternatives. Potential land waste alone could represent 75-100% above that required.

2. Projected

Fording Coal Limited have projected a labour force increase by the end of 1977 to 1063 and by the end of 1978 to 1223. They have indicated also that, over a yet unstated period, they wish to develop a more desirable mix ratio of single, childless married and married with children employees. This, in our opinion, would maximize at singles 15%, childless married 20%, and married with children 65%. The possibility of obtaining this mix and the time period required would be a product of the Company's hiring and development policies.

For reference the following combinations were developed:

Labour Force	Mix Ratio			
	Single	Childless Married	Families	
1063	40	20	40	*
	30	20	50	
1223	30	20	50	
	15	20	65	*
1500	15	15	70	*

* Included with this report.

The latter set of numbers was developed recognizing potential for increased production and because, in our experience, such a margin of error should be allowed for labour projections when considering ultimate development.

The Support and Service population has been developed from experience in like communities.

Elkford Total Population Projections Based on Various Fording Employment Levels and Mixes

Fording Role		1,063		1,063		1,223		1,223		1,500
Singles	40% -	425	30% -	319	30% -	367	15% -	183	15% -	225
Childless Married	20% -	213	20% -	213	20% -	245	20% -	245	15% -	225
Married w/children	40% -	425	50% -	531	50% -	611	65% -	795	70% -	1050
A. Basic Industry:										
Singles - Males		405		299		347		163		205
- Females		20		20		20		20		20
Childless - Males		192		198		228		228		200
- Females		192		198		228		228		200
Married w/ - Males		425		531		611		795		1050
- Females		425		531		611		795		1050
- Children	@2.75	1,169	@2.75	1,460	@2.50	1,528	@2.50	1,988	@2.25	2,362
T1-Total Basic Generation		2,828		3,237		3,573		4,217		5,087
B. Support & Service Industry (assumed from field data*)										
Singles - Males		52		63		57		51		(127
- Females		39		46		43		39		(
Childless - Males		26		32		50		67		63
- Females		26		32		50		67		63
Married w/ - Males		17		21		34		47		62
- Females		17		21		34		47		62
- Children	@2.1	36		44		59		74		132
T2 - Total Service Generation	(7.5%)	213	(8.0%)	259	(8.5%)	304	(9.3%)	392	(10.3%)	509
T1 + T2 Total Population		3,041		3,496		3,877		4,609		5,596

* further survey required to establish status of employees and population potential

C. HOUSING

1. Existing

a. Present Elkford Housing Inventory (from August 1975 listing)

	Fording Employees	Non-Fording Employees	Vanant Units	Total
i) Singles Units (camp)	415	13	48	476
ii) Apartments	57	3	-	60
iii) Mobile Homes	183	9	-	192
iv) Detached Houses	224	20	2	246
Totals	879	45	50	974

b. Housing Under Construction - 1975

i) Apartments - studio	20	
ii) Townhouse	15	
iii) Duplexes	16	
iv) Detached Houses	72	
Total		123

c. Serviced Land Available for Construction - 1975

i) Apartments - Studio	57		
- 1 Bedroom	29		
- 2 Bedroom	25	111	
ii) Detached		84	
Total			195

iii) Lots held in reserve for possible road realignments.- (5).

2. Projected

A selective upgrading of development density on existing serviced land would increase the yield.

The development program to a large extent will be governed by available serviced land. A recommended housing mix as an indicator is projected for 1063 labour force at 40% single, 20% childless married, and 40% families, and as the ultimate for building purposes a 1223 labour force at 15% single, 20% childless married, and 65% families. It would be the intent to build a number of units of each type, not to exceed the latter requirements.

A recommended housing mix as a guage for future land requirements is projected for a 1500 labour force at 15% single, 15% childless married, and 70% families.

a. *Analysis of Housing Requirements for 1063 Fording employees*

based on the following status breakdown:

Single men/women	-	40%	=	425
Childless married	-	20%	=	213
Married w/children	-	40%	=	425
		100%		1063

Total married 213 + 425	=	638	
Less 2% employed wives	=	21	(assumed from childless married)
Net male married (families)	=	617	

Childless married families	= 213 - 21	=	192
Married w/children families		=	425
Total families			617

i) Fording Generated Housing Requirement (theoretical)

a.	425 singles	20% bachelor apartments	82	
		80% camp rooms	343	425
b.	192 childless couples (213-21 wives)	25% 1 BR apartments	48	
		10% 2 BR apartments	19	
		45% trailers	87	
		20% mobile homes	38	192

c. 425 families w/children
(1 child - 3 person household 27% = 115
2 child.- 4 person household 39% = 166
3 child.- 5 person household 24% = 102
4 child.- 6+person household 10% = 42)

115 - 3 person households	10% 2 BR garden apartments	12	
	15% 2/3 BR townhouses	17	
	20% 3 BR duplexes	23	
	55% mobile homes	63	115
166 - 4 person households	10% 3/4 BR townhouses	17	
	15% 3 BR duplexes	25	
	25% mobile homes	41	
	50% 3 BR detached houses	83	166
102 - 5 person households	10% 4 BR townhouses	10	
	20% 4 BR duplexes	20	
	70% 3/4 BR detached houses	72	102
42 - 6 and more person households	- 4 BR detached houses		42

TOTAL DWELLING UNITS 1042

ii) Support and Service Industry Generated Housing Requirement

(theoretical base from population tables)

a.	90 singles	20% bachelor or studio apartments	18	
		80% Hotel/Boarding rooms	73	91
b.	26 childless couples	25% 1 BR apartments	6	
		10% 2 BR apartments	3	
		45% trailers	12	
		20% mobile homes	5	26

c. 17 families w/children
(1 child - 3 person household 27% = 4
2 child.- 4 person household 39% = 7
3 child.- 5 person household 24% = 4
4 child.+-6 person household+ 10% = 2)

4 - 3 person households (2 BR base)	10% 2 BR garden apartments	-	
	15% 2 BR town houses	1	
	20% 3 BR duplexes	1	
	55% mobile homes	2	4
7 - 4 person households (3 BR base)	10% 3 BR townhouses	1	
	15% 3 BR duplexes	1	
	25% mobile homes	2	
	50% 3 BR detached houses	3	7
4 - 5 person households (3/4 BR split)	10% 4 BR townhouses	-	
	20% 4 BR duplexes	1	
	70% 3/4 BR detached houses	3	4
2 - 6 or more person households (4 BR base)	100% 4 BR detached houses		2

TOTAL DWELLING UNITS 134

b. Analysis of Housing Requirements for 1223 Fording employees

based on the following status breakdown:

Single men/women	-	15%	=	183
Childless married	-	20%	=	245
Married w/children	-	65%	=	795
		100%		1223

Total married 245 + 795	=	1040
Less employed wives	=	21 (assumed from childless married)
Net male married (families)	=	1019

Childless married families	= 245 - 21 =	224
Married w/children families	=	795
		1019

i) Fording Generated Housing Requirement (theoretical)

a. 183 singles		100% studio apartments		183
b. 224 childless couples	(245 - 21 wives)	25% 1 BR apartments	56	
		10% 2 BR apartments	22	
		45% trailers	101	
		20% mobile homes	45	224

c. 795 families w/children
(1 child - 3 person household 27% = 215
2 child.- 4 person household 39% = 310
3 child.- 5 person household 24% = 191
4+child.- 6+person household 10% = 79)

214 - 3 person households	(2 BR base)	25% 2 BR garden apartments	54	
		20% 3 BR townhouses	43	
		55% mobile homes	118	215
310 - 4 person households	(3 BR base)	10% 3 BR townhouses	31	
		15% 3 BR duplexes	46	
		25% mobile homes	78	
		50% 3 BR detached houses	155	310
191 - 5 person households	(3/4 BR base)	10% 4 BR townhouses	19	
		20% 4 BR duplexes	38	
		35% 3 BR detached houses	67	
		35% 4 BR detached houses	67	191
79 - 6+ person households	(4 BR base)	100% 4 BR detached houses		79

TOTAL DWELLING UNITS 1202

ii) <u>Support and Service Industry Generated Housing Requirement</u>

(theoretical base from population table)

a.	90 singles	100% bachelor or studio apartments		90
b.	67 childless couples	25% 1 BR apartments	17	
		10% 2 BR apartments	7	
		45% trailers	30	
		20% mobile homes	13	67

c. 47 families w/children
(1 child - 3 person household 27% = 13
2 child.- 4 person household 39% = 18
3 child.- 5 person household 24% = 11
4+child.- 6+person household 10% = 5)

13 - 3 person households (2 BR base)	10% 2 BR garden apartments	1	
	15% 2 BR townhouses	2	
	20% 3 BR duplexes	3	
	55% mobile homes	7	13
18 - 4 person households (3 BR base)	10% 3 BR townhouses	2	
	15% 3 BR duplexes	3	
	25% mobile homes	4	
	50% 3 BR detached houses	9	18
11 - 5 person households (3/4 BR split)	10% 4 BR townhouses	1	
	20% 4 BR duplexes	2	
	70% 3/4 BR detached houses	8	11
5 - 6 or more person households (4 BR base)	100% 4 BR detached houses		5
TOTAL DWELLING UNITS			204

c. Analysis of Housing Requirements for 1500 Fording employees

based on the following status breakdown:

Single men/women	-	15%	=	225
Childless married	-	15%	=	225
Married w/children	-	70%	=	1050

Total married = 225 + 1050		=	1275	
Less employed wives		=	25 (assumed from childless married)	
Net male married (families)		=	1250	
Childless married families	= 225-25		=	200
Married w/children families			=	1050
				1250

i) Fording Generated Housing Requirement (theoretical)

a. 225 singles	100% bachelor or studio apartments			225
b. 200 childless couples (225-25 wives)	25% 1 BR apartments		50	
	10% 2 BR apartments		20	
	45% trailers		90	
	20% mobile homes		40	200

c. 1050 families w/children
(1 child - 3 person household 27% = 283
2 child.- 4 person household 39% = 410
3 child.- 5 person household 24% = 252
4+child.- 6+person household 10% = 105)

283 - 3 person households (2 BR base)	10% 2 BR garden apartments	28	
	15% 2 BR townhouses	42	
	20% 3 BR duplexes	57	
	55% mobile homes	156	283
410 - 4 person households (3 BR base)	10% 3 BR townhouses	41	
	15% 3 BR duplexes	61	
	25% mobile homes	103	
	50% 3 BR detached houses	205	410
252 - 5 person households (3/4 BR split)	10% 4 BR townhouses	25	
	20% 4 BR duplexes	50	
	70% 3/4 BR detached houses	177	252
105 - 6 or more person households (4 BR base)	100% 4 BR detached houses		105
TOTAL DWELLING UNITS			1475

ii) <u>Support and Service Industry Generated Housing Requirement</u>

(theoretical base from population table)

a.	127 singles	100% bachelor or studio apartments		127
b.	63 childless couples	25% 1 BR apartments	16	
		10% 2 BR apartments	6	
		45% trailers	28	
		20% mobile homes	13	63

c. 62 families w/children
(1 child - 3 person household 27% = 17
2 child.- 4 person household 39% = 24
3 child.- 5 person household 24% = 15
4+child.- 6+person household 10% = 6)

17 - 3 person households (2 BR base)	10% 2 BR garden apartments	2	
	15% 2 BR townhouses	3	
	20% 3 BR duplexes	3	
	55% mobile homes	9	17
24 - 4 person households (3 BR base)	10% 3 BR townhouses	2	
	15% 3 BR duplexes	4	
	25% mobile homes	6	
	50% 3 BR detached houses	12	24
15 - 5 person households (3/4 bedroom split)	10% 4 BR townhouses	1	
	20% 4 BR duplexes	3	
	70% 3/4 BR detached houses	11	15
6 - 6 or more person households (4 BR base)	100% 4 BR detached houses		6

TOTAL DWELLING UNITS	252

D. SERVICING

1. Existing

a. Design Criteria

i) Sewerage

Domestic average	60	Imp. gal/cap/day
Babbitt Peaking Factor		
Infiltration	1000	Imp. gal/acre/day
	500	Imp. gal/acre/day

ii) Water Supply Demands

Peak day domestic	400	Imp. gal/person/day
Peak hour	500	Imp. gal/person/day
Fire flow	1000*	Imp. gal/min. 3 hour duration

* Used whenever school or commercial areas involved.

b. Sewage Treatment System/Capacity

The sewage treatment works were expanded in 1974-75 by Fording Coal Limited to upgrade the quality of treatment and also to increase the capacity. The capacity designed for was 3000 persons and was intended to serve the townsite plus the Phase 5 expansion of 1975 which when fully developed, the total of the two would reach a population of 3000 persons.

c. Water Supply System/Capacity

The water supply system comprises a water intake on Boivin Creek which was replaced in 1975, a 12-inch supply main, and a 6- and 8-inch distribution network within the existing townsite and Phase 5 areas. The system has been sized on the basis of serving an ultimate population of 3000 persons at a peak hourly flow rate of 500 Imperial gallons per person per day plus a fire flow of 1000 Imperial gallons per minute (Igpm). At the peak flow rates the pressure drop within the Phase 5 area becomes the limiting factor and would become marginal should additional supply capacity be required.

2. Projected

a. Sewage Treatment/Capacity

To increase the capacity of the treatment works the next economical incremental size is 1500 to 3000 persons. This incremental size is necessary to take advantage of integrating and existing berm into the works which will reduce earthwork and also provide some economy of scale for the additional aeration equipment required. The cost estimate shown is for a size increase of 2200 persons to give a total capacity of 5200 persons which at present would appear to be the ultimate requirement for Fording's planned operation.

For costs of a planned size of either 1500 or 3000 persons the estimated cost of the 2200 person size can be adjusted down or up by 15% to give the respective capacity cost.

Estimated construction cost of expansion (2200 persons)	$ 250,000.	
Engineering and contingencies at 25%	62,500.	
Total	$ 312,500.	(1976 $)*

Other factors such as upgrading of existing sewer laterals and sewage pump stations depend directly on the specific nature of future development, and are considered in those respective sections of this report.

*Does not include Rip-rap.

b. Water Supply System/Capacity

To sustain pressures within the Phase 5 area for an increase in supply capacity, a balancing reservoir should be installed above and to the south of Phase 5. This would have the effect of reducing pressure drops in Phase 5 during peak flows since the townsite and Phase 5 would be supplied from two directions, the reservoir and Boivin Creek intake.

To increase the capacity of the system to 5200 persons, a 150,000 Imperial gallon reservoir would be required.

Estimated construction cost of reservoir and appurtenances	$ 145,000.	
Engineering and Contingencies at 25%	36,000.	
Total	$ 181,000.	(1976 $)

Other factors depend directly on the specific nature of future development, and are considered in those respective sections of this report.

E. EDUCATION

1. Existing

a. Population

Statistics supplied for 1974[1] suggest that child age groups in Elkford range approximately as follows:

303 pre-school aged	(0 - 5)	-	38.5%	(47.5%)
351 elementary aged	(6 - 13)	-	44.5%	(36.5%)
135 secondary aged	(14 plus)	-	17%	(16.0%)

To the right are noted percentages of child age distributions previously encountered in resource towns. Comparison indicates a markedly reduced proportion of pre-schoolers and a slightly higher proportion of secondary school-aged children.

The lower proportion of pre-schoolers can be attributed to the greater birth control effectiveness and generally lowered birth rate, and to a predominence of 'older' families as a result of company relocations from other operations. This latter cause would also support a higher than usual proporation in the secondary-aged group.

The massive hirings of married and familied employees implied by current objectives would produce a composite force whose proportions would tend to revert toward the more usual statistics. As average family size lowered, the proportion of pre-schoolers would increase, and the proportion of secondary-aged children decrease.

For purposes of this preliminary analysis it is adequate to view the likely impact in terms of median proportions, vis:

pre-school aged	(0 - 5)	- 43%
elementary aged	(6 - 13)	- 40%
secondary aged	(14 plus)	- 17%

b. Facilities

i) Pre-school - none

ii) Elementary - 16 classroom school } 7.11 acres
- associated field }

iii) Secondary - none - students are bussed to Sparwood
site reserved 17.80 acres

[1]School District No. 1 - Fernie, B.C.

2. Projected

a. Education Facility Requirements
(theoretical based on 1063 Fording employees)

i) Fording generated children:

425 families	x 2.75	=	1169

ii) Support and Service industry generated children:
(from total population table)

17 families	x 2.1	=	36
Total children (theoretical)			1205

iii) Distribution:

Preschool	43%	518	
Elementary	40%	482	
Secondary	17%	205	1205

iv) Facility requirements:

Preschool	nil			
Elementary	482/35	=	14 classrooms	(7.0 acres)
Secondary	205/31	=	7 classrooms	(3.5 acres)

b. Education Facility Requirements
(theoretical based on 1223 Fording employees)

i) Fording generated children:

795 families	x 2.5	=	1998

ii) Support and Service industry generated children:
(from total population table)

		=	74
Total children (theoretical)			2072

iii) Distribution:

Preschool	43%	891	
Elementary	40%	828	
Secondary	17%	352	2072

iv) Facility requirements:

Preschool	nil			
Elementary	828/35	=	24 classrooms*	(12.0 acres)
Secondary	352/31	=	12 classrooms	(6.0 acres)

* 2 school sites required

c. Education Facility Requirements
(theoretical based on 1500 Fording employees)

i) Fording generated children:

1050 families	x 2.25	=	2362

ii) Support and Service industry generated children:
(from total population table)

		=	132
Total children (theoretical)			2494

iii) Distribution:

Preschool	43%	1072	
Elementary	40%	998	
Secondary	17%	424	2494

iv) Facility requirements:

Preschool	nil			
Elementary	998/35	=	28 classrooms*	(14.0 acres)
Secondary	424/31	=	14 classrooms	(7.0 acres)

* 2 school sites required.

F. COMMERCIAL

1. Existing

a. Existing Retail Commercial & Service Commercial Content and Land Areas:

Outlet	Given Gross Area	Given Site Area
Food Store (Safeway)	8,200 sq. ft.)	
Bank (Royal Bank)	2,400 sq. ft.)	
Drug Store	2,400 sq. ft.)	
Govt. Liquor Store	2,400 sq. ft.)	
Post Office	2,400 sq. ft.)	3.50 ac. ±
Clothing Store	2,400 sq. ft.)	
General Store (Catalogue)	2,400 sq. ft.)	
Furnishings, Appliance	450 sq. ft.)	
Hotel - 20 rooms	)	
150 seat parlour	)	1.20 ac.
32 seat lounge	(misc.))	
	22,850 sq.ft. plus hotel complex	4.70 ac.
Plus Service Station		approx. 0.50 ac.
		Approx. Total 5.20 ac.

2. Projected

Commercial facilities and land requirements associated with a population of 5200 persons.

a. Evaluation 1

Rule of thumb allowance of 10 sq.ft. of gross commercial floor area per person.

5,200 persons @ 10 sq.ft./person = 52,000 ft. G.F.A.

Land requirement based on parking @ 5.5 stalls (@ 350 sq.ft.)
per 1,000 sq.ft. G.F.A. = 5.5 x 52 x 350 = 100,100
plus G.F.A. including 10% contingency = 52,000 x 110% = 57,200

157,300

converts to 3.61 ac.

This can be substantially provided by the present centre.

b. Evaluation 2

Commercial land requirement suggested by H. Bartholomew statistics of satellite cities (Land Use in American Cities).

Total Commercial Land (Retail and Service):
.15 to .22 acres/100 persons

for 5,200 persons = $\frac{5,200}{100}$ x .15, .22 = 7.8 to 11.4 acres

This evaluation is based on somewhat antiquated material and does not reflect present day intensifications of development such as large shopping centre complexes and other forms brought about by present day land values. For this reason, and because shopping practices will go beyond Elkford for certain purchases (automobiles, major repairs, major appliances, etc.) the above allowances per 100 persons are selected from the lower portion of the range for satellite cities.

c. Evaluation 3

Comparison of number of retail commerical outlets with those of other centres having similar population at time of survey (Source - D.B.S. census data sheets).

Centre	Population at time of survey	Total Outlets	Food	Gen. Mdse	Auto	Apparel	Hdwr Furn.	Other
Hinton, Alta.	4,307	41	7	5	10	6	5	8
Kimberley, B.C.	5,901	56	12	4	13	8	8	11
Merritt, B.C.	4,500	61	11	4	18	9	9	10
Mission, B.C.	5,351	61	10	4	18	8	8	13
Quesnel, B.C.	5,725	71	12	4	18	11	11	15
Average of above	5,157	58	10.4	4.2	15.4	8.4	8.2	11.4

In making comparisons between Elkford and the above centres at similar stage of development, the Elkford circumstance should reflect the following:

i) single industry community sustained by non-renewable resource as a deterrent to the attraction of private investment,

ii) absence of strong trading area as support for certain marginal commercial facilities,

iii) proximity of Sparwood, Fernie and Alberta communities as competitors in commercial area.

If it is assumed that auto-related outlets in Elkford are unlikely to exceed 4 in number*, an appropriate base number of outlets for a town of 5,200 persons would be approximately:

Total Outlets	Food	Gen.Mdse.	Auto	Apparel	Hdwe/Furn.	Other
44	10	4	4*	8	8	10

The initial tendency of a small growing town is to seek diversity and a full range of shopping. This is followed by a desire for competitiveness and duplicate outlets.

If the above is discounted roughly 20% to reflect the general Elkford circumstance; if the 'Automotive' category is held at 4* as previously noted; and if it is recognized that diversification will favour upholding of the number of 'Other' category outlets, the expectation for Elkford commercial suitable for a population of 5,200 would be:

Total Outlets	Food	Gen.Mdse.	Auto	Apparel	Hdwe/Furn.	Other
39	9	3	4*	6	6	10, or more

The above evaluation suggests that Elkford at present contains only about 1/3 of the number of outlets that may be supported by a population of 5,200 persons, having the characteristic of 70% of basic industry employment filled by married men with families.

d. Evaluation 4

Based on estimated annual community expenditures on local commercial merchandise:

i) Estimated gross annual income:

Employment Group		Number	Assumed Average Annual Income	Estimated Annual Gross Income
Male:	Basic Industry	1,355	$17,000.	$23,035,000.
	Service Industry	49	14,000.	686,000.
Female:	Basic Industry	45	7,500.	337,500.
	Service Industry	26	8,000.	208,000.
Totals		1,475		$24,266,500.

To reflect the raised saving increment attributable to incidence of working wives, the base annual gross income used for expenditure base is reduced to $24,000,000.

ii) Proportion of gross annual income to local retail commercial:

It is generally accepted that approx. 62.5% of annual gross income is expended on retail item purchases.

$24,000,000. x .625 = $15,000,000. per annum expended

Because of the proximity of Sparwood, Fernie and Alberta and the gaps in outlet types and merchandise types in Elkford, it is suggested that local retail outlets will capture only about 50 - 60% of the potential annual expenditure amount, as follows:

Commodity Group	% total expend-itures	% capture locally	Annual Sales Volume	Assumed Sales Vol/s.f.	Indicated area requirement
Food	25.8	22.0	3,300,000	150	22,000
Gen. Mdse.	19.8	11.5	1,725,000	60	28,750
Auto	24.3	8.0	1,200,000	55	21,818
Apparel/Access.	5.2	2.5	375,000	45	8,333
Hdwe/Home Furn.	5.6	3.6	540,000	40	13,500
Other retail	19.3	9.0	1,350,000	55	24,545
Totals:	100%	56.6%	8,490,000		118,946s.f.

iii) Translation into land requirements:

Gross Retail floor area/above	- 118,946 s.f.		
Service and Admin. allowance @ 15%	- 17,842		
Approximate gross building area	136,788 s.f.		
Parking and buffer area @ 1925/100 GFA = 1925 x 118.9	= 228,882 s.f.		
Suggested total land requirement	= 365,670 s.f.	=	8.39 acres
Less available land		=	5.20 acres
Suggested additional land requirement		=	3.19 acres

e. Conclusion - Commercial Requirements

The foregoing studies suggested commercial land areas for Elkford at 5,200 population level, as follows:

Evaluation 1	3.61 acres
Evaluation 2	7.80 acres
Evaluation 4	8.39 acres

The range of disparity is considerable and confirms that no hard and fast formula is applicable. Land use efficiency, scale and type of development, outlet efficiency, range of content, quality of merchant and merchandise, and life of community are all modifying factors.

It is suggested that the most appropriate sizing of commercial land requirements for Elkford might come from preparation of a list of essential outlets and their more usual floor area requirements. This could be translated into a total land requirement which included service, amenity, and off-street parking allowances.

A suggested list of retail and service commercial outlets appropriate for a town of 5,200 persons is as follows. Approximate gross leasable areas are listed.

Category	Existing (Expanded)	Additional	Totals
A. Food & Food Service:			
1. Supermarket	13,000		
2. Meats/Fish/Poultry		1,800	
3. Delicatessen/Bakery		900	
4. Candy and Nuts		600	
5. Restaurant	2,000		
6. Restaurant/Take Out		1,800	
7. Fast Food Take Out		450	
8. Cocktail Lounge	900		
9. Beverage Parlour	2,400		23,850
B. General Merchandise:			
1. Junior Department Store		8,000	
2. Variety Store		3,200	
3. Catalogue	3,600		14,800
C. Automotive:			
1. Automotive Accessories		3,600	
2. Service Station #1	(½ acre)		
3. Service Station #2		(½ acre)	
4. Auto Sales (Marginal)		(½ acre)	3,600 (plus 1½ acres)
D. Apparel:			
1. General Clothing	4,000		
2. Ladies Wear/Specialties		1,800	
3. Children's Wear		1,800	
4. Men's Wear		1,800	
5. Family Shoes		1,800	
6. Jean Shop		900	12,100
E. Hardware/Home Furnishings:			
1. Hardware & Bldg. Supplies		6,000	
2. Furniture/Appliances		3,200	
3. Radio/TV/Stereo		1,200	
4. Interior Furnishings		2,400	
5. Glass, China, Gifts		1,200	
6. Leather Goods, Imports (Marginal)		1,200	15,200

Category	Existing (Expanded)	Additional	Totals
F. Other Outlets:			
1. Govt. Liquor Store	2,400		
2. Post Office	2,400		
3. Drug Store #1	5,000		
4. Perscription Drugs #2		3,000	
5. Branch Bank #1	3,600		
6. Branch Bank #2		2,400	
7. Books, Stationery, Cards		1,200	
8. Toys and Hobbies		1,200	
9. Pet Shop		900	
10. Sporting Goods		1,200	
11. Camera/Photo		600	23,900
	Sub Total A - F		93,450 sq. ft. (plus 1½ acres)
G. Personal Service: (Service Commercial)			
1. Laundry/Dry Cleaning		1,800	
2. Shoe Repair		600	
3. Beauty Parlour		1,200	
4. Barber Shop		600	
5. Professional Offices		3,600	7,800
	Summary Total		101,250 sq. ft. (plus 1½ acres)

Total Gross Leasable Area	=	101,250 s.f.	
Service Areas & Fringe @ 15%	=	15,188 s.f.	
On-site Parking @ 5 cars/1000 GFA on Categories A to F = 93.45 x 5 x 350	=	163,537 s.f.	
Total Estimated Land Requirement	=	279,975 s.f.	(6.43 ac.)
plus 1½ acres			1.50
			7.93 ac.

Present Commercial Land:	Shopping Centre	3.5 ac.	
	Motel	1.2 ac.	
	Service Station	0.5 ac.	5.20 ac.
Approximate New Land Requirement			2.73 ac.

A recommended approach to extending the commercial content of Elkford would be to:

i) Locate all Personal Service and Automotive Outlets in Area F. Convert all such outlets in present shopping centre to retail sales type outlets.

ii) Expand existing shopping centre to limit of site capacity:

Available site - approx 3.5 acres	-	152,460 s.f.
60% allocated to on-site parking	-	91,476
Net to building GLA, service and fringe	-	60,984
Less 17% allowance to service and fringe	-	10,367
Net to gross leasable area	-	50,617
Less present gross leasable area (as given)	-	22,850
Net potential expansion of GLA	-	27,767

iii) Create local commercial area related to convenience for secondary neighbourhood area. Such centre might include:

Restaurant

Theatre-hall

Library

Gift Shops

Sporting Goods

Pets

Camera

Drug Store #2

Books, Stationery

Radio, T.V.

Interior Furnishings

Toys and Hobbies

Professional Offices

G. RECREATION

1. Existing

Present recreation facilities and land areas:

a. Recreational Facility
- Skating Arena and associated team/change rooms
- 3 sheets curling ice and associated lounge/viewing areas
- library
- 250 place banquet hall and associated kitchen/cloak areas
- 2 hobby rooms
- associated office/concession/circulation areas

b. Ski Hill and Clubhouse -

c. 9 Hole Golf Course -

d. 2 Tennis Courts)
) -
e. Baseball diamond)

f. Parkland -

2. Projected

For a population of 5,200 persons, land areas for park/recreation use should be reserved on the basis of 2.35 ac/1000 population.

Using a 5,200 person base, park/recreation reserves should be in the order of:

$$\frac{5200 - 2353}{1000} \times 2.35 = 6.69$$

plus 5% for roads = .34

Total additional land reserve = 7.03 acres.

UNECON

H. MISCELLANEOUS

1. Existing

a) Religious: 2 sites have been identified and reserved for Church purposes.

b) Municipal/Public Safety/Utilities:

A municipal hall, fire hall and municipal works yard exist.

A hydro substation and telephone equipment facility of sufficient capacity for the exising demand exists

c) Health: A Diagnostic and Treatment Centre with ambulance facility is under construction and scheduled for completion early 1977.

d) Service Industrial:

Sites with service stations, building supplies, warehouse, etc. exist to serve the present community demands.

2. Proposed

a) Religious: One further site is proposed to provide, in total, for Roman Catholic, Protestant and other persuations.

b) Municipal/Public Safety/Utilities:

Provision for expansion is proposed for municipal administration, fire fighting, hydro, T.V., telephone, water supply and sewage treatment.

A Public Safety facility for a five man police detachment and related Provincial agencies (Social and Judicial) is required.

A Provincial highways depot may be required.

c) Health: A land reserve is proposed to expand the Diagnostic and Treatment Centre to a 25 bed facility.

d) Service Industrial:

Additional sites are proposed for machine shops, warehouses, building supplies, etc.

I. LAND

The projected land requirements, in addition to the existing, for the development stages analyzed, i.e. 1223 and 1500 labour force for Fording Coal Limited may be tabulated as follows:

		1223 EMPLOYEES		1500 EMPLOYEES	
		POP.: 4609		POP.: 5596	
		No.	Acres	No.	Acres
A. Housing	(Existing)				
Studio Apts.	(99) @ 30/acre	174	5.8	253	8.4
Walk up Apts.	(69) @ 20/acre	33	1.7	23	1.2
Garden Apts.	(23) @ 18/acre	32	1.8	7	.4
Townhouse lots	(15) @ 12/acre	83	6.9	99	8.3
Duplex lots	(16) @ 7/acre	76	10.9	162	23.2
Trailer park lots	(92) @ 10/acre	39	3.9	26	2.6
Mobile Home lots	(100) @ 7/acre	165	23.6	227	32.4
Detached lots	(318) @ 4/acre	72	18.0	198	49.5
Total net residential acreage			72.6		126.0
Add 20% for road allowances			14.5		25.2
Gross residential land	T.		87.1		151.2
B. Schools					
Elementary	(1)	1	7.0	1	7.0
Secondary		-	-		-
C. Religious	(2)			1	1.3
D. Recreation					
Land reserves			5.3		7.0

I. LAND (continued)

	1223 EMPLOYEES		1500 EMPLOYEES	
	POP.: 4609		POP.: 5596	
	No.	Acres	No.	Acres
E. Municipal-Public Safety & Utilities (Existing)				
Municipal Offices (1)	+	.5	+	.5
Public Safety		1.0		2.0
Works Yard (1)	+	.5	+	.5
Sub-Station (1)	1	.5	1	.5
Dept. Highways Yard	1	1.0	1	1.0
F. Health				
Hospital Reserve				2.5
G. Commercial		1.7		2.7
H. Service Industrial				
Service Station (2) @ .5/acre		-	1	.5
Auto Dealer @ .3/acre	2	.6	4	2.4
Machine Shop @ .5/acre	1	.5	2	1.0
Misc. outlets (11)@ .5/acre			4	2.0
SUB-TOTAL: B, C, D, E, F, G, and H		18.6		30.9
+ Roads at 25%		4.7		7.7
+ Second access		15.0		15.0
Gross B through H		38.3		53.6
TOTAL LAND REQUIREMENT				
Gross A		87.1		151.2
Gross B through H		38.3		53.6
		125.4		204.8

CHAPTER II

POTENTIAL AREAS FOR EXPANSION OF THE VILLAGE OF ELKFORD

A. PREAMBLE

Projections for land requirements to house and serve Fording Coal Limited forecast employment increases indicate that the town of Elkford is currently approaching saturation of that area originally envisioned as townsite.

The nature of the topography around the present townsite is such that future town expansion areas must be developed beyond areas of steep slopes or similar detrimental characteristic. Thus the form of the growing town will evolve into that of a number of connected neighbourhoods, spaced apart by difficult terrain. Since the water supply and sewage disposal facilities of present Elkford are near full utilization, these outlying new neighbourhoods will have to incorporate upgraded or new water supply and new sewage disposal facilities. Therefore, development of such areas would have to be of a magnitude which would justify the cost of connection roads, water supply, and sewage disposal facilities.

The present town is largely single family residential in land use. Very little multiple housing was provided as the Company saw employment potential in terms of a very high percentage of married persons with families, and retention of construction camp facilities as single persons accommodation. The resultant 'slack' land use intensity has created some potential for intensification of presently undeveloped land and through redevelopment of the original Phase 1 subdivision which contains a large number of mobile homes.

An appraisal of potential development lands from aerial photography, mapping and a windshield field survey indicates five (5) potential development areas related to Elkford, which are illustrated on Diagram - D1.

These areas have been reviewed with respect to characteristics, indicated yield and municipal servicing related to this yield.

B. AREA A

1. Characteristics:

An outlying bench area of glacial till where over 200 acres have been identified as having a slope of less than 8%, predominantly to east and south. The potential for spectacular views up, down and across the valley are high.

As an extension of Elkford, this area would create a loop around recreation-oriented lands on the valley floor floodplain and provide an additional arterial connection to the highway.

It would contain sites for an elementary school, a local commercial/ service area and neighbourhood recreation facilities.

2. Yield

The indicative yield of the bench to the South and West of the existing development known as Phase 5, and at an average elevation of 4,350 ft., is as follows:

Approximate gross area			288 ac.
Recreation reserves	>	8% slope	48 ac.
School reserves	<	8% slope	20 ac.
Commercial reserve	<	8% slope	10 ac.
Balance for housing	<	8% slope	210 ac.

At an average yield of 4 units/acre equals 840 dwellings.

At an average population of 4 persons/unit equals 3400 persons.

3. Services

a. Off-Site Servicing - 840 Dwellings
-3400 Persons

1) Water Supply

For a development of this size, pumping facilities, line sizes and reservoir capacity will be significant. Indications are Boivin Creek is capable of supplying water for such a development however, the capacity and capabilities of the existing water intake to accommodate such demands would require further assessment. An allowance for upgrading this facility has been included. The feasibility of pumping from the present intake to a reservoir above the site would require further investigations. An allowance for approximately 900 feet of difficult construction along this route has been made. Demands of such magnitude could not be "tapped" from the existing Phase 5 system without creating unacceptable pressure and supply deficiencies within the present townsite. The capability of the existing 12-inch supply main would be questionable.

ii) Sanitary Sewers

Two alternatives for the disposal of sanitary sewage have been considered:

a. Gravity sewer from the site to the 'highway' then pumped adjacent to the highway north to the existing sewage lagoons.

b. Gravity sewer from the site to a lift station to a mechanical sewage treatment plant located in the vicinity of the highway.

No consideration has been given to conveying this sewage to the Phase 5 system, thence through the balance of the system to the sewage lagoons. Such a scheme would involve extensive relief sewering (4000 feet ±), on site pumping and a new lift station at the lagoons.

iii) Roads and Site Access

For a development of this size a second access will be required. Approximately 7500 linear feet of road with extensive earthworks is allowed.

iv) Flood Protection

Not required.

v) Storm Drainage

Available information indicates that no piping of watercourses or on-site surface runoff will be required. Allowances have been included to cover the cost of culverting road access crossings.

vi) Cost Estimate

	Alternative 1	Alternative 2
a. Water supply	$ 540,000	$ 540,000
b. Sanitary sewers	478,800*	782,000**
c. Roads and site access	800,000	800,000
d. Flood protection	nil	nil
e. Storm drainage	8,000	8,000
Total	$1,826,800	$2,130,000
Plus 25% Engineering and Contingencies	456,700	532,500
Total Cost Estimate	$2,283,500	$2,662,500

* Does not include expansion requirements to existing sewage lagoons.

** Includes cost of mechanical sewage treatment plants below site.

b. On-Site Servicing

i) Water Distribution

Available information indicates that sub-soils are granular in nature with a low water table. Construction conditions for this utility are expected to be excellent.

ii) Sanitary Sewers

Topographic contour plans indicate that initial, intermediate and ultimate development can be accommodated with a completely gravity system. This bears in mind that no consideration has been given to conveying any sewage generated by the ultimate development through Phase 5. Similar to the water distribution, construction conditions should be good.

iii) Roads

In order to facilitate required site distances and lot access, considerable road grading is anticipated. If site material is acceptable for road base construction it will represent some cost savings. It may be advisable that, should the decision be made to proceed with development based on the ultimate plan, a borrow pit be developed as close to the site as possible. Investigation in this respect will be required. Optimum road and lot patterns will have a significant effect in keeping road excavations to the minimum. Clearing of the road rights-of-way for the total width is anticipated.

iv) Drainage

Contour plans do not show any on-site watercourses, therefore no particular provision for such work has been considered.

v) Storm Drainage

No provision for storm sewering has been made on the assumption that natural percolation of surface runoff will be acceptable. Soils information indicates that this can be anticipated. Roadway culverting has been assumed as required.

vi) Hydro Service

Assuming the electrical power distribution will be overhead and that development is considered as a registered subdivision, electrical service is expected to be provided at no cost to the developer.

vii) Site Preparation

Overall clearing for roads and lots has been assumed. Grading of the site for mobile homes and driveway access will be required in some areas. Mobile home lots will require pre-planning in order to establish servicing terminal points. Particular consideration has been given to the servicing of lots which will be used for dwellings other than mobile homes. This recognizes that sewer and water services will terminate at the property line, whereas mobile home services terminate beneath the home in proximity to the home's service core. It is assumed that no selective clearing nor special salvage of topsoil will be required.

viii) Other Utilities

Due to the proximity of the site to existing telephone, cable-vision, and natural gas utilities, it is anticipated that these services will be provided at no cost to the developer.

C. AREA B

1. Characteristics

This area represents a long-recognized potential for development in the form of a strip encirclement of Bear Hill. A portion of this area, perhaps 25% - 30% could be serviced from the upper Boivin subdivision area, but the majority would required new servicing facilities, the fall being toward north and east away from the existing town.

Its development would offer another potential arterial connection to an extended highway.

Recent Provincial Government studies indicate that the western sections of this area are exposed to avalanche danger.

2. Yield

The indicative yield of the bench to the North of the existing development known as Phases 3 and 4, divided into two natural areas by a ridge, and at an average elevation of 4375 ft. is as follows:

Approximate gross area	114 ac.
Recreation reserves > 8% slope	20 ac.
School reserves	8 ac.
Balance for housing	86 ac.

At an average yield of 4 units/acre equals 344 units

At an average population of 4 persons/acre equals 1400 persons

3. Services

a. Off-Site Servicing - 344 Lots

i) Water Supply

The water supply provision to accommodate development of 344 lots will require construction of reservoir capacity and water pumping station capability. Optimum routing of the 8-inch diameter supply main through the development can represent a cost saving by serving as a distribution main for some properties. Provision for a school in this area will effect water storage requirements for fire flows. The water pumping station and the reservoir are necessary in order to avoid excessive pressure "drawdowns" in the existing town and to satisty supply and pressure requirements within this development.

ii) Sanitary Sewers

Three alternatives for the disposal of sewage generated by this expansion were studied:

a. Alternative #1 is a gravity system with alignment within the existing Hydro right-of-way and connection to the existing system at the north end of Galbraith Drive. Further survey information will be required to confirm this alignment. Permission to use the Hydro right-of-way for sewer purposes would be required.

b. Alternative #2 considered a gravity line from the north end of the development east to the existing highway then pumped from that point to the connection at Galbraith Drive. Construction along this alignment would appear to be more favourable than in Alternative #1.

c. Alternative #3 considered all of the on-site sewers gravitating to a sewage pump station at the low point then pumped south to connect to the gravity system installed under the initial development.

An additional 1900 linear feet of relief sewers will be required in order to accommodate the ultimate 344 lot development. This applies to each of the three alternatives discussed above.

A new sewage pump station at the sewage treatment lagoons will be required.

iii) Roads and Site Access

This expansion considers construction of a second access road from an assumed highway extension to the north end of the site. An allowance for the construction of approximately 1400 linear feet of road has been made for this purpose.

iv) Flood Protection

Not required.

v) Storm Drainage

An allowance for culverting of existing ditches has been made at road access crossings.

vi) Cost Estimates

	Alternative #1	Alternative #2	Alternative #3
a. Water supply	$ 281,400	$ 281,400	$ 281,400
b. Sanitary sewers	258,150	305,700	268,400
c. Roads and site access	185,000	185,000	185,000
d. Flood protection	nil	nil	nil
e. Storm drainage	88,500	88,500	88,500
Total	$ 813,050	$ 860,600	$ 823,300
Plus 25% Engineering and Contingencies	203,262	215,150	205,825
Total Cost Estimate	$1,016,312	$1,075,750	$1,029,125

b. On-Site Servicing

i) Water Distribution

As previously mentioned, some construction cost saving may be realized by utilizing a portion of the water supply main for distribution purposes. Indications are that construction of this utility should present no abnormal problems, due to the nature of the existing sub-soils.

ii) Sanitary Sewers

All on-site or internal sanitary sewers will be gravity. Piping installation should encounter conditions similar to the water distribution piping.

iii) Roads

It is anticipated that road grading will require a considerable amount of excavation and filling in order to provide the required lot access and sight distances. Should it be found that the sub-soils contain material which will be acceptable for road construction cost savings can be anticipated. Indications are that this may be the case for much of the area.

iv) Drainage

It has been assumed that no work will be required on any of the existing water courses within the site. Detailed planning of lot and road layout will have to consider this factor.

v) Storm Drainage

No provision for storm sewering has been made on the assumption that natural percolation of surface runoff will be similar to the majority of the townsite. Roadway culverting has been assumed as required.

vi) Hydro Service

Based on the assumption that electrical power distribution will be overhead and that the development is considered as a registered subdivision, electrical service is expected to be provided at no cost to the developer.

vii) Site Preparation

Overall clearing for roads and lots has been assumed. Grading of the site suitable for mobile home placement is required. In order to establish servicing terminal points on the individual lots, pre-planning on an individual lot basis will be required. It has been assumed that no effort will be made to salvage any topsoil during site grading operations. It is also assumed that no selective or special clearing will be done.

viii) Other Utilities

It has been assumed that development contributions in providing telephone, natural gas and cablevision service will be nominal due to the proximity of the site to the existing facilities.

D. AREA C

1. Characteristics

The Round Prairie area was originally considered as a potential townsite for Elkford. It consists of reworked glacial till outwash fan created by, and bisected by Crossing Creek. Its 'aspect' was considered less attractive than the more open characteristic of the valley at Boivin Creek, three miles southward.

It remains, however, as developable land of reasonable potential in two benches sloping gently to the east, and separated by steep slopes. The development in particular of access roads to the upper bench will prove most difficult and be extremely costly.

Recent Provincial Government studies suggest that servicing on the upper bench could be expensive due to the nature of the soils.

2. Yield

The indicative yield of the benches approximately three miles to the north of Elkford, at the locality known as Round Prairie, and situated on Crossing Creek at an average elevation of 4325 feet for the lower and 4575 feet for the upper is as follows:

Approximate gross area - Lower	184 ac.	
Upper	236 ac.	
		420 ac.
Recreation reserves > 8% slope - Lower	59 ac.	
- Upper	100 ac.	
		159 ac.
School reserves < 8% slope		30 ac.
Commercial/Municipal/Service Industrial reserves		42 ac.
Balance for housing		189 ac.

At an average yield of 4 units/acre equals 756 units

At an average population of 4 persons/unit equals 3025 persons.

3. Services

a. Off-site Servicing - 756 dwellings
- 3025 persons

i) Lower Bench

A) Water Supply

Water supply for this site considers two possibilities namely:

a. Intake structure on Crossing Creek above the site.

b. Wells adjacent to the Elk River and north of the site with pumping to a reservoir above the site.

Before any conclusions can be reached on which method is most suitable, additional information pertaining to both possibilities will be required. Some of the questions which must be answered are:

a. Is Crossing Creek capable of supplying quality water to fulfill anticipated demands?

b. Will wells adjacent to the Elk River provide quality water at sufficient rates?

On the basis of previous reports on townsite development in the Elk Valley, it is expected that wells adjacent to the Elk River can provide the required quality and quantity of water for a development of this size. It is assumed that Crossing Creek can also satisfy the requirements. Soil reports for the area indicate that favourable conditions for underground piping exist.

B) Sanitary Sewers

Contour plans indicate that internal sewers will be entirely gravity to one point of collection. Two alternatives for the disposal of sewage are considered.

a. Alternate #1 considers a mechanical sewage treatment plant located below the site and adjacent to the highway, with outfall to the Elk River.

b. Alternative #2 considers collection at a sewage pump station located adjacent to the highway with pumping via approximately 20,000 feet of force main to the existing lagoons in Elkford. Construction of such a scheme is not considered practical, however, a cost estimate has been provided.

C) Roads and Site Access

The existing gravel highway from the north end of Elkford to this site would require upgrading (15,000'±). Widening and two paved travel lanes with shoulders would be a minimum requirement. A nominal allowance for access to the site from the highway is included in the cost estimates.

D) Flood Protection

Development would be confined above the flood plain of the Elk River. On this basis no provisions for flood protection have been made.

E) Storm Drainage

An allowance for conveying surface runoff generated within the site has been included. This covers culvert crossings of the highway.

F) Hydro Power Line

An existing hydro power line crosses the bottom of the site from south to north. Consideration should be given to the relocation of this facility. No cost provisions for this relocation are included.

G) Cost Estimates

	Alternative #1	Alternative #2
a. Water supply	$ 235,000	$ 495,500
b. Sanitary sewers	362,000	362,000
c. Roads and site access	575,000	575,000
d. Flood protection	nil	nil
e. Storm drainage	5,000	5,000
Total	$1,177,000	$1,437,500
Plus 25% Engineering and Contingencies	294,250	359,375
Total Cost Estimate	$1,471,250	$1,796,875

Note: Cost estimate - sewage disposal by pumping to Elkford sewage lagoons (18,400') - $690,000.

ii) Upper Bench

It is assumed that, due to the restrictive access and general elevation in relation to potential water supply, the development of the upper bench would only be considered as an extension of development on the lower bench. The following considerations and costs are so based.

A) Water Supply

Would require an expansion of the intake developed for the lower bench. A pump station, force main, 225,000 Imp. gallon storage reservoir, access road, chlorination and supply main would be required to complete the system.

Preliminary information suggests servicing costs may be increased due to large boulders in the terrain.

B) Sanitary Sewers

Contour plans indicate that internal sewers will be entirely gravity to a point of collection.

Provision of a gravity connecting main; expansion of the plant pump station, mechanical treatment plant and outfall to the river would be required to complete the system. Servicing cost would be increased as for the water supply.

C) Roads and Site Access

Preliminary contour plans indicate a continuous and steep slope separating the lower and upper benches. Two access roads are considered the minimum for entering the bench, particularly as the topography will result in roads of a minimum standard.

Initial investigation suggest these roads would be of 8% gradient with a 24 foot paved surface in a 40 foot road allowance. Guardrails would be required on the drop-away exposure.

E) Storm Drainage

An allowance for minimal conveying of surface run-off generated within the site has been included.

F) Cost Estimates

The estimates are developed as 'incremental' to the servicing estimates for the lower bench. They should not be considered 'out of context' as a development stage.

a. Water supply	$ 525,000
b. Sanitary sewers	195,000
c. Roads and site access	1,700,000
d. Flood protection	Nil
e. Storm drainage	10,000
Total	$2,430,000
Plus 25% Engineering and Contingencies	607,500
Total Cost Estimate	$3,037,500

b. On-site Servicing

i) Water Distribution

Installation conditions for the water distribution system should be fair, based on available soil reports which indicate granular sub-soils with boulders and a low water table.

ii) Sanitary Sewers

From the available contour plans, it is expected that the entire site may be serviced by a gravity system. Installation conditions should be similar to water distribution.

iii) Drainage

It has been assumed that no work will be required on any existing watercourses within the site.

iv) Storm Drainage

Based on available soil reports, it would appear that surface runoff can be accommodated by natural percolation. Roadway culverting has been assumed as required.

v) Hydro Service

It has been assumed that electrical power capable of servicing this site is available from the existing power lines, similar to areas A and B, on the assumption that distribution will be overhead.

vi) Site Preparations

Overall clearing for roads has been assumed. Grading of the site suitable for the type of dwelling, will be required. It would appear from the contour information that site grading work will not be extensive. Mobile home lot servicing will require preplanning in order to establish service terminal pointes. No allowances for salvaging topsoil during grading operations has been considered. Provisions for landscaping have not been considered necessary.

vii) Other Utilities

It is assumed that telephone, natural gas and cablevision as extensions of these services to the site from Elkford will be provided at no cost to the developer.

E. AREA D

1. Characteristics

This minor area East of the Elk River on the floodplain was investigated as a potential mobile home subdivision area. Flood protection servicing and access requirements will complicate development.

2. Yield

The indicative yield for the river plain to the East of the Elk River opposite the Boivin Creek/Elk River junction, at an average elevation of 4130 feet is as follows:

Approximate gross area 37.5 ac.

At an average yield of 4 units/acre equals 150 dwelling units.

At an average population of 4 persons/unit equals 640 persons.

3. Services

a. Off-site Servicing - 150 Lots

i) Water Supply

To provide water supply to the site a crossing of the Elk River will be required. Construction within the river will require approval from Provincial authorities and within their regulations. Costs for this work will be high due to this fact and scheduling of the work in conjunction with low river water levels.

ii) Sanitary Sewer

Pumping of the sewage from the site will be required, with a crossing of the Elk River. Government regulatory restrictions will be the same as the water supply main. Improvements to the existing pump station will be required.

iii) Roads and Site Access

The existing bridge crossing the Elk River is considered inadequate and replacement or upgrading to provide two vehicle lanes and a sidewalk will be required.

iv) Flood Protection

The site lies within the flood plain of the Elk River. Dyking and internal ditching will be required. This dyke would bound the site on the north and west with internal ditching parallel to the inside of the dyke, capable of intercepting high water tables. A drainage lift station located at the south end of this ditching will be required to pump to the river.

v) Cost Estimates

a. Water supply	$ 12,000
b. Sanitary sewers	55,000
c. Road and site access*	280,000 •
d. Flood protection	325,000
Total	$ 672,000
Plus 25% Engineering and Contingencies	168,000
Total Cost Estimate	$ 840,000

• Including bridge upgrading

b. On-site Servicing

i) Water Distribution

The presence of a water table which will be above the installed depth of this utility will add to the construction cost of this service.

ii) Sanitary Sewers

The high water table will present conditions similar to those outlined above.

iii) Roads

Construction of internal roads will require the removal of top-soil. Clearing of total width of right-of-way will be required with "heavy" clearing in most areas. It can be expected that all road construction materials will require "import".

iv) Drainage

The existing watercourse in the north one-third of the site will require cleaning, redefinition and grading. Culvert or bridge crossings will be necessary to obtain access to the north portion of the site. In many cases, no apparent natural watercourses drain the many local depressions, either filling or draining of such will be required.

v) Natural Gas Pipeline

A natural gas pipeline running north-south exists through the site. This utility is owned by Columbia Natural Gas Limited. Existing agreements may not permit development within this 40-foot right-of-way; this aspect would have to be explored. Site inspections indicate that this gas pipeline is "humped up" approximately 2 to 2-1/2' above the surrounding grade. In order to maintain minimum pipe cover, additional grading and site preparation work will be required. It can be expected that disruption to existing facilities will occur should future upgrading of this gas pipeline be required. Relocating this pipeline has not been considered as there would appear to be little, if any, adjacent available land for such.

vi) Storm Drainage

Provision for storm sewering will have to be made as natural percolation of surface runoff is questionable. As with water main and sanitary sewer installation, construction costs higher than normal can be expected due to the high water table and unstable trench conditions.

vii) Hydro Service

It is assumed electrical power distribution will be overhead and that the development is considered as a registered subdivision, in which Hydro service is provided at no cost to the developer.

viii) Site Preparations

Individual lot clearing will be required along with some site grading. Provisions for landscaping have not been considered necessary.

ix) Other Utilities

It is anticipated that telephone, natural gas and cablevision service will be available to the site from the adjacent existing facilities, and at no cost to the developer.

F. AREA E

1. Characteristics

A minor area on the Elk River floodplain to south of the golfcourse. Like Area D its development is questionable, because its location is downstream from the landslide on the east bank of the Elk River which represents a potential for blocking and deflecting the river over this area of floodplain. It should not be considered for development beyond those uses directly compatible with floodplain land.

2. Yield

The indicative yield of the river plain with alternate sites either east or west of the Highway, at an average elevation of 4125 feet is as follows:

Approximate gross area 50 ac.

At an average yield of 4 units/acre equals 200 units.

At an average yield of 4 persons/unit equals 800 persons.

3. Services

a. Off-site Servicing - 200 lots

i) Water Supply

Water supply to this site considered two alternatives:

1. Extension of the existing system parallel to and west of the highway to the site.

2. Connection to the south end of the Phase 5 system with a reservoir above the site.

High water tables and unstable trench conditions can be expected when constructing alternative #1. Topographic features pose the most significant problem in the construction of alternative #2.

ii) Sanitary Sewer

Pumping of sewage from the site will be required in order to outfall to the present lagoons.

iii) Roads and Site Access

No physical problems are anticipated in providing road access to the site from the highway.

iv) Flood Protection

No allowance for flood protection has been made in the estimates as it has been assumed for the area west of the highway that the highway will tend to provide some flood protection to the site.

Flood protection would definitely be required if located on the east side of the highway.

v) Cost Estimates

	Alternative #1	Alternative #2
a. Water supply	$ 120,000	$ 140,000
b. Sanitary sewers	96,000	96,000
c. Roads and site access	nil	nil
d. Flood protection	nil	nil
Total	$ 216,000	$ 236,000
Plus 25% Engineering and Contingencies	54,000	59,000
Total Cost Estimate	$ 270,000	$ 295,000

b. On-site Servicing

i) Water Distribution

The presence of a water table which will be above the installed depth of this utility will add to the construction cost of this service.

ii) Sanitary Sewers

The high water table will present conditions similar to those outlined above.

iii) Roads

Construction of internal roads will require the removal of topsoil. Clearing for roadways would be nominal.

iv) Drainage

It has been assumed that no changing, grading, or redefining any of the existing watercourses will be required.

v) Natural Gas Pipeline

It is believed that the existing natural gas pipeline lies within the Highway right-of-way and should be no significant obstacle to servicing the site.

vi) Storm Drainage

Provision for storm sewering will have to be made as natural percolation of surface runoff is questionable. As with water main and sanitary sewer installation, construction costs higher than normal can be expected due to the high water table and unstable trench conditions.

vii) Hydro Service

It is assumed electrical power distribution will be overhead and that the development is considered as a registered sub-division, in which Hydro service is provided at no cost to the developer.

viii) Site Preparations

Negligible site grading will be required, however, landscaping costs will offset this saving.

ix) Other Utilities

It is anticipated that telephone, natural gas and cablevision service will be available to the site from the adjacent existing facilities, and at no cost to the developer.

G. AREA F

1. Characteristics

This area, within the present Elkford town area, represents land currently under-developed. The original subdivision being largely occupied by mobile homes and trailers.

2. Yield

The indicative yield for redevelopment of the area South of Boivin Creek and West of the Provincial Highway, presently known as Phase 1, at an average elevation of 4,150 feet, is as follows:

Approximate gross area	27.5 ac.
Service-Commercial-Municipal	3.0 ac.
Health	2.0 ac.
Balance for housing	22:5 ac.

At an average yield of 12 units/acre equals 264 dwelling units.

At an average population of 4 persons/unit equals 1056 persons.

3. Services

Replot and rezone Area F (Phase 1.) then modify existing services as follows:

a. Criteria

i) density @ 12 units/acre
ii) 3.7 persons/unit
iii) Phase 5 - 100% occupancy

b. Water Distribution

Two alternatives have been considered to provide water service to the reploted areas. In either case, it will be required that the existing 6-inch water distribution "looping" is not affected. Depending on final development configuration and tolerances, the least expensive scheme would be to establish 10-feet permanent easements centered on the existing water mains. Water services could be utilized whenever appropriate and existing hydrants could remain in service. An allowance in the attached cost estimates has been made for new water service connections to apartment and commercial areas. If it is determined that the location of present water mains, within new development areas, cannot be tolerated, then new water main installations will be required.

c. Sanitary Sewers

Similarly to the water system, easements on existing sewers will be the least expensive. The cost estimates also considers relief sewer requirements resulting from increased contributory populations within this redevelopment. Relief sewers (765-feet) will be required "downstream" of this area.

d. Roads

Approximately 900 feet of road closures will be required. No cost allowance has been made for this item. Costs for the construction of new roadways (400-feet) resulting from realignments are included, based on the existing standard.

e. Other Utilities

It is likely that some development contribution can be expected to cover relocation and abandonment of existing natural gas, telephone, power, street lighting and cablevision facilities. Until further enquiries are made in this regard no cost allowances have been made in the cost estimates.

f. Cost Estimate

i) Water Distribution

Alternate #1 (provide easements)	a. Services	$ 3,500
	Plus 25% Engineering and Contingencies	875
	Total Cost Estimate	$ 4,375
Alternate #2 (new installations)	a. 8-inch dia. pipe	$ 39,000
	b. Services	3,500
	Total	$ 42,500
	Plus 25% Engineering and Contingencies	10,625
	Total Cost Estimate	$ 53,125

ii) Sanitary Sewers

Alternate #1 (provide easements)	a. Services	$ 1,800
	b. Relief Sewers	24,480
	Total	$ 26,280
	Plus 25% Engineering and Contingencies	6,570
	Total Cost Estimate	$ 32,850
Alternate #2 (new installations)	a. 8-inch diameter pipe	$ 40,950
	b. Services	1,800
	c. Relief Sewers	24,480
	Total	$ 67,230
	Plus 25% Engineering and Contingencies	16,808
	Total Cost Estimate	$ 84,038

iii) Roads

Realignment (400')	$ 32,000
Plus 25% Engineering and Contingencies	8,000
Total Cost Estimate	$ 40,000

iv) Summary

	Alternate #1	Alternate #2
Water Distribution	$ 4,375	$ 53,125
Sanitary Sewers	32,850	84,038
Roads	40,000	40,000
Totals	$ 77,225	$177,163

CHAPTER III

CONCLUSIONS

A. PREAMBLE

Fording Coal Limited's requirements for labour force stages of 1223 and 1500 employees are analyzed in the foregoing text.

Elco Mining Limited's proposed Elk River Coal Project is being planned as a 4,000,000 ton annual operation with a labour force of 1400, and with potential for expansion. This will generate a population similar to that developed by Fording Coal Limited which may base at Elkford.

Crows Nest Industries Limited's proposed Line Creek Project is being planned as a 1,000,000 ton annual operation with a labour force of 300. As the mine location is midway between Elkford and Sparwood, it is reasonable to assume one half of the population generated by this operation would base at Elkford.

B. DEVELOPMENT POTENTIAL CONCLUSIONS

1. Area A

Area A is considered a prime neighbourhood area for the development of housing with related educational, local commercial and recreational facilities.

Recognizing that the completion of housing in Phase 5 uses all the existing sanitary sewer disposal and water supply capacity, this area is eminently suitable as it returns the best off-site servicing costs, developed lot cost and yield to accommodate Fording growth plus potential development initiated from other sources.

It has the greatest development potential of any of the study areas and is in our opinion the logical area to develop as the next expansion of the Village of Elkford.

2. Area B

This area has a high development cost per lot. Full development would only accommodate the current Fording labour force projections (1223) without any potential for expansion if growth continued from this or other sources.

At the present time the 25 - 30% which is attachable to the upper Boivin area is viewed as a reserve for expansion of the present north side residential area of Elkford. Mobile home subdivision has been considered as a possible development form and this has been equated with the relocation of units from existing Phase 1 to permit its redevelopment in the form of extended towncentre facilities and new multiple housing.

Recognizing the potential avalanche hazard, this area can only be considered reserve for further study.

3. Area C

The remote location and high development costs for roads, water supply and sanitary sewage treatment would require a major impetus from another industry, such as the Elk River Coal Project to justify opening this area.

There is insufficient land to accommodate the estimated requirements for Elco Mining Limited.

Because of its distance from Elkford and the characteristics of separating terrain, it is unlikely that this area would ever exist as an easily identifiable part of Elkford. It would tend for many years to be "the area down the road", an area with second class status. This 'identification' problem would be intensified if development is initiated by another industry in the area. A 'second' community for a second major employer operating under different terms of reference in attracting labour could generate unacceptable social and community problems, as it is expected a considerable number of years would be required to effect integration of the 'existing' and 'new' communities.

In our opinion development of this area should not be considered further.

4. Area D & E

These areas are limited as to yield and development potential due to the floodplain influence which results in high servicing costs for water table, flood protection, and bridge upgrading.

They offer reserve potential as recreation park land and as relatively expensive development land in future when development intensity might justify high land improvement costs.

Monitoring of future population and housing trends may indicate a need to reconsider a smaller, well presented permanent camp as a "Singles" accommodation format.

Area E should be held in reserve for this consideration.

5. Area F (Existing Phase 1)

The present Village of Elkford has all but used the available Commercial-Municipal-Institutional Medium/High Density Residential and Service Industrial lands.

Within Area F the original subdivision is largely occupied by mobile homes and trailers which can be relocated, thereby permitting a more intense redevelopment of this central area of the town. A staged redevelopment of this area to include municipal, commercial and some multiple housing land uses will afford a means of introducing new housing forms in a preferred location, and the capability of reserves for commercial development required by the growing town.

5. (continued)

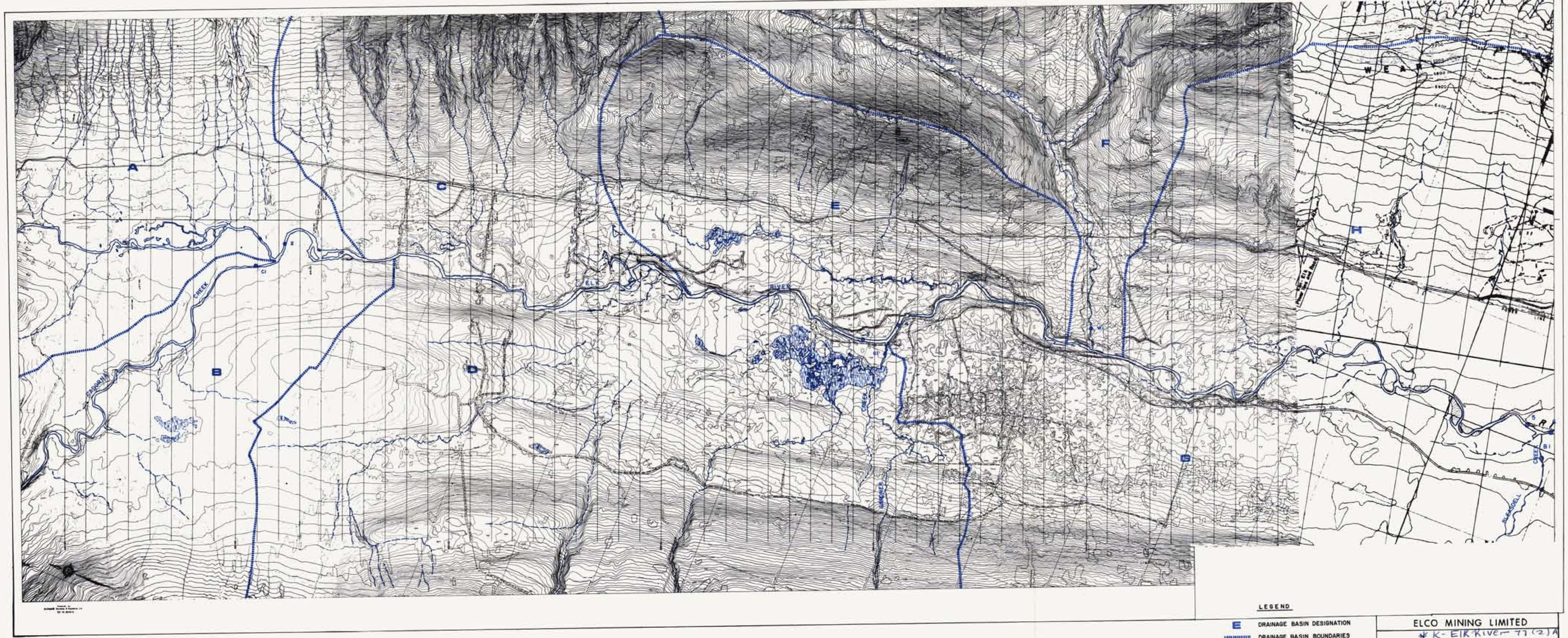
By virtue of its location at the town 'gate' and its relationship to existing land-use types noted above, this area should be rezoned and redeveloped to these land-uses.

C. SUMMARY

Land that is suitable for expansion of the Village of Elkford is very limited. Land that can be proven feasible for development with the growth as projected is even more limited.

Since the projected community requirements of the Fording Coal Limited and Elco Mining Limited operations cannot be accommodated on all the land suitable for expansion of the Village, and with the high cost of development, it is doubtful that Areas B and C will be developed in the forseeable future. Area B, even as a reserve, would require further investigation of the potential avalanche hazard.

Area A, replanned Area F and possibly Area E for specific use, are the only areas that can be considered feasible for development. These, as appraised from limited information, will only provide for the expansion resulting from the maximum projected Fording Coal Limited labour force. Without further planning from more accurate information, these areas should be considered for expansion to meet their requirements only.



LEGEND

E DRAINAGE BASIN DESIGNATION

DRAINAGE BASIN BOUNDARIES

ELCO MINING LIMITED

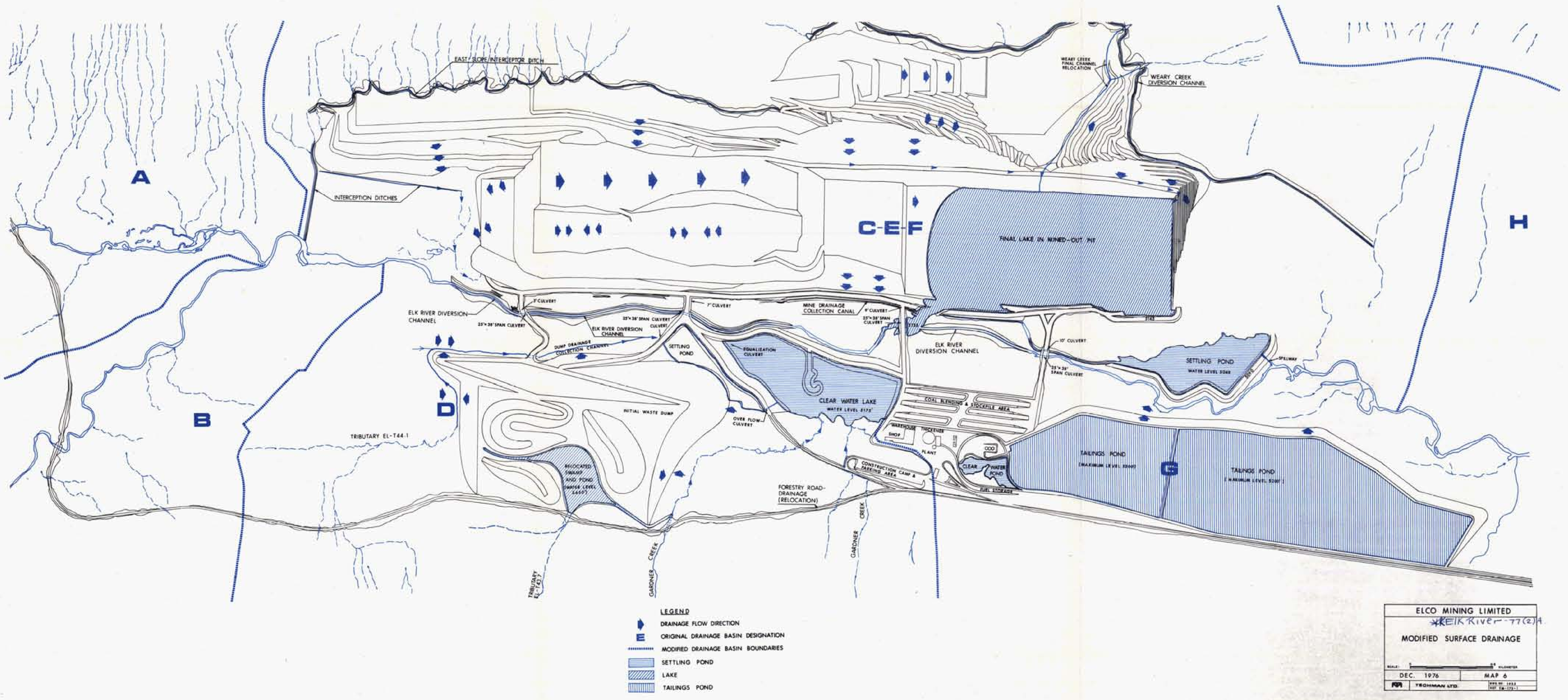
* K- Elk River - 77 (2) A

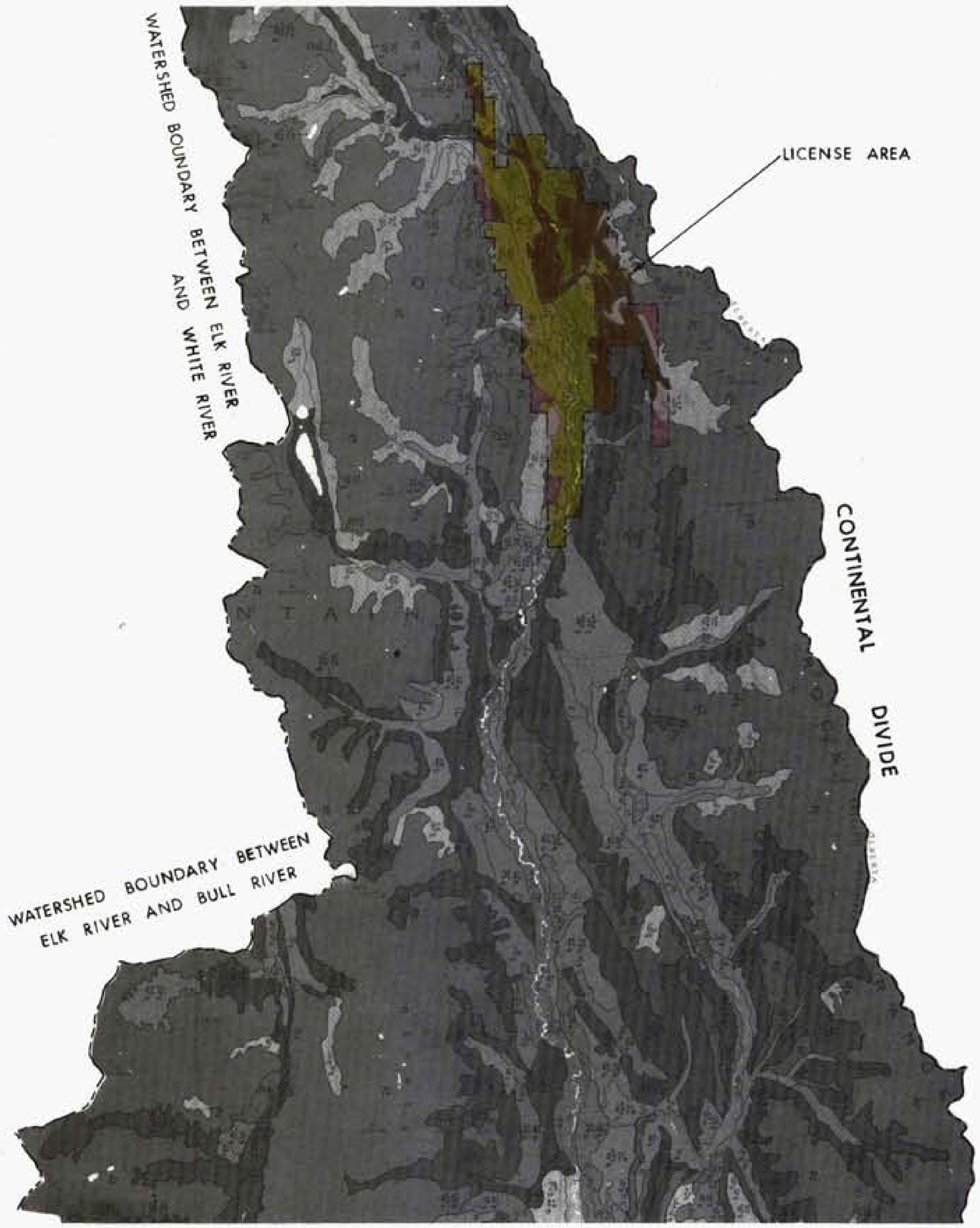
EXISTING SURFACE DRAINAGE

SCALE 0 — 0.5 KILOMETER

DEC. 1976 | MAP 5

TECHMAN LTD.


EAST SLOPE INTERCEPTOR DITCH
WEARY CREEK FINAL CHANNEL RELOCATION
WEARY CREEK DIVERSION CHANNEL
A
INTERCEPTION DITCHES
C-E-F
FINAL LAKE IN MINED-OUT PIT
H
ELK RIVER DIVERSION CHANNEL
2' CULVERT
25'x 38' SPAN CULVERT
25'x 38' SPAN CULVERT
ELK RIVER DIVERSION CHANNEL
DUMP DRAINAGE COLLECTION CHANNEL
7' CULVERT
SETTLING POND
EQUALIZATION CULVERT
MINE DRAINAGE COLLECTION CANAL
9' CULVERT
25'x 38' SPAN CULVERT
ELK RIVER DIVERSION CHANNEL
10' CULVERT
25'x 38' SPAN CULVERT
SETTLING POND
WATER LEVEL 5062
SPILLWAY
CLEAR WATER LAKE
WATER LEVEL 5175'
COAL BLENDING & STOCKPILE AREA
WAREHOUSE
THICKENER
SHOP
PLANT
B
D
TRIBUTARY EL-T44-1
INITIAL WASTE DUMP
OVER FLOW CULVERT
RELOCATED SWAMP AND POND
CONSTRUCTION CAMP & PARKING AREA
CLEAR WATER POND
FUEL STORAGE
TAILINGS POND
G
TAILINGS POND
FORESTRY ROAD DRAINAGE (RELOCATION)
TRIBUTARY EL-T47
GARDNER CREEK
GARDNER CREEK
LEGEND
DRAINAGE FLOW DIRECTION
E
ORIGINAL DRAINAGE BASIN DESIGNATION
MODIFIED DRAINAGE BASIN BOUNDARIES
SETTLING POND
LAKE
TAILINGS POND
ELCO MINING LIMITED
*Elk River - 77 (2) 4.
MODIFIED SURFACE DRAINAGE
DEC. 1976
MAP 6
TECHMAN LTD.



DESCRIPTIVE LEGEND

In this classification all mineral and organic soils are grouped into one of seven classes based upon their inherent ability to grow commercial timber. The best lands of Canada for commercial tree growth will be found in Class 1 and those in Class 7 cannot be expected to yield timber in commercial quantities; these represent the extremes. Because of unsuitable climate no Class 1 lands will be found in several regions of Canada and in certain regions the Class 2 areas will be too small to show at the chosen scales of mapping.

Some of the important factors on which the classification is based are:

- All known or inferred information about the unit including subsoil, soil profile, depth, moisture, fertility, landform, climate and vegetation.
- Associated with each capability class is a productivity range based on the mean annual increment of the best species or group of species adapted to the site at or near rotation age. Productivity classes are expressed in gross merchantable cubic foot volume to a minimum diameter of four inches. Thinnings, bark, and branch wood are not included. The productivity as expressed is that of "normal", i.e., fully-stocked stands. It may be assumed that only good management would have produced stands of this nature.
- The following are not considered: location, access, distance to markets, size of units, ownership, present state or special crops such as Christmas trees.

The classes are based on the natural state of the land without improvements such as fertilization, drainage or amelioration practices. It is realized that with improved forest management the productivity may change; to the extent that the limitations shown in the symbol may be altered, class changes may also take place. However, significant changes will only be achieved through costly and continuing practices.

CLASS 1 LANDS HAVING NO IMPORTANT LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

Soils are deep, permeable, of medium texture, moderately well-drained to imperfectly drained, have good water-holding capacity and are naturally high in fertility. Their topographic position is such that they frequently receive seepage and nutrients from adjacent areas. They are not subject to extremes of temperature or evapotranspiration. Productivity will usually be greater than 111 cubic feet per acre per year.
When required this class may be subdivided on the basis of productivity into classes 1 (111 to 130), 1a (131 to 150), 1b (151 to 170), 1c (171 to 190), 1d (191 to 210), and by 20 cubic foot classes thereafter, as necessary.

CLASS 2 LANDS HAVING SLIGHT LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

Soils are deep, well-drained to moderately well-drained, of medium to fine texture and have good water-holding capacity.
The most common limitations (all of a relatively slight nature) are: adverse climate, soil moisture deficiency, restricted rooting depth, somewhat low fertility, and the cumulative effects of several minor adverse soil characteristics.
Productivity will usually be from 90 to 110 cubic feet per acre per year.

CLASS 3 LANDS HAVING MODERATE LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

Soils may be deep to somewhat shallow, well to imperfectly drained, of medium to fine texture with moderate to good water-holding capacity. They may be slightly low in fertility or suffer from periodic moisture imbalances.
The most common limitations are: adverse climate, restricted rooting depth, moderate deficiency or excess of soil moisture, somewhat low fertility, impeded soil drainage, exposure (in maritime areas) and occasional inundation.
Productivity will usually be from 71 to 90 cubic feet per acre per year.

CLASS 4 LANDS HAVING MODERATELY SEVERE LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

Soils may vary from deep to moderately shallow, from excessive through imperfect to poor drainage, from coarse through fine texture, from good to poor moisture holding capacity, from good to poor structure and from good to low natural fertility.
The most common limitations are: moisture deficiency or excess, adverse climate, restricted rooting depth, poor structure, excessive carbonates, exposure, or low fertility.
Productivity will usually be from 51 to 70 cubic feet per acre per year.

CLASS 5 LANDS HAVING SEVERE LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

Soils are frequently shallow to bedrock, stoney, excessively or poorly drained of coarse or fine texture, may have poor moisture holding capacity and be low in natural fertility.
The most common limitations (often in combination) are: moisture deficiency or excess, shallowness to bedrock, adverse regional or local climate, low natural fertility, exposure particularly in maritime areas, excessive stoniness and high levels of carbonates.
Productivity will usually be from 31 to 50 cubic feet per acre per year.

CLASS 6 LANDS HAVING SEVERE LIMITATIONS TO THE GROWTH OF COMMERCIAL FORESTS.

The mineral soils are frequently shallow, stoney, excessively drained, of coarse texture and low in fertility. A large percentage of the land in this class is composed of poorly drained organic soils.
The most common limitations (frequently in combination) are: shallowness to bedrock, deficiency or excess of soil moisture, high levels of soluble salts, low natural fertility, exposure, inundation and stoniness.
Productivity will usually be from 11 to 30 cubic feet per acre per year.

LANDS HAVING SEVERE LIMITATIONS WHICH PRECLUDE THE GROWTH OF COMMERCIAL FORESTS.

Mineral soils are usually extremely shallow to bedrock, subject to regular flooding, or contain toxic levels of soluble salts. Actively eroding or extremely dry soils may also be placed in this class. A large percentage of the land is very poorly drained organic soils.
The most common limitations are: shallowness to bedrock, excessive soil moisture, frequent inundation, active erosion, toxic levels of soluble salts, and extremes of climate or exposure.
Productivity will usually be less than 10 cubic feet per acre per year.

SUBCLASSES

Except for Class 1, subclasses indicate the kind of limitation for each class. The subclasses are as follows:

CLIMATE
Denotes a significant adverse departure from what is considered the median climate of the region, that is, a limitation as a result of local climate; adverse regional climate will be expressed by the class level.

SUBCLASS A – droughty or arid conditions as a result of climate.

SUBCLASS C – a combination of more than one climatic factor or when it is not possible to decide which of two or more features of climate is significant.

SUBCLASS H – low temperatures, that is too cold.

SUBCLASS U – exposure.

SOIL MOISTURE
Denotes a soil moisture condition less than optimum for the growth of commercial forests but not including inundation.

SUBCLASS M – soil moisture deficiency.

SUBCLASS W – soil moisture excess.

SUBCLASS X – a pattern of "M" and "W" too intimately associated to map separately.

SUBCLASS Z – a pattern of wet organic soils and bedrock too intimately associated to map separately.

PERMEABILITY AND DEPTH OF ROOTING ZONE
Denotes limitations of soil permeability or physical limitation to rooting depth.

SUBCLASS D – physical restriction to rooting by dense or consolidated layers, other than bedrock.

SUBCLASS R – restriction of rooting zone by bedrock.

SUBCLASS Y – intimate pattern of shallowness and compaction or other restricting layers.

OTHER SOIL FACTORS
Denote factors of the soil which, individually or in combination, adversely affect growth.

SUBCLASS E – actively eroding soils.

SUBCLASS F – low fertility.

SUBCLASS I – soils periodically inundated by streams or lakes.

SUBCLASS L – excessive levels of calcium.

SUBCLASS N – excessive levels of toxic elements such as soluble salts.

SUBCLASS P – stoniness which affects forest density or growth.

SUBCLASS S – a combination of soil factors, none of which, by themselves would affect the class level but cumulatively lower the capability class.

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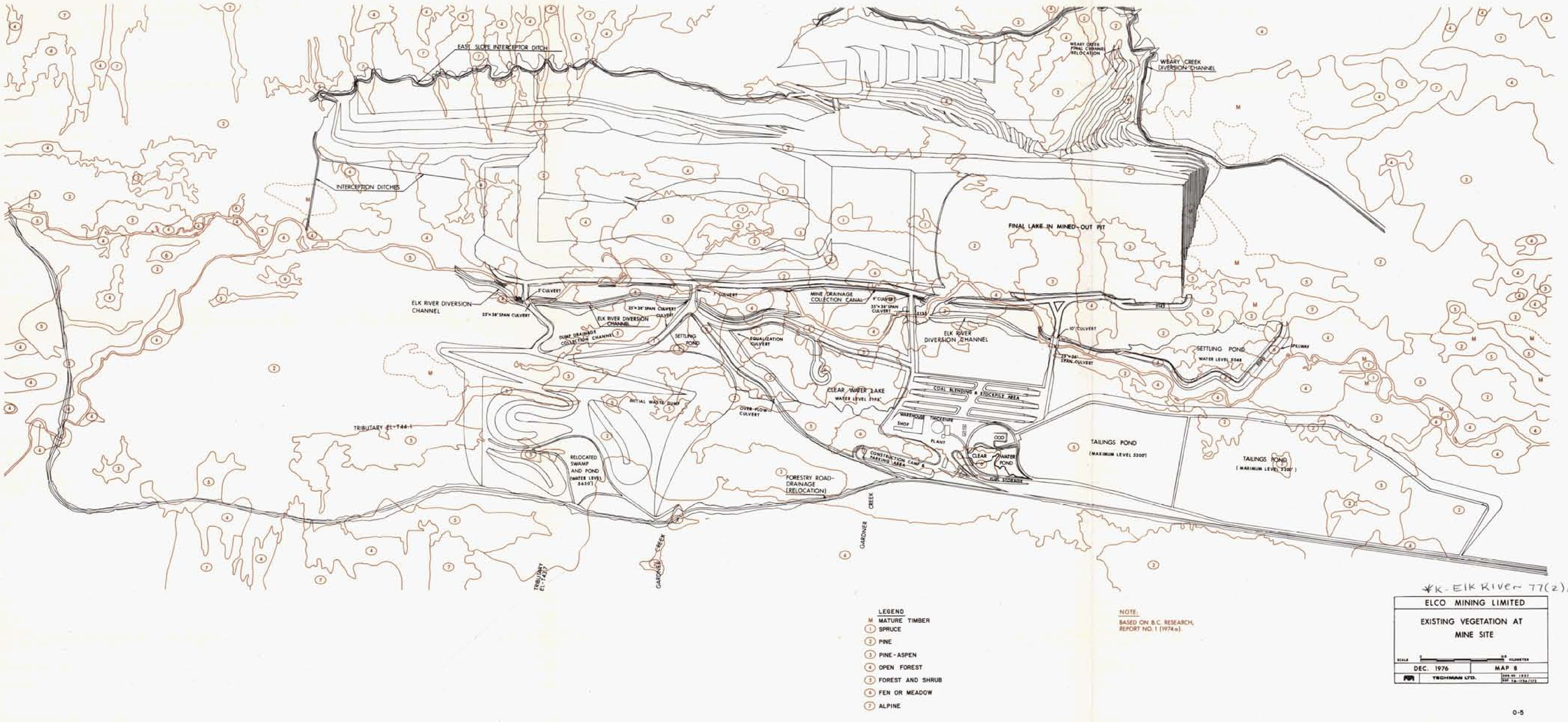
*K - Elk River 77(2)A

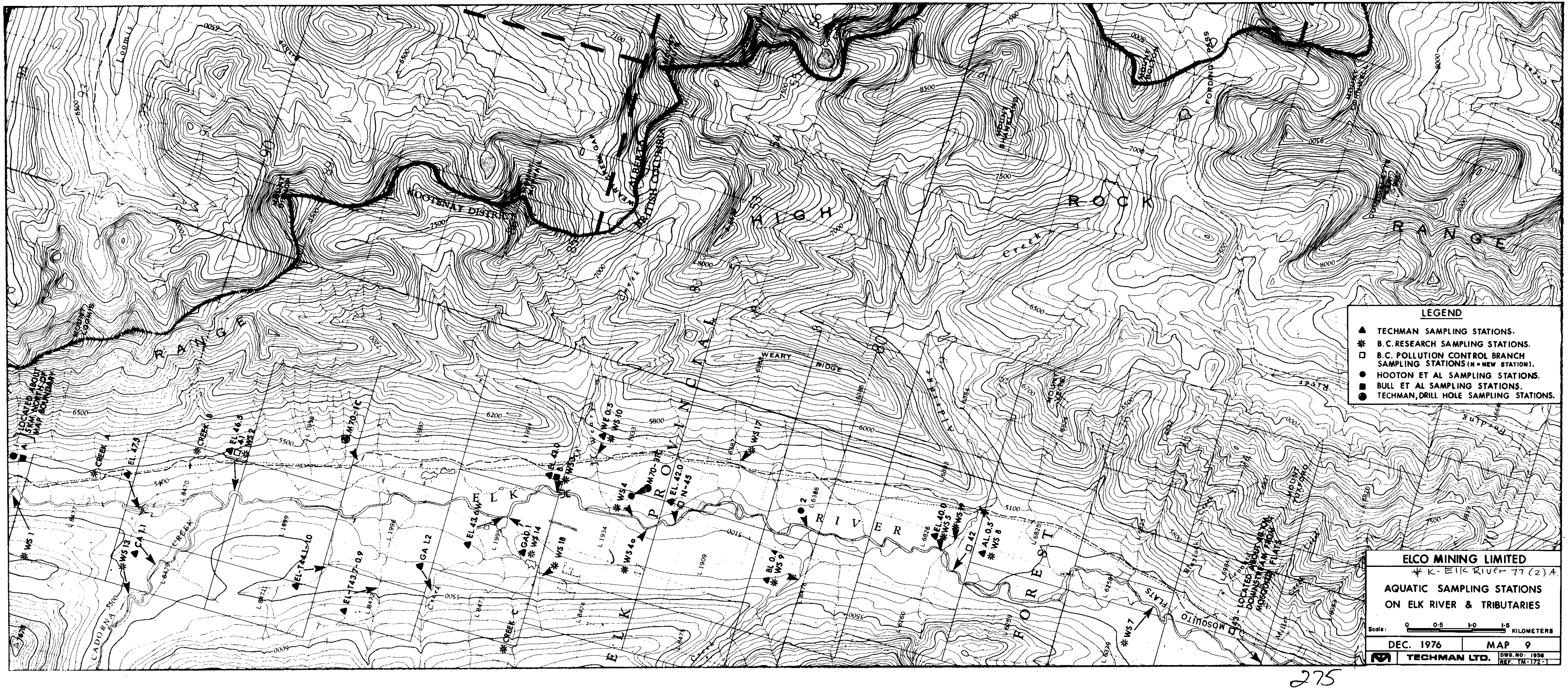
CORRIDOR FOREST CAPABILITY MAP

SCALE: 0 5 10 15 KILOMETERS

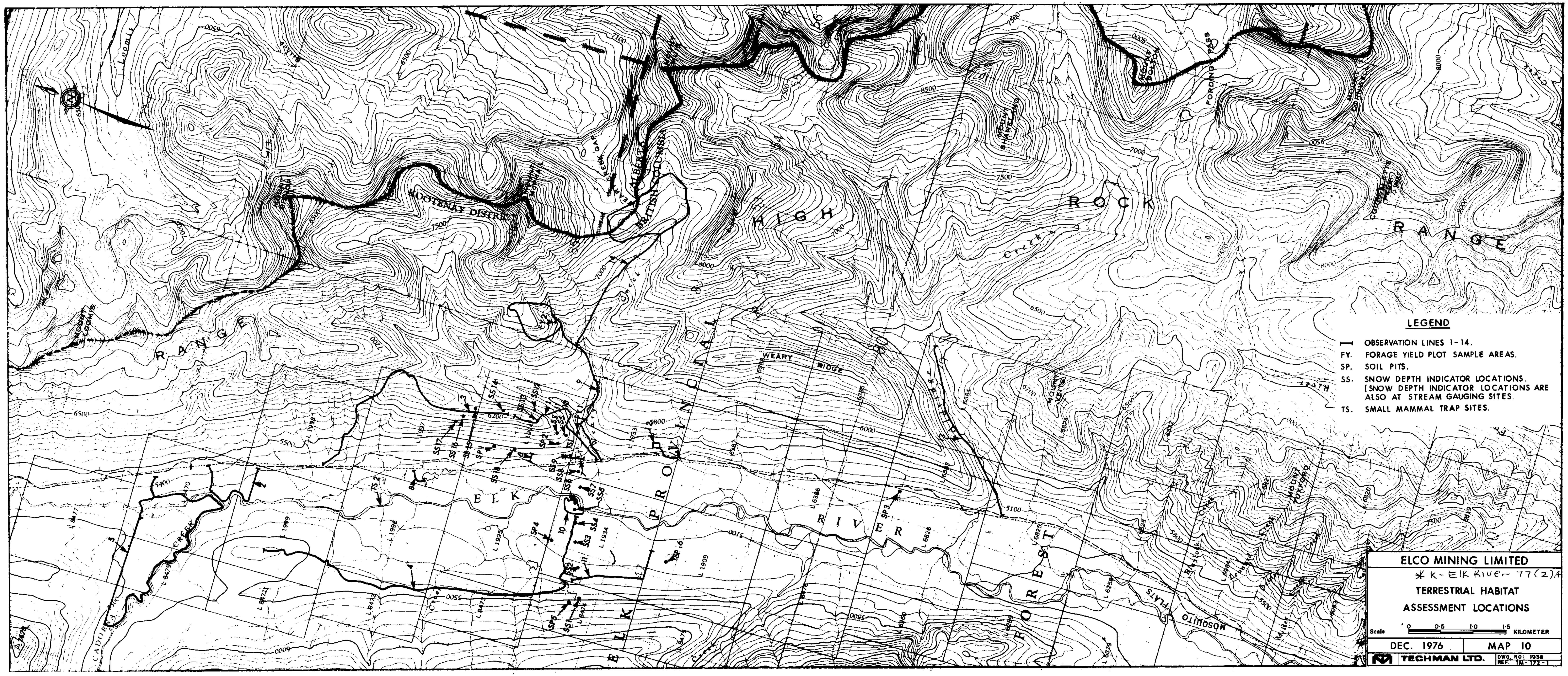
DECEMBER 1976. MAP 7

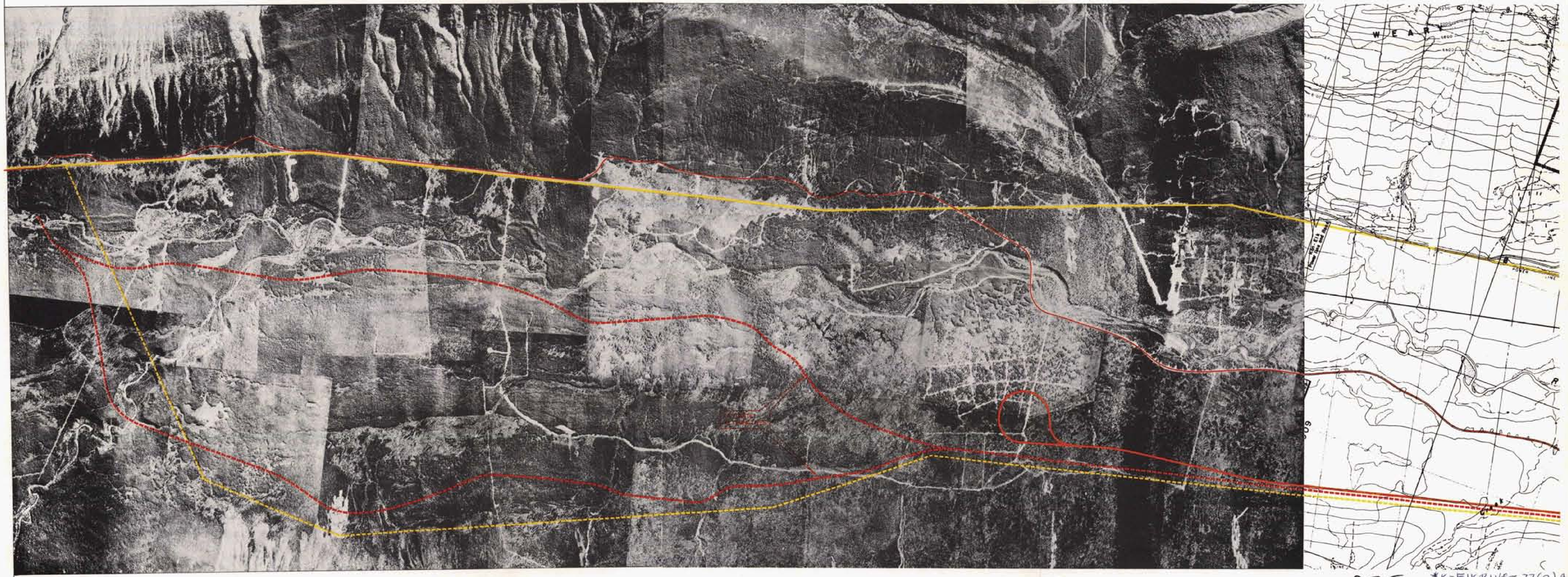
TECHMAN LTD. DWG No. 1936 REF. TM-172-1


EAST SLOPE INTERCEPTOR DITCH
WEARY CREEK FINAL CHANNEL RELOCATION
WEARY CREEK DIVERSION CHANNEL
INTERCEPTION DITCHES
FINAL LAKE IN MINED-OUT PIT
ELK RIVER DIVERSION CHANNEL
25'x38' SPAN CULVERT
ELK RIVER DIVERSION CHANNEL
DUMP DRAINAGE COLLECTION CHANNEL
SETTLING POND
EQUALIZATION CULVERT
MINE DRAINAGE COLLECTION CANAL
ELK RIVER DIVERSION CHANNEL
10' CULVERT
SETTLING POND
WATER LEVEL 5048
SPILLWAY
CLEAR WATER LAKE
WATER LEVEL 5175'
COAL BLENDING & STOCKPILE AREA
WAREHOUSE
THICKENER
SHOP
PLANT
CLEAR WATER POND
CONSTRUCTION CAMP & PARKING AREA
FUEL STORAGE
TAILINGS POND
(MAXIMUM LEVEL 5200')
TAILINGS POND
(MAXIMUM LEVEL 5200')
INITIAL WASTE DUMP
OVER FLOW CULVERT
TRIBUTARY EL-T44.1
RELOCATED SWAMP AND POND (WATER LEVEL 5630')
FORESTRY ROAD DRAINAGE (RELOCATION)
GARDNER CREEK
GARDNER CREEK
TRIBUTARY EL-T43
LEGEND
M MATURE TIMBER
1 SPRUCE
2 PINE
3 PINE-ASPEN
4 OPEN FOREST
5 FOREST AND SHRUB
6 FEN OR MEADOW
7 ALPINE
NOTE:
BASED ON B.C. RESEARCH, REPORT NO. 1 (1974a).
*K-Elk River 77(2)A
ELCO MINING LIMITED
EXISTING VEGETATION AT MINE SITE
DEC. 1976
MAP 8
TECHMAN LTD.


LEGEND
TECHMAN SAMPLING STATIONS.
B.C. RESEARCH SAMPLING STATIONS.
B.C. POLLUTION CONTROL BRANCH SAMPLING STATIONS (N = NEW STATION).
HOOTON ET AL SAMPLING STATIONS.
BULL ET AL SAMPLING STATIONS.
TECHMAN, DRILL HOLE SAMPLING STATIONS.
HIGH ROCK RANGE
ELK PROVINCIAL FOREST
ELK RIVER
KOOTENAY DISTRICT
ALBERTA
BRITISH COLUMBIA
WEARY RIDGE
MOSQUITO FLATS
FORDING PASS
CADORNA
ELCO MINING LIMITED
* K-Elk River 77 (2) A.
AQUATIC SAMPLING STATIONS
ON ELK RIVER & TRIBUTARIES
Scale: 0 0·5 1·0 1·5 KILOMETERS
DEC. 1976
MAP 9
TECHMAN LTD.
DWG. NO: 1956
REF. TM-172-1

275


HIGH ROCK RANGE
ELK PROVINCIAL FOREST
ELK RIVER
KOOTENAY DISTRICT
ALBERTA
BRITISH COLUMBIA
WEARY RIDGE
MOSQUITO FLATS
FORDING PASS
LEGEND
OBSERVATION LINES 1-14.
FY. FORAGE YIELD PLOT SAMPLE AREAS.
SP. SOIL PITS.
SS. SNOW DEPTH INDICATOR LOCATIONS. (SNOW DEPTH INDICATOR LOCATIONS ARE ALSO AT STREAM GAUGING SITES.
TS. SMALL MAMMAL TRAP SITES.
ELCO MINING LIMITED
* K-Elk River 77(2)A
TERRESTRIAL HABITAT
ASSESSMENT LOCATIONS
Scale 0 0·5 1·0 1·5 KILOMETER
DEC. 1976
MAP 10
TECHMAN LTD.
DWG. NO: 1938
REF. TM-172-1



275 *K-EIKRiver 77(2)A

EXISTING POWER LINE LOCATION
POWER LINE RELOCATION
EXISTING FORESTRY ROAD
HIGHWAY LOCATION (FORESTRY)
RAILWAY LOCATION

0-1 MINING AT COMPLETION
0-2 ROAD AND UTILITY MODIFICATIONS
0-3 EXISTING SURFACE DRAINAGE AND MONITORING STATIONS
0-4 MODIFIED SURFACE DRAINAGE
0-5 EXISTING VEGETATION
0-6 REVEGETATION PLAN

ELCO MINING LIMITED

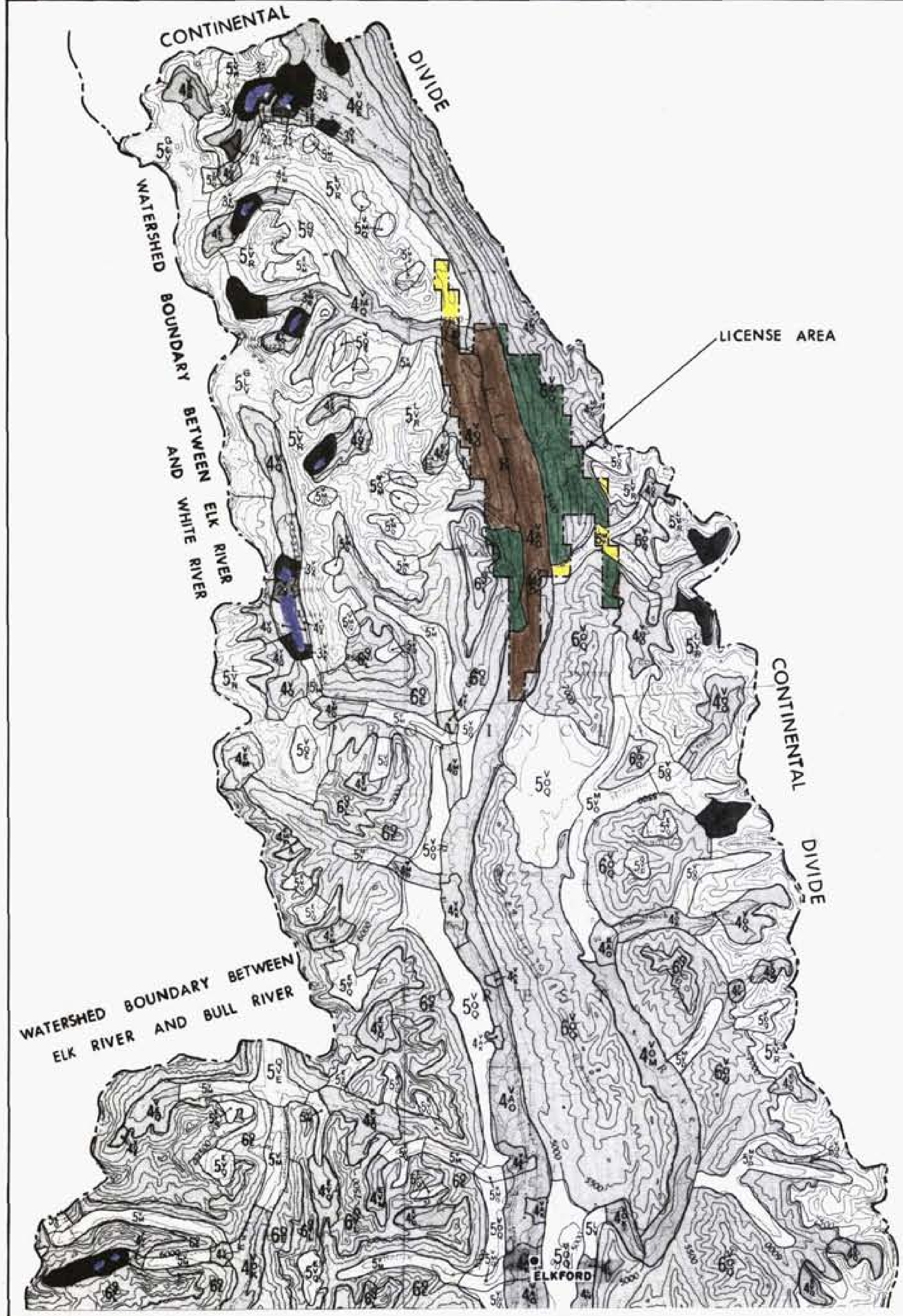
MINESITE ROAD AND UTILITY MODIFICATIONS

DEC. 1976 | MAP 11

TECHMAN LTD.


ELCO MINING LIMITED
*K-Elk River 77(2)A
CORRIDOR MAP
MINESITE TO ELKFORD
1 0 1 2
MILES
DECEMBER, 1976
MAP 12
TECHMAN LTD.
DWG. NO: 1941
REF. TM-113A/172-1
LEGEND
ALTERNATIVE RAILWAY LOCATION
RAILWAY LOCATION
HIGHWAY LOCATION (FORESTRY)
POWER LINE RELOCATION
POWER LINE MAINTENANCE TRAIL
1976
EXPLORATION AREA
MINESITE AREA
(SEE FIGURE 4)
KOOTENAY DISTRICT
ALBERTA
BRITISH COLUMBIA
HIGH ROCK RANGE
EXISTING C.P.R. FORDING RAILWAY
ELK RIVER
GREENHILLS RANGE
ELK PROVINCIAL FOREST
ABBY RIDGE
LEASE BOUNDARY
ELKFORD
Campsite


SPARWOOD
Grave Lake
ELK
PROVINCIAL
FOREST
LEGEND
ALTERNATIVE RAILWAY LOCATION
RAILWAY LOCATION
HIGHWAY LOCATION (FORESTRY)
POWER LINE RELOCATION
POWERLINE MAINTENANCE TRAIL
ELCO MINING LIMITED
*K-Elk River 77(2)A
275
CORRIDOR MAP
SOUTH OF ELKFORD
1 0 1 2
MILES
DECEMBER, 1976
MAP 12A
TECHMAN LTD.
DWG. NO: 1942
REF. TM-172-1



DESCRIPTIVE LEGEND

Seven classes of land are differentiated on the basis of the intensity of outdoor recreational use, or the quantity of outdoor recreation, which may be generated and sustained per unit area of land per annum, under perfect market conditions.

"Quantity" may be measured by visitor days, a visitor day being any reasonable portion of a 24 hour period during which an individual person uses a unit of land for recreation.

"Perfect market conditions" implies uniform demand and accessibility for all areas, which means that location relative to population centres and to present access do not affect the classification.

Intensive and dispersed activities are recognized. Intensive activities are those in which relatively large numbers of people may be accommodated per unit area, while dispersed activities are those which normally require a relatively larger area per person.

Some important factors concerning the classification are:

- The purpose of the inventory is to provide a reliable assessment of the quality, quantity and distribution of the natural recreation resources within the settled parts of Canada.
- The inventory is of an essentially reconnaissance nature, based on interpretation of aerial photographs, field checks, and available records, and the maps should be interpreted accordingly.
- The inventory classification is designed in accordance with present popular preferences in non-urban outdoor recreation. Urban areas (generally over 1,000 population with permanent urban character), as well as some non-urban industrial areas, are not classified.
- Land is ranked according to its natural capability under existing conditions, whether in natural or modified state; but no assumptions are made concerning its capability given further major artificial modifications.
- Sound recreation land management and development practices are assumed for all areas in practical relation to the natural capability of each area.
- Water bodies are not directly classified. Their recreational values accrue to the adjoining shoreland or land unit.
- Opportunities for recreation afforded by the presence in an area of wildlife and sport fish are indicated in instances where reliable information was available, but the ranking does not reflect the biological productivity of the area. Wildlife capability is indicated in a companion series of maps.

CLASS 1 LANDS IN THIS CLASS HAVE VERY HIGH CAPABILITY FOR OUTDOOR RECREATION.

Class 1 lands have natural capability to engender and sustain very high total annual use based on one or more recreational activities of an intensive nature. Class 1 land units should be able to generate and sustain a level of use comparable to that evident at an outstanding and large bathing beach or a nationally known ski slope.

CLASS 2 LANDS IN THIS CLASS HAVE A HIGH CAPABILITY FOR OUTDOOR RECREATION.

Class 2 lands have natural capability to engender and sustain high total annual use based on one or more recreational activities of an intensive nature.

CLASS 3 LANDS IN THIS CLASS HAVE A MODERATELY HIGH CAPABILITY FOR OUTDOOR RECREATION.

Class 3 lands have natural capability to engender and sustain moderately high total annual use based usually on intensive or moderately intensive activities.

CLASS 4 LANDS IN THIS CLASS HAVE MODERATE CAPABILITY FOR OUTDOOR RECREATION.

Class 4 lands have natural capability to engender and sustain moderate total annual use based usually on dispersed activities.

CLASS 5 LANDS IN THIS CLASS HAVE MODERATELY LOW CAPABILITY FOR OUTDOOR RECREATION.

Class 5 lands have natural capability to engender and sustain moderately low total annual use based on dispersed activities.

CLASS 6 LANDS IN THIS CLASS HAVE LOW CAPABILITY FOR OUTDOOR RECREATION.

Class 6 lands lack the natural quality and significant features to rate higher, but have the natural capability to engender and sustain low total annual use based on dispersed activities.

SUBCLASSES

Subclasses indicate the kinds of features which provide opportunity for recreation. They are, therefore, positive aspects of land and do not indicate limitations to use. Features may be omitted from a unit, either because of the imposed three-feature limit, or because their presence was unknown or unconfirmed.

The degree to which these features are judged capable, collectively, of generating and sustaining use for recreation, determines the class. The sequence in which they are listed indicates the order of their significance. Subordinate features may be relatively insignificant and the class of a unit should not be interpreted to indicate the capability of a secondary or tertiary feature.

The subclasses are:

SUBCLASS A—Land providing access to water affording opportunity for angling or viewing of sport fish.

SUBCLASS B—Shoreland capable of supporting family beach activities. In high class units this will include family bathing. In Classes 4 and 5, the activities may be confined to dry land due to cold water or other limitations.

SUBCLASS C—Land fronting on and providing direct access to waterways with significant capability for canoe tripping.

SUBCLASS D—Shoreland with deeper inshore water suitable for swimming or boat mooring or launching.

SUBCLASS E—Land with vegetation possessing recreational value.

SUBCLASS F—Waterfall or rapids.

SUBCLASS G—Significant glacier view or experience.

SUBCLASS H—Historic or pre-historic site.

SUBCLASS J—Area offering particular opportunities for gathering and collecting items of popular interest.

SUBCLASS K—Shoreland or upland suited to organized camping, usually associated with other features.

SUBCLASS L—Interesting landform features other than rock formations.

SUBCLASS M—Frequent small water bodies or continuous streams occurring in upland areas.

SUBCLASS N—Land (usually shoreland) suited to family or other recreation lodging use.

SUBCLASS O—Land affording opportunity for viewing of upland wildlife.

SUBCLASS P—Areas exhibiting cultural landscape patterns of agricultural, industrial or social interest.

SUBCLASS Q—Areas exhibiting variety, in topography or land and water relationships, which enhances opportunities for general outdoor recreation such as hiking and nature study or for aesthetic appreciation of the area.

SUBCLASS R—Interesting rock formations.

SUBCLASS S—A combination of slopes, snow conditions and climate providing downhill skiing opportunities.

SUBCLASS T—Thermal springs.

SUBCLASS U—Shoreland fronting water accommodating yachting or deep water boat tripping.

SUBCLASS V—A vantage point or area which offers a superior view relative to the class of the unit(s) which contain it, or a corridor or other area which provides frequent viewing opportunities.

SUBCLASS W—Land affording opportunity for viewing of wetland wildlife.

SUBCLASS X—Miscellaneous features with recreational capability.

SUBCLASS Y—Shoreland providing access to water suitable for popular forms of family boating.

SUBCLASS Z—Areas exhibiting major, permanent, non-urban man-made structures of recreational interest.

ELCO MINING LIMITED

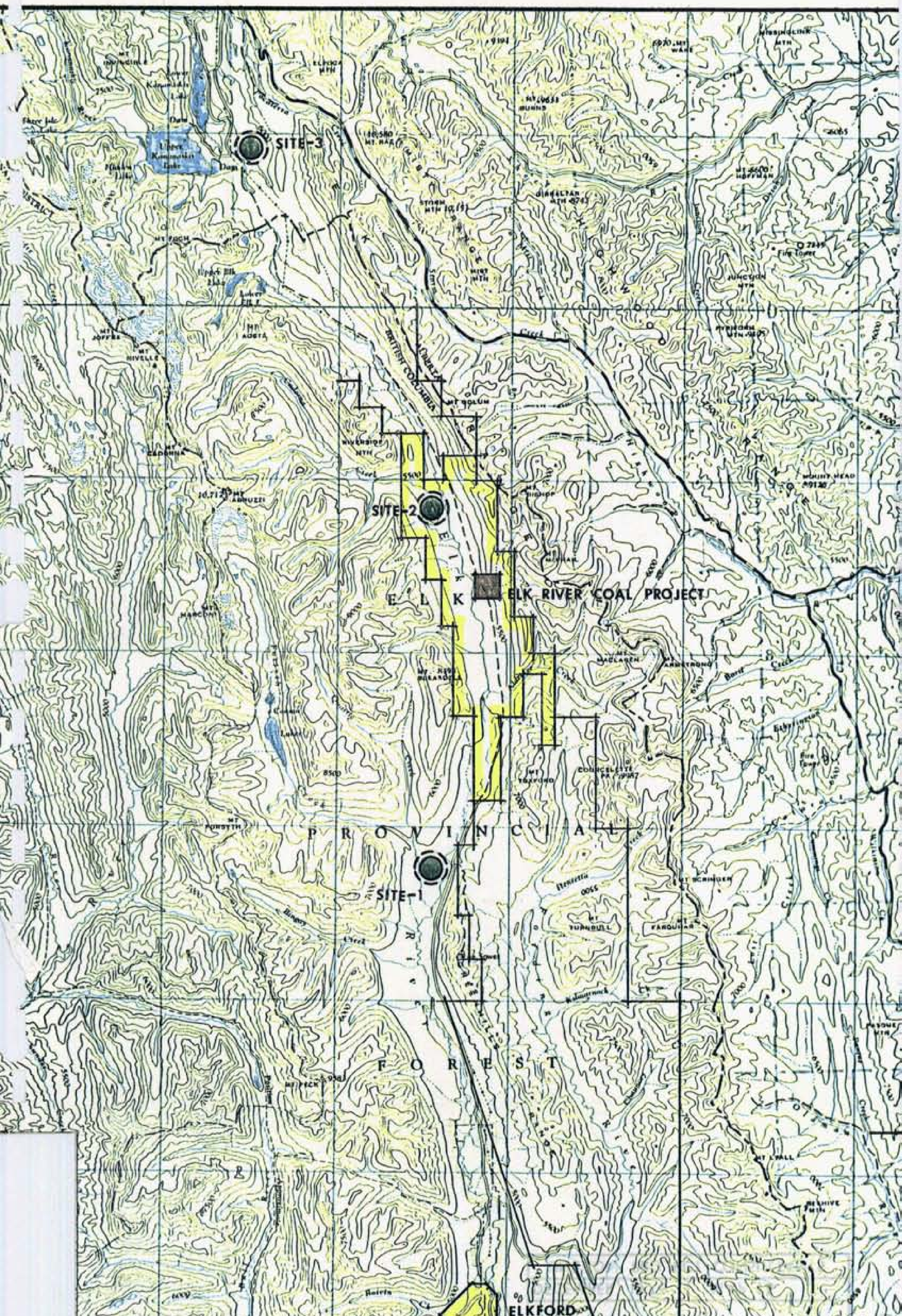
*K- Elk River 77(2) A.

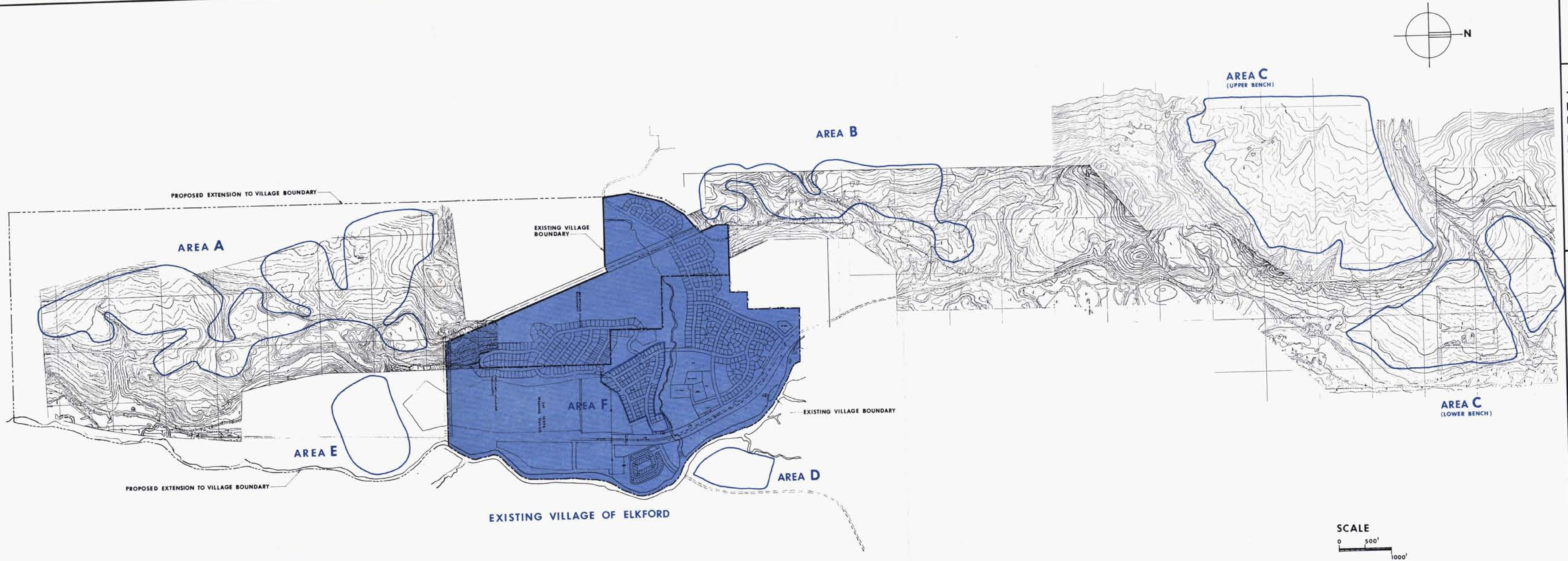
CANADA LAND INVENTORY
RECREATION LAND CAPABILITY

Scale: 0 5 10 15 KILOMETERS

DECEMBER, 1976. | MAP 13

TECHMAN LTD. DWG. NO: 1943 REF. TM-113A/172-1


SITE-3
SITE-2
ELK RIVER COAL PROJECT
P R O V I N C I A L
SITE-1
F O R E S T
ELKFORD



THE
UNECON PARTNERSHIP

PROJECT CONSULTANTS

PLANNING
ARCHITECTURE
ENGINEERING
MANAGEMENT

CONSULTANTS

DEC 1976

PROJECT TITLE

VILLAGE OF ELKFORD

CONSOLIDATED POTENTIAL DEVELOPMENT LANDS

D1

275

K-ELK RIVER 77(9)A

252/B

ADDENDUM

prepared for the

Environment and Land Use Committee

as requested by the

Chairman of the

Coal Guidelines Steering Committee

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
STAGE I REPORT

ADDENDUM

prepared for the

Environment and Land Use Committee

as requested by the

Chairman of the

Coal Guidelines Steering Committee

BY

ELCO MINING LIMITED

APRIL 1977

CONTENTS

YOUR FILE ______________

QUOTE YOUR REPLY

TO ______________

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

01.APR.1977

25th March, 1977

Dr. Martin J. Bik,
Elco Mining Ltd.,
2800, Scotia Centre,
700 - 2nd Street S.W.,
Calgary, Alberta,
T2P 2W2

Dear Dr. Bik:

re - Elk River Stage I Report

The Coal Guidelines Steering Committee has reviewed the draft Stage I report and has the followng comments to make.

1. The sections describing the project, the minesite design and the existing environmental conditions in the project area are thorough and well presented.

2. The Committee would like to see more attention paid to identification of data gaps in the biophysical and land resource impact section. In view of the relatively short time span before the Stage II Studies are scheduled to be completed, the Committee would like a detailed description of proposed and continuing biophysical programmes to meet Stage II assessments (see Section 1.3 of the Guidelines).

   Since the consultants will require maximum lead time to undertake such studies, you should initiate such programmes as quickly as possible. However, we do ask that you provide to the Committee an Addendum outlining your present programme for the summer so we can include this with the report for distribution and response from the reviewing agencies. The Addendum should outline all proposed monitoring and biophysical studies, with emphasis on wildlife, fisheries and heritage resource studies.

3. The report did not present a preliminary environmental assessment of the road and rail routes and a short report of these impacts should be included in your Addendum.

Continued.../

TO: Dr. Martin J. Bik

FROM: Jon O'Riordan
25th March, 1977

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4. With respect to the social and community development requirements of the Guidelines, the Steering Committee notes that the Developer has concentrated on the physical components of social and community programmes and plans and has not fully addressed or answered questions related to social planning factors which are essential to identification and management of such impacts associated with the proposed Elk River Coal Project. It is the understanding of the Committee that the Developer has recently taken steps to fulfill both the Stage I and Stage II requirements during the course of Stage II. The Committee therefore requests that a detailed outline of the socio-economic and community impact assessment and management study programme be submitted to the Chairman of the Committee prior to the circulation of the Developer's Stage I report to agencies of the Provincial Government. It is further understood that this programme outline will be presented at a meeting in Vancouver on April 13, 1977 to be attended by members of the Committee and key Provincial agency officials with the Developer and consultants to be engaged in the Developer's socio-economic and community impact assessment and planning programme.

5. For the Stage II report, the Committee will seek a wide array of economic data so that the Government can complete a benefit-cost analysis of the project from the public viewpoint. Members of the Committee are currently developing a check list of data requirements for this task and we will be sending you this list in the near future. I recommend a meeting to clarify the process and procedures required in the economic analysis once you have received this letter.

In summary, the Committee requests an Addendum that contains the following information:

i) A programme outline for biophysical resource impact assessment and management studies planned for this summer and fall.

ii) Detailed terms of reference for the community and socio-economic impact assessment and management studies.

iii) A short report on the impacts of the proposed road and rail routes.

Continued.../

TO: Dr. Martin J. Bik

FROM: Jon O'Riordan
25th March, 1977

This Addendum should be finalised immediately after your meeting with Mr. Karlsen so that it can be circulated with the Stage I report. We would like you to send us 40 copies of the two volume report plus Addendum for distribution to the reviewing agencies. A summary of their comments will be provided to you within four weeks of distribution.

In view of the time constraints, I feel it would be useful for you and your consultants to meet with members of the Committee to discuss specific aspects of your work programme. Arrangements have already been made with Mr. Karlsen; perhaps you can arrange additional meetings at about the same time to cover biophysical, economic and engineering programmes, after your Addendum has been submitted to us.

Thank you for co-operating with the Guidelines process and we look forward to further contact on this project.

Yours sincerely,

J. O'Riordan

Jon O'Riordan
Chairman,
Coal Guidelines Steering Committee

JO'R/JMO

cc. Coal Guidelines Steering Committee

II Biophysical Resource Effect Assessment Program, Spring and Summer of 1977, Elk River Coal Project

Elco Mining Limited

April 1977

Introduction

The Environmental Field Program for 1977 was evolved by establishing a set of objectives and a table of contents for the Stage II Report to the Government of British Columbia as per the Guidelines for Coal Development issued by the Environment and Land Use Committee. The field program is designed to fill all identified information gaps that should be addressed in the Stage II Report. This report is scheduled to be submitted to the Government of British Columbia during the fall of 1977.

Upon completion of the environmental field program during the summer of 1977, a monitoring effort will be maintained with particular emphasis on climate, hydrology and water quality. The objective of this continuing program is to establish and/or verify the environmental design criteria, the reclamation objectives and the reclamation plan for the proposed Elk River Coal Project and the attendant community development(s).

Section II of this Addendum is structured on the proposed format of the Stage II Report. The tentative table of contents of each chapter is introduced followed by general comments on the objectives adopted for the chapter. The highlights of the field information acquisition program are described in the final paragraphs.

Report Content

1.0 Introduction

2.0 Climate and Air Quality
- 2.1 Regional Climate
- 2.2 Local Climate
- 2.3 Local Air Quality
- 2.4 Dispersion Climatology
- 2.5 Emissions
  - 2.5.1 Mine Complex
  - 2.5.2 Townsite
  - 2.5.3 Transport Corridors

Objectives

Data from existing synoptic and climatic stations in the region will be used to construct a general overview of the regional climate. The data gathered to date in the Upper Elk River Valley by the Resource Analysis Branch of the Department of the Environment will be used to establish the local climate conditions. The latter data are limited. It is intended to infer the variation range of the local climatic parameters by way of establishing the relationship with the limited observation series in the Upper Elk River Valley with the longer term monthly averages for selected stations in the region.

Those climatic parameters that either control or influence the dispersion of emissions will be discussed. The expected nature and volume of emissions from the mine complex, the townsite and the transport corridors will be described.

On the basis of the descriptive information contained in sections 2.1 to 2.5 inclusive, the recognized effects of the realization of the Elk River Coal Project on the local air quality and on the local mesoclimate will then be described.

Mitigative options to cope with the identified effects will then be reviewed. These options are either of a design nature or relate to operational procedures that might be adopted.

The section on alternatives will discuss the cost implications of various mitigative alternatives. In general, the Company will select those alternatives that give the maximum return in terms of environmental protection for the lowest cost. It is also recognized that in some cases, the cost of implementation of mitigative measures might not warrant the mitigation of an effect, as the benefits gained from the expenditure on environmental protection might seem insignificant in view of the cost.

The selected alternatives will then be stated and the reasons for the selection provided.

Field Program

Since very little is known relative to the present air quality in the Upper Elk River Valley, an attempt will be made to borrow an air quality observation trailer for some length of time. In this way, we hope to establish some baseline values. Moreover, a dust fall observation network will be installed during this spring. The location of the observation points will be reviewed with the Pollution Control Branch of the Department of the Environment prior to implementation. Some initial observations are expected to be reported in the Stage II Report. The dust fall network will be maintained in operational state to establish a baseline over two or three years prior to the start of operation of the project.

Three climatic observation stations are intended to be installed in the Upper Elk River Valley. One is proposed to be located on the top of Little Weary Ridge. The second station is proposed to be located on the minesite itself.

The third station will be located in the Forsyth Creek area. This station is expected to generate data for one of several townsite location alternatives currently under consideration for community development required for the realization of the Elk River Coal Project. This network of climatic observation stations will be maintained for the purpose of establishing the environmental design parameters for the project and the community development. They will also be maintained during the operation of the project in support of reclamation planning and air pollution control purposes.

The dispersion climatology of the Upper Elk River Valley will be assessed by using radiosondes, and constant altitude balloons. Intensive field surveys are planned for April and July. Upon completion of the analysis of the data thus obtained, a decision will be taken respecting a continuation of a minisonde dispersion climatology observation program. Such a program, which might be run for a year or longer, will only be implemented if there are potential emission dispersion problems of such apparent gravity that the cost of a twice daily minisonde survey can be considered to be justified.

The location and equipment selection of the three proposed climate observation stations has been discussed with the Resource Analysis Branch of the Department of the Environment. A measure of joint operation of the proposed stations appears possible and some instrumentation might be provided by the RAB.

Since the benefits of the proposed climatic observation program accrue to the region as well as to the Elk River Coal Project, the proponent is of the opinion that a 50/50 sharing of capital and operating costs for this program with the Government of British Columbia is fair and reasonable, under the circumstances.

Report Content

3.0 Geology and Terrain
- 3.1 Bedrock Geology
  - 3.1.1 Stratigraphy
  - 3.1.2 Structure
- 3.2 Geomorphology
  - 3.2.1 Land Forms
  - 3.2.2 Erosion Hazard Areas
  - 3.2.3 Land Surface Stability Characteristics
  - 3.2.4 Environmental Hazards (avalanche areas, flooding potential)
- 3.3 Surficial Materials
- 3.4 Soils

Objectives

The first five sections of this chapter are descriptive in nature. In section 3.2, particular attention will be paid to naturally occurring indications of hazards. The erosion potential under natural conditions, the indications in the terrain of land surface instability, and the naturally occurring environmental hazards, such as the avalanche areas and the flooding potential of low lying areas, as inferred from field observations will be described.

The section of terrain capability will describe not only the naturally existing growth capability of the soils, but also the resource that this soil represents in terms of reclamation of mined-out areas. To the extent possible, the distribution and volume of granular materials will be identified.

The remainder of this chapter is structured similar to the chapter on climatology. First, the development effects will be identified in a general way. Changes in the stability of the land surface and the possibly enhanced erosion potential, particularly during the construction phase, will be discussed. A statement of losses of resources expected to result from modification of the land surface and the land forms might be included. Particular attention will be paid to the effects of soil surface modification. To the extent possible, a quantitative statement will be attempted of losses in granular materials, that will be covered by the proposed external waste-dumps.

The mitigative options for identified terrain effects are pertinent to the ultimate success of terrain reclamation. The chapter will address the choice of terrain reclamation objectives that is offering in the given physical situation.

The section on reclamation alternatives will treat the actual physical planning alternatives and address the cost-benefit question mostly in a qualitative way. Although it is possible to estimate the cost of various reclamation alternatives in dollars, the benefits cannot be stated in these terms.

The selection of the preferred alternative(s) will have to be made on the basis of the lowest cost associated with the establishment of a stable vegetated surface, in the absence of clear reclamation objectives in terms of future land use. Subsequent chapters will then address the question of the preferred successor land use objectives.

Field Program

The field program will comprise the mapping and the collection of samples from surficial materials, wherever exposed; the mapping of groundwater seepage areas and sampling to determine water qualities; the mapping of unstable terrain, avalanche areas and areas hazarded by flooding.

The geological and geomorphological component of this chapter will be supported with the usual maps, sections and diagrams. Moreover, a photo interpretation map of the minesite, the transportation corridor and the Forsyth Creek townsite alternatives will be included. An isopach map of the surficial deposits will also be prepared, to the extent that this is possible from existing drill hole information and terrain observations of the contact of surficial deposits with bedrock.

The soils component of this chapter will require intensive fieldwork in the minesite area in particular to establish the characteristics of the topsoil and its suitability for use in the establishment of a suitable growth medium on reconstructed land forms. The soil types will be mapped on a scale of one in ten thousand; attention will be paid to the volumes of peat in the area of the future mine as well as in the areas planned to be covered with external overburden dumps. This field effort will be supported with substantial laboratory testing of soil materials.

Report Content

4.0 Surface and Groundwater
- 4.1 Regional Groundwater Regime
- 4.2 Local Groundwater Regime
  - 4.2.1 Occurrence
  - 4.2.2 Levels
  - 4.2.3 Movement
- 4.3 Groundwater Quality
- 4.4 Surface Drainage
  - 4.4.1 Elk River
  - 4.4.2 Tributaries
- 4.5 Surface Water Quality
  - 4.5.1 Elk River
  - 4.5.2 Tributaries
- 4.6 Present Use
- 4.7 Effects of Development

4.7.1 Mine Complex - Drainage Modification
- 4.7.2 Mine Complex - Water Quantity
- 4.7.3 Mine Complex - Water Quality
- 4.7.4 Townsite
- 4.7.5 Transportation and Utility Corridor - Quantity
- 4.7.6 Transportation and Utility Corridor - Quality

4.8 Mitigative Options
(Technique, Procedure or Measures)

4.9 Protective Objectives

4.10 Design Alternatives

4.11 Preferred Alternatives

4.12 Summary and Conclusions

Objectives

The first six sections of this chapter describe the existing conditions, limited however, to those items that have a direct bearing on the operation of the project itself, or on the effects that the project might have on the quality of the surface and groundwater resources.

The section on mitigative options is of similar nature as that planned for Chapter 2. Either design solutions are involved, or the adoption of certain operational procedures could be considered.

Prior to discussing design alternatives, it is necessary to establish fair and reasonable objectives for environmental protection, insofar as such objectives have not yet been established by regulation. The remainder of the chapter will then follow the format already discussed for chapter 2.0.

Field Program

The field program will comprise the continuation of the stream gauging program already in progress, the continuing collection of water samples for the determination of routine water quality parameters including heavy metal concentrations; the collection of sediment samples from certain locations considered to be critical to determine the particle size distribution and the concentration of heavy metals; the collection of water samples from seepages, abandoned drill holes, adits and soil trenches for the determination of routine water quality parameters and the concentration of heavy metals, in particular, relative to anticipated mine drainage quality characteristics.

The stream gauging program will be continued. The guidance by the Hydrology Division of the Water Investigations Branch of the Department of the Environment has not yet been received, however, it is assumed that the proponent's program is adequate for regulatory purposes.

Report Content

5.0 Aquatic Biota
- 5.1 Aquatic Habitats of the Upper Elk River Valley
  - 5.1.1 Elk River
  - 5.1.2 Tributaries
  - 5.1.3 Lakes and Ponds
- 5.2 Aquatic Life
  - 5.2.1 Elk River
  - 5.2.2 Tributaries
  - 5.2.3 Lakes and Ponds
- 5.3 Consumptive Usage
- 5.4 Effects of Development
  - 5.4.1 Minesite
  - 5.4.2 Townsite
  - 5.4.3 Transportation and Utility Corridor
- 5.5 Habitat and Aquatic Life Conservation Objectives
- 5.6 Fisheries Resource Management and Design Alternatives
- 5.7 Selected Alternatives
- 5.9 Summary and Conclusion
  - 5.9.1 Recommended Resource Management Strategies

Objectives

The general structure of this chapter is similar to those previously discussed. The consumptive usage of a renewable resource will be taken into account here. The selection of mitigative alternatives will address the management of the effects of increased access to the area in general. The direct effect of the project can be stated in terms of the qualitative and quantitative effects on habitat sizes and characteristics. The indirect effects are associated with the attitudes of the present and future inhabitants of the area towards voluntary conservation of the fisheries resource.

The discussion of conservation objectives, therefore, will address the design alternatives that should be considered for the implementation of the project, as well as fisheries resource management strategies. Since the implementation of the latter is a responsibility of the provincial government rather than of the proponent of the Elk River Coal Project, the eventual recommendations respecting this subject have been set aside in a special subsection of the last section of this chapter.

Field Program

The field program will be a continuation of the series of observations and a site sampling, already commenced in the fall of 1976.

The sampling stations for algae and macroinvertebrates will be revisited to continue the assessment of the species diversity and relative productivity of the different reaches of the stream. Moreover, an attempt will be made to relate the existing sedimentation to invertebrate productivity. The objective of this aspect of the aquatic biota component of the environmental studies is to assess the potential effects of stream diversion. It is the proponent's intention to provide, if possible, within the reconstructed landscape, a volume and quality of aquatic habitat that is at least comparable, if not similar, to that which might be disturbed as a result of the implementation of the Elk River Coal Project.

During the spring, a fish migration survey will be conducted to determine whether fish migrate from the Elk River into the Gardner and Weary Creeks. This survey might also yield information on the numbers and species of fish migrating past the project area.

Should the spring migration survey indicate that no migration takes place past the minesite, a further survey will be implemented during the fall. The hitherto adopted view that fish passage through the proposed diversion channel(s) must be assured might be abandoned, should definitive conclusions be reached that such migrations are not taking place in the natural channel of the Elk River.

Report Content

6.0 Vegetation (Objective, Methodology and Status)
- 6.1 The Vegetation of the Upper Elk Valley
  - 6.1.1 Existing Cover
  - 6.1.2 Plant Associations, Communities, and Successional Considerations
- 6.2 Forestry Resources and Capability
  - 6.2.1 Present Timber Production
  - 6.2.2 Present Production Capability
  - 6.2.3 Potential Future Capability
- 6.3 Wildlife Habitat Characteristics and Capabilities
  - 6.3.1 Mine Complex
  - 6.3.2 Townsite
  - 6.3.3 Transportation and Utility Corridors
- 6.4 Development Effects
  - 6.4.1 Mine Complex
  - 6.4.2 Townsite
  - 6.4.3 Transportation and Utility Corridors
  - 6.4.4 Indirect Effects
- 6.5 Mitigation Options (Activities, Procedures, Measures)
- 6.6 Resource Management Alternatives (Trade-offs, Timber, Wildlife and Recreation)

Objectives

The structure as well as the objectives of this chapter are similar to the chapter on the aquatic biota. The indirect effects of the development are again treated in a separate subsection.

Most of the work required to complete this chapter is of none-field nature. The CLI and RAB land capability maps and the FS Timber Type Maps will be used to assess existing and potential vegetation capabilities as well as project effects.

The development of the resource management alternatives is planned to include a discussion of objectives.

Field Program

The field component of the environmental work dedicated to this chapter will comprise an expansion of the quantitative assessment of natural and seeded plant growth on disturbed sites. The soil conditions at the Elk River site and the species composition and cover percentages on disturbed sites in and near the project area will be documented.

It is not intended to establish field trial test plots in conjunction with the reclamation of exploration disturbances at this time. For the time being, we intend to continue to use established practices that have been demonstrated to be successful.

Should the project be continued beyond the currently active Planning Phase Ia, the question as to whether small field trial test plots should be established in the project area or, alternative, field scale trails should be undertaken on land where construction disturbance has been completed, will be decided.

Report Content

7.0 Wildlife
- 7.1 Existing Wildlife Populations of the Upper Elk Valley
  - 7.1.1 Big Game
  - 7.1.2 Small Game
  - 7.1.3 Fur-Bearers
  - 7.1.4 Upland Birds
  - 7.1.5 Waterfowl
  - 7.1.6 Others
- 7.2 Habitat Capability and Utilization
  - 7.2.1 Upper Elk Valley
  - 7.2.2 Migration and Seasonal Movement
  - 7.2.3 Mine Complex
  - 7.2.4 Townsite
  - 7.2.5 Transportation and Utility Corridors
- 7.3 Consumptive Use
  - 7.3.1 Hunting
  - 7.3.2 Fur Trapping
- 7.4 Development Effects
  - 7.4.1 Mine Complex
  - 7.4.2 Townsite
  - 7.4.3 Transportation and Utility Corridors
  - 7.4.4 Indirect Effects
- 7.5 Mitigation Options
  - 7.5.1 Habitat Manipulation
  - 7.5.2 Wildlife Management
  - 7.5.3 Regulation of Consumptive Use

Objectives

The structure of this chapter is similar to chapter 5.0. The nature of the objectives is almost identical to the former chapter. The final section of chapter 7.0 again includes the provision for the making of recommendations to the provincial government respecting resource management alternatives that the proponent suggests for consideration.

Field Program

The fieldwork to attain the objectives set out for this chapter comprises the comparative evaluation of habitat types of ungulates, the assessment of the relative frequency of other wildlife sign and the presence of birds.

Small mammal trapping will be conducted at the minesite and the townsite.

Interviews will be conducted with wildlife biologists and guides, trappers and other persons with site-specific knowledge of the wildlife resources of the Upper Elk Watershed.

Depending on the conclusions reached during the spring and summer wildlife inventory program, an optional additional information gathering program might be undertaken in the fall. This additional program would focus on hunting activity, including the monitoring of traffic and possibly also interviews with hunters met in the Upper Elk River Watershed area.

Report Content

8.0 Recreation
- 8.1 Existing Recreation
- 8.2 Recreation Capability
- 8.3 Direct Effects of Project on Recreation
- 8.4 Indirect Effects on Project Recreation
- 8.5 Mitigation Options
- 8.6 Recommended Management Objectives
- 8.7 Alternatives
- 8.8 Selected Alternatives
- 8.9 Summary and Conclusions

Objectives

After some considerable discussion within the environmental consulting team and between that team and the proponent, it was decided to treat recreation in the environmental volume. The rationale being that the concern about recreation pressures on the existing environment is of environmental rather than socio-economic nature. In a subsequent volume of the Stage II Report, the recreation needs of the existing and future population of the Upper Elk River Valley will be discussed.

Field Program

The field survey effort in support of this chapter comprises a creel census and possibly traffic counters during seasons for which a high use level of the general area is anticipated.

The socio-economic studies that were commissioned by the proponent also provide for a survey of community opinions relative to recreation demands. It is expected that part of the results of the socio-economic studies will be incorporated in this particular chapter.

Report Content

9.0 Land and Resource Use
- 9.1 Current Use
  - 9.1.1 Minerals and Petroleum
  - 9.1.2 Agriculture
  - 9.1.3 Grazing
  - 9.1.4 Forestry
  - 9.1.5 Wildlife
  - 9.1.6 Recreation
  - 9.1.7 Urban Development
- 9.2 Projected Use
  - 9.2.1 Minerals and Petroleum
  - 9.2.2 Agriculture
  - 9.2.3 Grazing
  - 9.2.4 Forestry
  - 9.2.5 Wildlife
  - 9.2.6 Recreation
  - 9.2.7 Urban Development
- 9.3 Revenue
- 9.4 Development Effects
- 9.5 Mitigation Options
- 9.6 Land Use and Resource Management Objectives
- 9.7 Selected Alternatives
- 9.8 Summary and Conclusions

Objectives

The Guidelines for Coal Development view land and resource use as an integral component of the biophysical appreciation of a project. Similarly to the subject of recreation, we are dealing here with the use potential or actual useage of existing resources. This is a mancentered rather than an environmentcentered subject.

Consequently, there is merit in placing this section either in the analysis of the economic benefits of the project, or in the analysis of the socio-economic effects. In our view, the decisions that need to be taken to resolve competing or conflicting land use modes would be formulated in social and economic terms. Environmentally protective considerations are but one factor recognized in the decision making process.

Field Program

The factual basis for the formulation of management objectives would be comprised in previous chapters of this volume.

III Detailed Terms of Reference of the Socio-economic Studies, Spring 1977, Elk River Coal Project

Elco Mining Limited

April 1977

International Environmental Consultants will undertake the following socio-economic studies and prepare draft reports for inclusion in the Elk River Coal Project Stage II Report to the Government of British Columbia. The content and nature of the studies and reports shall be such as to adequately fulfill the requirements set out in the Coal Development Guidelines published by the Environment and Land Use Committee of British Columbia.

The general objectives for the five task areas, although described below as discrete assignments, are recognized as being interrelated and the studies will be undertaken within the framework of an integrated and suitably coordinated program.

GENERAL TASK OBJECTIVES

I. Economic Benefits

Prepare an analysis of the economic benefits of the Elk River Coal Project to the Elk River Valley, the Kootenay Region, the Province of British Columbia and to Canada. Economic benefits are defined to include income and employment generated. The level of detail of costs and benefits shall permit an assessment of cost sharing responsibilities and the database for intelligent dialogue between various sectors of society relative to cost sharing expectations.

II. Public Consultation and Information

a) Identify the subject areas and audiences or public sectors for whom either public information programs or dialogues would be useful for the design and implementation of the Elk River Coal Project.

b) Formulate a community consultation program for the Elk River Coal Project.

c) Formulate a program for the timely dissemination of accurate and appropriate information to the public sectors.

d) Identify an appropriate schedule for implementing the public information and community consultation programs.

III. Manpower Availability

Inventory and assess the labour markets from which the Project's labour force may be drawn. The assessment will consider qualitative as well as quantitative requirements including training.

IV. Community Development; Social Plan

Identify and evaluate alternative social plans and select that social plan which provides the settlement system most conducive to a stable labour force for the Elk River Coal Project.

V. Socio-economic Impact

a) To inventory the socio-economic features of the region identified to be affected, including socio-economic dynamics.

b) To identify the socio-economic effects of the implementation of the Elk River Coal Project to the extent needed to fulfill the requirements of the ELUC Coal Development Guidelines.

c) To identify the strategy alternatives required to respond to these effects.

d) To select and justify the preferred strategies.

SPECIFIC TASKS

I. Economic Benefits

a) Collate and review all information on expected categories of capital and recurrent expenditures and employment related directly to the Project and all other appropriate economic information.

b) Identify and quantify the probable economic benefits of the Elk River Coal Project including direct and induced employment and income.

c) Identify and quantify as possible the locational incidence of the economic benefits including the local, regional, provincial and national economics as appropriate.

d) Identify and quantify as possible the sectoral and institutional incidence of these economic benefits including personal incomes and government revenues.

e) Identify and quantify the possible economic costs of the project.

f) Review progress with other team members and Elco. This review is scheduled for May 20, 1977.

g) Report findings as discrete chapter contributions to Volume V of the Stage II Report (Economic Benefits and Socio-economic Effects); scheduled for June 30, 1977.

II. Public Consultation and Information

a) Identify the local community leaders to be contacted via Elco.

b) During the period April 17-27, 1977, interview these individuals with Elco, where appropriate, to establish opinions of what are principal subject areas of local concern and who are the people or sectors who shape local opinions that should be subsequently contacted.

c) Summarize the results of these interviews and formulate a detailed plan for approaching local sectors relative to the consultative processes; relative to perceptions of the project; and relative to community input into design and implementation of the project. This summary and plan will be in the form of a Project-Memorandum to the Client.

d) Review with client and reach agreement on the approach to be followed in subsequent interviews. (Review is scheduled for April 29, 1977).

e) Conduct detailed local interviews and identify the areas of public concern; public views of the project; and public views of how a productive community consultation project might be structured.

f) Review results with Elco. (This review is scheduled for May 20, 1977).

g) Formulate and recommend to Elco an appropriate community consultation program including a time schedule and budget and report in letter format to the Client. This report will include the results obtained from Task 5.

h) Formulate and recommend to Elco an appropriate public information program including a time schedule and budget and report in letter format to the Client.

i) Review Tasks 7 and 8 with the Client and revise the reports as agreed. This review is scheduled for June 17, 1977.

III. Manpower Availability

a) From the records of relevant previous Canadian mine development experiences, identify and rank characteristics of an appropriately stable labour force.

b) Survey appropriate candidate labour supply sources and rank according suitability.

c) Develop appropriate criteria to evaluate labour force supply alternatives.

d) Determine, with the Client, the desired labour mix with respect to skill levels. Review of this item is scheduled for April 29, 1977.

e) Recommend the preferred supply sources and state reasons.

f) Report the findings to the Client as discrete Chapter Contributions to Volume IV (Townsite and Community Development) and Volume V (Economic Benefits and Socio-economic Effects) of the Stage II Report. This reporting is scheduled for May 20, 1977.

IV. Community Development - Social Plan

a) From records and other sources for relevant previous Canadian mine development experience, identify and rank characteristics of settlement systems conducive to a stable labour force.

b) Formally review and comment to Elco on the existing preliminary planning study report. This review is scheduled for April 29, 1977 in the form of a Project Memorandum.

c) Formulate social criteria appropriate to evaluate possible alternative settlement systems.

d) Review progress with Elco. This review is scheduled for April 29, 1977.

e) Develop specific social design criteria for community planning.

f) Identify alternative social plans for a settlement system.

g) Review progress with Elco. This review is scheduled for May 20, 1977.

h) Using the agreed upon criteria, evaluate social plan alternatives.

i) Select the most suitable alternative and justify the selection.

j) Report the findings as discrete chapter contributions to Volume IV (Townsite and Community Development) of the Stage II Report; review this contribution with the Client and adjust the draft chapters as agreed with the Client. This reporting and review is scheduled for June 17, 1977.

V. Socio-economic Effects

a) Make fact finding reconnaissance of subject area.

b) Identify, in a general way, the areas anticipated to be affected.

c) Collect and compile all available relevant socio-economic information as per Part 2, Section 2, of the ELUC Coal Development Guidelines.

d) Identify the critical information deficiencies.

e) Document the scope, budget and schedule for further necessary information collection.

f) Reach agreement with Client on any additional work required to fill critical information deficiencies. This review is scheduled for April 29, 1977.

g) Complete the information base as agreed.

h) Verify the significantly affected regions.

i) Project the anticipated effects in these regions and review with the Client. This review is scheduled for May 20, 1977.

j) Formulate management alternatives for critical effects.

k) Select the most appropriate alternatives and justify the selection.

l) Report the findings as discrete chapter contributions to Volume V (Economic Benefits and Socio-economic Effects) of the Stage II Report. Review with the Client and adjust draft contributions as agreed. This reporting and review is scheduled for June 17, 1977.

IV Summary of a Preliminary Assessment of Potential Environmental Effects of the Proposed Road and Rail Routes for the Elk River Coal Project

Elco Mining Limited
April 1977

The Railway Route

The map showing two railway corridors was included in the Stage I Report. Of the two, the Boivin Pass Route is considered to be the most suitable. Further studies are under way to ascertain its technical fesibility in comparison with the west side route. Field surveys have prompted further alterations to the Boivin Pass Route. Included with this Addendum are a series of maps showing the newly proposed location for this railway route. It should be noted that the crossing of the Elk River is now proposed to take place further upstream, near Forsyth Creek, in the vicinity of one of the proposed community development location alternatives. North of Forsyth Creek the railway and the road are now proposed to be placed in one corridor. The separation between the centre lines of both will generally be in the order of several hundred feet, occasionally as the terrain requires this will be reduced to a minimum of one hundred feet.

The Highway Route

The highway is proposed to be located generally following the existing forestry road. Minor changes are proposed to be made to the detailed routing to improve the alignment, particularly for the purpose of reducing the accident potential implied in the rather abrupt curves of the forestry road. A major realignment is proposed just to the south of one of the proposed community development alternatives. This realignment is predicted on the assumption that town development would indeed take place on this site. Should there be no town development here, then the proposed realignment might be reconsidered.

Environmental Assessment

The railway route is generally located above the more sensitive Elk River Valley bottom, except where the line crosses the bridge to the other side of the valley. This crossing, which for engineering and desirable alignment reasons, was located near the proposed townsite alternative, traverses the flood plain of the Elk River at one of its most narrow reaches.

Only minor land form modifications will be required for the construction of both the railway and the road as currently proposed. There are only minor stretches of steep terrain where higher than average side hill cuts or larger than average embankment fills will be required for the railway. For some distance to the north of the proposed townsite development alternative, a high side hill cut will have to be made to accommodate the road and railway. Perusal of the provided topographic base of that particular area readily shows that no acceptable alternative is available other than that selected as per the proposed alignments.

The detailed engineering and field location surveys are insufficiently advanced to stage at this time whether, in general, a balance between cut and fill sections can be achieved. An assessment as to whether and how many disposal areas for excess fill materials and borrow areas for additional fill along other sections will be required, cannot be made at this time.

Highway construction will require a widening of the clearing cut to accommodate the existing forestry road. While removing additional forest cover as a consequence on the one hand, some environmental and aesthetic benefits will also be derived since the practices followed in the clearing operations to construct the forestry access road were not of a standard that is considered environmentally acceptable in this day and age.

Existing land use capability for the area is expressed on the Canada Land Inventory Land Capability Analysis Map indicates that 69 percent of the proposed railway route passes through moderate big game range, 10 percent through high yield forest, while the remainder traverses moderate and limited yield classes.

Fifty-eight percent of the length of the road passes through moderate big game range, 31 percent through high yield forest and the remainder through moderate yield forest.

A winter wildlife survey revealed light use of the valley bottom and very limited use of the west slope of the Greenhills range by elk and moose.

More definitive assessments of the proposed routes can be made once field studies have been completed. Further progress is also dependent upon receipt of the biophysical classification of the corridor, which is being prepared by the Resource Analysis Branch of the Department of the Environment, which is expected in the near future.